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Implementing Cloud-Centric IoT Transformations: Merits and Demerits

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Abstract

This study critically analyzed the merits and demerits of implementing cloud-centric cloud Internet of Things (IoT) transformation in ac manufacturing enterprise that specializes in automobile parts. The objective of cloud computing at AC Manufacturing Inc., a mid-sized business that specialises in car parts, should be accomplished with the intention of either increasing revenue or decreasing the time spent on various tasks. The departments of the entire organisation may operate more simply thanks to cloud computing. On the other side, cloud computing brings up certain issues that might become troublesome regarding reliability, safety, legal responsibility, and credibility. It is thus suggested that the management of AC Manufacturing Inc. embrace cloud computing, but with periodic staff training and retraining, in light of the comprehensive analysis of the merits and demerits of cloud computing.

Keywords: Cloud-centric, IOT, Transformation, Manufacturing enterprise, JEL classification codes: O14.

1 | Introduction

In the last five decades, technology has been advancing, it is now being applied in all human activities. In recent times, the world is heading towards the end of the fourth industrial revolution and the fifth industrial revolution is approaching. The cloud Internet of Things (IoT) is among the basic elements of the fourth industrial revolution (4.0). These days, only desktop, tablet, and smartphone devices may be used to access the internet [1]. According to Koo et al. [2], cloud computing is the term used to describe the Internet-based

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delivery of computer services, as well as servers, databases, storage, software, networking, intelligence, and analytics.

It is necessary to explain the benefits of cloud computing adoption for AC Manufacturing Inc., a mid-sized company that specialises in automobile components. Transferring data, services, applications, and localhost applications to the distributed cloud computing infrastructure. Several elements, such as planning and a review of the effects on ongoing business processes, will dictate the outcome of this data transfer process. One of the most common tasks in a public cloud computing environment is moving locally stored data.

One of the IoT development industries with the quickest growth is the automobile industry. The cloud computing revolution has fundamentally altered the way cars operate in the automobile industry. Engine fuel economy is not the only thing driving demand in the market today. For the last ten years, industry analysts have estimated that there will be 26 billion to 30.73 billion internet-connected items by the end of 2020, with the number of IoT-enabled gadgets expected to reach 75.44 billion by 2025 [3].

The first purpose of the Internet was to facilitate the transmission of information between persons via a network [4], [5]. Then, e-commerce and e-business were the main uses of the Internet as a service [6]. People used social media and several other platforms like Facebook, Skype, Orkut, and YouTube to engage with one another during the internet of people [7].

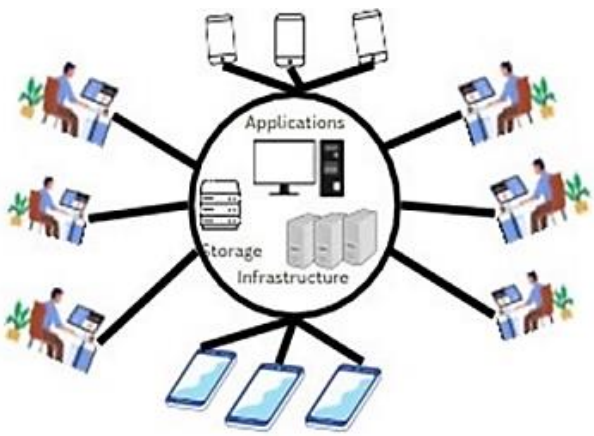
Machine-to-machine (M2M) and human-to-human communication have been the focus of technology up until recently. In this stage, the mechanism facilitates the interfacing of several devices, including wireless devices in a network, sensors, controllers, and other devices, without requiring human intervention [8]. IoT applications are expanding more quickly than previous breakthroughs and goods.

Being in the automotive industry, AC Manufacturing Inc. stands to benefit greatly from cloud computing [9], [10]. The move to cloud computing will probably have a big influence on how the company manages its computer and information resources [11], [12]. Being a worldwide automotive part chain and mid-sized business, the corporation must gain from technological investments. A detailed study must be conducted to identify the primary issues that need to be looked at before switching to the cloud because every company will have a distinct strategy [12].

2|Literature Review

2.1|Opportunities and Challenges When Migrating IT Resources to Cloud Computing

A close substitute to keeping a data centre on a company's property is provided by cloud computing. We are in charge of overseeing every aspect of an on-premises data centre, which includes setting up a data storage area, virtualization, installing the operating system and any other required apps, purchasing and installing hardware, and configuring the network and firewall [13]. The organisation is in charge of overseeing it for the



duration of its existence after the first stage has been finished. *Fig. 1* depicts the general cloud computing procedures.

Fig. 1. General cloud computing procedures, Source: Nigar et al. [14].

A wide spectrum of end users may use the cloud in several ways due to its adaptable IT architecture [15], [16]. When additional users join the system, the cloud provider can instantaneously and dynamically allocate computer resources. Cloud providers utilise a customizable cloud structure that uses very successful management of resources concerning the scale strategy to boost computer resources [17], [18].

2.2 | Challenges When Migrating IT Resources to Cloud Computing

Some of the difficulties that will arise when migrating IT resources to the cloud are illustrated in *Fig. 2*. The majority of the research for AC Manufacturing Inc. in cloud environments focuses on helping the company get beyond challenges brought on by changing workloads and optimising areas that aren't quite working. The following are the most typical challenges related to cloud migration:

I. Not having a clear strategy based on business objectives.

II. Cloud sprawl brought on by a lack of knowledge about the entire range of cloud environments.

III. Going over budget.

IV. Security chinks and critical service failures.

V. Human error and insufficient expertise to activate, control and manoeuvre the latest infrastructure.

Fig. 2. Challenges of cloud computing, Source: Nigar et al. [14].

2.3 | Costs Management

Chieu et al. [19] evaluated corporate personnel and found that organisations move to the cloud without doing a proper project assessment, which results in an erroneous cost projection. Furthermore, the management believed that since cloud environments are dynamic, costs may rise out of nowhere should the business decide to add new services or extend its application base [20]. Experts advise beginning with the application's least-used services rather than its most-used ones because data migration is a slower process where organisations may save money [21].

2.4 | Right Performance and Quality

The quality, reliability, and performance of cloud apps can be regarded as basic factors in determining the success of a seamless transfer [22]. Hence, characteristics such as quick access and the least amount of downtime must be thoroughly examined before making arrangements for migration [9].

2.5 | Lack of Resources or Expertise

One of the major problems with cloud computing is a lack of resources or experience [23]. Due to the considerable advancements in cloud computing, organisations are quickly moving their workloads to the cloud [23]. These problems make it harder for firms to maintain their equipment and raise the demand for expertise. Enhancing the IT team's training can help reduce the following issues.

2.6 | Control

Control is among the major issues conflicting consumers in cloud computing. When IT is properly managed, agreed policies are followed, and the right IT resources are deployed and used [24]. Verify that these resources are in good operating order and that necessary maintenance has been performed; moreover, confirm that these resources complement the organization's planning and operational objectives [25]. Organisations do not now have total control over operations, DE-provisioning, or infrastructure provisioning in the Cloud World. Best practices and control assistance are offered by third-party Cloud Service Providers (CSPs) [26].

2.7 | Internet Connectivity

Services provided by cloud computing rely only on a reliable, fast internet connection. Thus, the mid-sized company AC Manufacturing Inc. may experience connectivity issues and needs to make a large investment in internet connections to ensure success [27].

2.8 | Security, Compliance, and Risks When Migrating IT Resources to Cloud Computing

Regardless of whether the systems and apps are hosted on-site or in the cloud, a variety of business types and the sectors they operate in may demand varying degrees of security and compliance validation requirements [25]. "The cloud" refers to a new way of supplying computing resources rather than a new technology. On the one side, fraudsters could find a large concentration of resources and shared infrastructure more alluring, especially when paired with publicly accessible cloud administrative APIs. However, cloud-based security solutions may also be more affordable, scalable, and resilient than other options.

Many benefits, including reduced capital costs, flexibility, and durability, draw businesses to cloud computing. However, there could be both favourable and unfavourable consequences for safety [28]. Because a third party, the cloud provider, is providing services on behalf of the organisation, a new paradigm of shared responsibility arises when deploying a cloud strategy. Although the CSP is in charge of cloud security, organisation managers are also accountable for managing security within the cloud. Rather than putting their faith in the CSP to handle security, management ought to investigate exactly what is under their jurisdiction [29].

3 | Structures, Services and Deployment Models

The three biggest public cloud providers, also referred to as hyperscalers or GCPs, are Microsoft Azure, Amazon Web Services (AWS), and Google Cloud Platform [30]. These three providers' remarkable rise over the preceding five years is a clear sign of the growing trajectory of cloud usage. AWS continues to lead the industry in terms of both market share and the range of services it provides. Azure, on the other hand, has proven to be the second that is gradually closing the distance. Azure is the most extensively used cloud platform among businesses, while Google Cloud, which offers massive platforms for enterprises, is the fastest-growing of the Big Three and is recognised as a pioneer in the field [31].

3.1 | Types of Service Models

Public cloud providers often offer three different cloud computing service models.

3.1.1 | Software as a Service (SaaS)

All SaaS solutions are usually cloud-based and may be accessed through an app or a web browser. The end user should only worry about the data saved on the application. the underlying operating system, virtual operating system, or physical infrastructure are all taken care of by the cloud provider. Also, the program's software is handled by them. Popular programs for SaaS programmers include Google Workspace, Microsoft 365, and Salesforce, to name a few [32].

3.1.2 | Platform as a Service (PaaS)

PaaS modify Infrastructure as a Service (IaaS) concepts. According to Giessmann and Stanoevska-Slabeva [33], end users are not in charge of maintaining the virtual machines that are a component of the operating systems that run on them. Instead, customers devote their time and energy to the deployment and upkeep of their apps, that is, applications built on top of the PaaS service. According to Devi and Ganesan [34], this feature enhances market speed by enabling end users to access certain application services more quickly, all the while reducing operational complexity. Services that are included in the PaaS category include Microsoft Azure Web Apps, Google App Engine, and Amazon Elastic Beanstalk.

3.1.3 | Infrastructure as a Service (IaaS)

Since it offers a cloud-based service that can be accessed whenever needed, IaaS, or IaaS, is the most significant aspect of cloud computing. Independent access to computer resources, such as virtual resources (used to operate virtual machines) and dedicated hardware, storage, and networking resources, enables the provision of an on-demand, cloud-based service. This has led to a large number of clients using cloud computing for the first time [31].

Although these resources have some resemblance to well-known on-premises technology, the end user just pays for the usage of the resources (virtual computers, for example), with the cloud platform provider managing the underlying infrastructure [35]. Specifically, Google Cloud Platform (Compute Engine), Microsoft Azure Virtual Machines, and Amazon Elastic Compute Cloud (EC2) are popular IaaS computing platforms. The summary is shown in *Table 1*.

Table 1. Summary of cloud computing services delivery models.

Software-as-a-Service Merits	Platform-as a-Service	Infrastructure-as-a-Service
This paradigm is for the dissemination of software.	These are some of the development tools and applications that are housed on the provider's servers.	Under the pay-per-use model, which is a single-tenant arrangement, the cloud computing service provider allows resources that are exclusively shared with customers who have signed contracts.
Through a network, it enables the user to access apps hosted by service provider infrastructure.	It provides programmers with a platform on which to create their apps without worrying about the infrastructure supporting the service.	AWS, Google Compute Engine (GCE), Microsoft Azure, and Cisco Meta-cloud are a few examples of this paradigm.
Customers in this approach, who are mostly end users who subscribe to ready-to-use apps, receive software.	It makes it easier to manage the software development life cycle effectively, from planning to maintenance.	It lessens the requirement for a sizable upfront expenditure on servers, networking equipment, and processing power.
It corresponds to a pay-as-you-go.	Programming languages, including Java, Python, and Net, are used by the platform.	Moreover, the model can efficiently and rapidly increase or release computational resources.
It provides cloud users with a service that lets them use the program	Today's developers and programmers rely on its products, WordPress, GoDaddy, and AWS.	Determining the boundaries of security accountability is often challenging due

from a web browser without any complicated setup, upkeep, or expensive startup costs.		to the proliferation of cloud delivery methods.

Table 1. Continued.

Software-as-a-Service Merits	Platform-as a-Service	Infrastructure-as-a-Service
It raises user consciousness of security. Real-world SaaS apps include Microsoft Office 365, DropBox, Salesforce, Google Apps, and Cisco Webex.	With the PaaS technologies, users may develop unique apps.	Security is the joint responsibility of clients and CSPs.
Critical Issues		
Insecurity and unauthorized usage are on the high.	Certain programme development environments, like C++, are notorious for their memory management, which provides attackers with a window of opportunity to launch many assaults, including stack overflow. Attackers might take merit of some RDBMSs, like Oracle, that have improper authentication inherited from them, allowing users who have authenticated at the OS level to access databases with administrator capabilities without a username or password.	Two popular ways for attackers to target infrastructure are denial of service (DoS) assaults and malware, and most of the time
Mitigations		
Security measures like multi-factor authentication, password complexity, and retention must be enforced by the SaaS provider.	Developers must adhere to security standards and best practices while developing applications.	As the first line of defence defending the system's perimeter, the infrastructure utilised by consumers must be secure.
SaaS providers must have procedures in place to safeguard user data and guarantee that it is always available for authorised usage.	Developers must test and fix any flaws that hackers may use to access user data and compromise systems.	The service provider is in charge of the model security.

3.2|Types of Deployment Models

Currently in use are four fundamental categories of cloud computing deployment strategies.

3.2.1|Private cloud

This is often referred to as internal cloud. The term "private cloud" refers to a version of the on-premises IT infrastructure that includes certain elements of public cloud computing. Self-service, semi-automated, and resource usage are some of these attributes. For internal use, it is frequently privately owned and operated by a single organisation or a business [31].

It is essential to keep in mind that customers' private clouds can be housed on their property, in their own data centre, on a third party's property as a co-location facility, or even at a local service provider as a managed service offering. There are benefits and drawbacks to each of these choices [36]. Many business clients would rather continue to use private clouds that are operated by specialised IT teams and housed in their data centres. According to Li et al. [37], these teams are in charge of the day-to-day administration of the infrastructure platform as well as its provisioning and procurement [38].

3.2.2 | Public cloud

This is also referred to as external cloud. The hyperscalers or large CSPs own and control the public cloud. It is a globally distributed shared Information Technology (IT) infrastructure with logical partitions to protect the security and privacy of many tenants. This type of service provider creates and builds scalable platforms and guarantees the presence of logical security barriers so that their clients may use these environments risk-free. Independently and without assistance from humans [39].

3.2.3 | Hybrid cloud

Hybrid clouds are created when deployment frameworks for public and private clouds are integrated. In this instance, clients receive an IT solution that is more tailored to the requirements of every department or line of business inside the organisation, giving them access to the greatest aspects of both. According to Singh [40], hybrid cloud administration is incredibly flexible, enabling users to meet strict requirements like data sovereignty and security without sacrificing the public cloud's benefits like innovation, cost-effectiveness, and scalability. However, only the most demanding clients, such as major organisations, may find a hybrid cloud approach applicable due to its operational complexity [40].

3.2.4 | Multi or community cloud

Even if it is debatable, the multi-cloud method focuses primarily on integrating several public cloud-hosted platforms (at least two or more), with or without the involvement of private clouds. This structure's implementation is essentially a specific type of hybrid cloud technology. This objective can be accomplished with or without the use of private clouds. According to Singh [40], it is the deployment of applications across several cloud platforms that are managed by utilising a heterogeneous structure and governance style among all CSPs. The summary of deployment model types is shown in *Table 2*.

Table 2. Summary types of cloud computing deployment models.

Indices	Deployment models			
	Private cloud	**Public cloud**	**Multi or community cloud**	**Hybrid cloud**
Users	Single user, group, or institution	All users or large groups of users via the Internet	Communities that have similar goals and concerns, such as security	Variability in an organization's needs
Operations	Third-party or service providers may work on-site or off-site	CSPs	Institutions directly, through an off-site or on-site third party.	A combination of two or more deployment models.
Cost	Cotly	Cost-effective and elastic ways of deploying IT solutions	Costly	Costly
Security	Less secure as a result of the insufficient resources and knowledge allocated to the systems and services. Malevolent entities execute assaults by taking merit of the inadequately protected elements.	Less secure since there aren't as many resources and experts available for the systems and services. The services and systems hosted by the cloud are	Higher criteria for policy compliance, privacy, and protection. Community cloud security depends on how informed the community is of security issues.	Cloud hybridization carries a number of security issues. Attackers use weaknesses in one or more clouds to gain access to the entire system.

	subject to several security risks when connected to the internet.

4 | Discussions

4.1 | Concept of Virtualization in the Context of Servers, Storage, and Network Systems

The process of creating digital replicas of real-world equipment, including servers, storage systems, and networks, is known as "virtualization" [41]. Virtual software that mimics the capabilities of actual hardware allows several virtual machines to run concurrently on a single physical computer. Through virtualization, companies may obtain greater returns on their investments and optimise how well they use their hardware resources [41].

The management of AC Manufacturing Inc. will have more freedom in how the company interacts with any chosen hardware resource if the company employs virtualization. Physical servers need to be maintained and cleaned, and they need to use energy and storage space. If it becomes necessary to access them, the alternatives are sometimes limited by things like network architecture and physical closeness. Because virtualization abstracts the functions of real hardware into software, it can get around all of these limitations. When linked to the internet, physical infrastructure may be utilised, updated, and controlled similarly to an application. Consider the case of AC Manufacturing Inc., a company that sells automobile parts and needs servers for the following three purposes:

I. Keeping track of corporate emails securely.

II. Keeping up with a customer-facing application.

III. Performing tasks on company-related apps.

4.2 | Efficient Hardware Use

The company was able to create three virtual machines, or digital servers, on a single physical server by utilising virtualization technology. It establishes the operating system requirements for virtual machines and can use them in the same way as physical servers. But they now own fewer pieces of equipment, which has reduced related expenses.

4.3 | Infrastructure as a Service

The management of an automotive manufacturing firm may go a step further and utilise a virtual machine or cloud instance provided by a cloud computing service provider like AWS. All underlying hardware maintenance is within the purview of AWS, and the organisation is free to request server capacity in a range of configurations.

5 | Merits of virtualization

There are several merits of virtualization to business, among are:

5.1 | Efficient Resource Utilization

Virtualization may help the company data centre make better use of its hardware resources. Less money will be spent on electricity, cooling equipment, and generators, among other utilities [31].

5.2 | IT Administration that is Fully Automated

With the advent of virtualization, computers may now be controlled through a variety of software programs. Creation, configuration and deployment of scripts to create virtual machine templates is the responsibility of managers. By minimising human settings that are prone to error, the management can regularly duplicate the infrastructure and preserve its integrity [36].

5.3 | Accelerated Catastrophe Recovery

More time is spent to regain access to the IT infrastructure and replace or fix a physical server when external factors, including natural disasters or cyberattacks, negatively affect a company's activities [32].

5.4 | Strategies for Migration, as Well as the Benefits of Cloud-Based Service for Business Applications

Before starting the relocation process, every organisation must finish all necessary preparations. Each cloud provider has its own set of methods for migrating to the cloud [36]. These cloud migration techniques can be modified to match AC Manufacturing Inc.'s cloud migration plan. The most crucial part of this procedure is to always keep the company's clients and other end users in mind at every stage of the move. Below are listed strategies for migration:

I. Conduct a thorough analysis of the existing IT infrastructure to identify areas where cloud migration can yield the most significant cost savings.

II. Consider leveraging cloud-native services and serverless architectures to optimize resource utilization further and reduce costs.

III. Regularly review and optimize the cloud resource allocation based on usage patterns and demand fluctuations.

IV. Implement robust monitoring and cost management tools to track and control the cloud expenditure effectively.

V. Explore different pricing models offered by cloud providers, such as reserved instances or spot instances, to find the most cost-effective options for the company workload.

The benefits of cloud-based services for business applications are:

I. It enhances quick innovation for businesses in a saving manner.

II. It helps businesses navigate resource consumption as the tools can significantly increase operational efficiencies.

III. At present, businesses with a myriad of cost-reduction opportunities.

IV. CSPs operate massive data centres and serve a large number of customers simultaneously. This enables them to spread their infrastructure costs across multiple clients, resulting in lower overall costs for each business.

V. With cloud computing, businesses no longer need to worry about hardware upgrades, software updates, security patches, and other routine maintenance tasks. These responsibilities are taken care of by the CSP, allowing businesses to focus their resources and efforts on core competencies.

6 | Critical Issues in Configuring/Setting up the Cloud Environment with Locally-Based Resources

The automobile components company AC Manufacturing Inc. is a shining illustration of how cloud computing allows for affordable scalability. The business required a flexible infrastructure to meet the demands of its growing user base as it expanded quickly. AC Manufacturing Inc. was able to scale its resources

up or down in response to client demand by moving to the cloud, which increased performance and cut expenses.

6.1|Experience from Practical

While establishing and configuring cloud environments and virtual machines, important concerns affecting the efficacy, security, and performance of IT infrastructure must be taken into consideration. I participated in a workshop where we configured a cloud environment for a web application in collaboration with a well-known CSP. Performance issues resulted from inefficient resource allocation spurred on by a rise in user demand. It was not evident from the setup how various workloads would be managed.

This underscored how important it is to plan for resource provisioning and scalability to avoid underperformance or disruptions during spikes in demand. The session emphasised the significance of dynamic scaling features, such as auto-scaling groups, to maximise resource utilisation. The significance of fully understanding application usage patterns and making use of cloud-native capabilities to facilitate automated scaling was underlined. It was necessary to undertake capacity planning and load testing early in the setup process to identify possible bottlenecks in scalability and to provide a robust and responsive cloud environment.

6.2|Criteria for Comparison

The comparison between the deployment of cloud resources and locally-based IT resources is shown in *Table 3*.

Table 3. Comparison between cloud solution and locally based IT infrastructure.

Business related indices	Cloud infrastructure solution	Locally based IT infrastructure
Leveraging Scalability	Cloud services allow organizations to scale their resources up or down based on demand, enabling them to pay only for what they use. This flexibility translates into significant cost savings as businesses no longer have to bear the burden of maintaining idle resources.	With traditional on-premises infrastructure, businesses often have to invest in expensive hardware and software licenses to accommodate peak workloads, leading to underutilization during non-peak periods.
Optimizing IT Infrastructure	By offloading the responsibility of managing physical servers and data centres, organizations can eliminate the need for in-house IT staff, saving on salaries, benefits, and training costs.	In this case, the organization incurs associated costs of managing physical servers and data centres, in-house IT staff, and training costs.
Minimizing capital expenditure	Cloud computing offers an attractive alternative by shifting the cost burden from capital expenditure to operational expenditure. Instead of investing in expensive hardware and software licenses, businesses can subscribe to cloud services on a pay-as-you-go basis, spreading the costs over time. This not only allows AC Manufacturing Inc. and other similar enterprises to access enterprise-grade technology at a fraction of the cost but also enables them to allocate their limited resources more efficiently.	Traditional IT infrastructure often requires significant upfront capital expenditure, making it a barrier for many medium-sized enterprises such as AC Manufacturing Inc.

Reliance on infrastructure	This eliminates the need for maintaining on-premises infrastructure and allows organizations to scale their operations seamlessly as per their requirements.	Reliance on physical servers or personal computers, businesses can access and utilize a shared pool of computing resources, including servers, storage, databases, software, and networking, through the cloud cost time.

7 | Conclusion

The objective of cloud computing at AC Manufacturing Inc., a mid-sized business that specialises in car parts, should be accomplished in this project with the intention of either increasing revenue or decreasing the time spent on various tasks. The departments of the entire organisation may operate more simply thanks to cloud computing. On the other side, cloud computing brings up certain issues that might become troublesome regarding reliability, safety, legal responsibility, and credibility. It is thus recommended that the management of AC Manufacturing Inc. embrace cloud computing, but with periodic staff training and retraining, in light of the comprehensive analysis of the merits and difficulties of cloud computing.

Advanced algorithms have been put in place by AC Manufacturing Inc. to examine user traffic patterns and automatically modify the way cloud resources are allocated. Through the use of this strategy, MC Manufacturing Inc. has been able to reduce its infrastructure expenditures, leading to considerable savings considerably. The corporation stated that its cloud migration has resulted in yearly savings of millions of dollars, demonstrating the cloud's ability to save costs.

Author contribution

AOA: conceptualization, Writing–original draft, Supervision.

SIO: resources, Writing–review & editing.

AAA: writing–original draft, Introduction, Discussions.

MAO: resources, Writing–review & editing; The authors read and approved the final manuscript.

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Conflicts of Interest

The author declares that there is no competing interest.

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