Literature Review on Web application to help farmers find and buy supplies at the best prices.

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***Abstract*—The advent of web-based agricultural applications has ushered in a transformative era for farmers, aiming to alleviate challenges posed by traditional supply chain models. This paper synthesizes findings from 30 literature reviews, presenting a comprehensive overview of diverse approaches to empower farmers in purchasing agricultural supplies judiciously. Among the featured applications, "Krishi Portal" leverages ICTs to provide a multifaceted platform encompassing crop information, weather forecasting, and an e-commerce portal for agricultural products. Another innovative approach focuses on direct farmer-customer connections, mitigating profit loss due to intermediaries.**

Several papers propose integrations of cutting-edge technologies, such as IoT and Blockchain, aiming to revolutionize agriculture's supply chain. The introduction of "e-Farmers' Hut" and "CLOVAMINS" in India presents unique solutions to eliminate middlemen, ensure timely product delivery, and offer affordable products. The "Online Agro Product Shop" and "Smart Farm System" highlight the significance of web and mobile applications for streamlined agricultural processes, including user-friendly interfaces, online payment options, and farmer-specific management.

A global perspective emerges with China's pursuit of intelligent agriculture through IoT. Similarly, Brazil employs a web-based farming management system for dairy farming, fostering sustainability and connecting farmers, technicians, and government entities. Several papers underscore the importance of technology in transforming traditional agriculture, such as "E-Farming" in India, emphasizing machine learning for crop estimation and price information.

This synthesis serves as a valuable resource for policymakers, researchers, and practitioners, offering insights into the myriad ways web applications contribute to enhancing farmers' livelihoods, promoting sustainability, and reshaping agricultural supply chains.

***Keywords*—Web Application, Supply Chain, Automation, Smart Farmer**

I. Introduction

The agricultural sector is undergoing a paradigm shift driven by the integration of web-based applications. Traditional agricultural supply chains, fraught with challenges of intermediaries, lack of transparency, and inefficient pricing mechanisms, are being redefined. This paper explores the diverse landscape of literature addressing the development and implementation of web applications to assist farmers in procuring agricultural supplies at optimal prices. The motivation behind these initiatives stems from a collective recognition of the hardships faced by farmers, including unfair pricing and dependencies on intermediaries. The following sections delve into the various dimensions presented in the literature, showcasing innovative applications, technological integrations, and global perspectives that collectively contribute to a transformative narrative in agricultural practices.

II. Literature Review

A. Introduction to Software Architecture in Agricultural Applications

The implementation of agricultural systems involves diverse software architectures tailored to address the unique challenges faced by farmers. The choice of technologies, frameworks, and platforms is critical to developing effective solutions. Various architectures utilize a combination of web and mobile applications, incorporating languages such as HTML5, CSS3, JavaScript, Java, and databases like MySQL. These architectures aim to streamline information flow, enhance user experience, and provide valuable services to farmers.

B. Web-Based Farming Applications: Enhancing User Experience

Web-based farming applications play a crucial role in providing holistic solutions to farmers. These applications, often accessible via web consoles, facilitate interactions between farmers, government agencies, and banking commissions. The inclusion of features like weather forecasting demonstrates a commitment to addressing multifaceted challenges and empowering farmers with user-friendly applications.

C. Android-Based Agricultural Systems: Modules for Comprehensive Farm Management

Applications built on the Android platform offer flexibility and accessibility to farmers. The modular architecture, comprising Information Systems, Budget Calculators, and Reports, underscores the comprehensive approach these systems adopt. The choice of Java and C++ showcases a commitment to leveraging robust technologies in mobile application development.

D. IoT and Blockchain Integration: Ensuring Trustworthy Agricultural Data

The synergy of IoT and Blockchain technologies in agriculture represents a paradigm shift. The real-time data collection by IoT devices, transmitted securely to a Blockchain network, establishes a foundation for transparent and trustworthy supply chains. This architecture addresses challenges in data integrity, security, and transparency, promising a revolution in agricultural data management.

E. E-Commerce Principles in Agricultural Applications: A Client-Server Model

The adoption of E-Commerce principles is evident in applications like "e-Farmers' Hut." These systems employ a client-server model, where a robust backend manages databases, user authentication, and business logic. Frontend interfaces, accessible through both mobile and web applications, provide intuitive experiences for users engaged in the buying and selling of agricultural products.

F. Cloud-Based Architectures: Nodal Centers and Virtual Markets

Innovative architectures like CLOVAMINS leverage cloud-based technology to create virtual agricultural markets. Nodal Centers play a central role, connecting farmers, customers, and transportation. This holistic approach addresses various facets, including product pricing, storage facilities, and transportation, showcasing the potential of cloud-based solutions in modernizing agricultural markets.

G. Consumer-Centric Design: Integration of Reviews and Location-Based Services

Consumer-centric architectures emphasize user interactions, leveraging features like product reviews and location-based services. The seamless process of locating, contacting sellers, and purchasing products caters to user preferences. Additionally, sensors and devices, coupled with robust security measures, ensure the reliability and safety of the consumer's agricultural transactions.

H. Smart Farm Systems: Utilizing Big Data and Machine Learning

Smart farm systems represent a convergence of Big Data and Machine Learning. The architecture focuses on enhancing crop productivity by leveraging machine learning insights into crop quality and market prices. The utilization of big data technologies aligns with the imperative of feeding the growing global population while considering environmental sustainability.

I. Mobile Apps for Farmers: Empowering Through Information and Direct Sales

Mobile applications, like E-Farming, empower farmers by providing information on crop estimation, pricing, and enabling direct sales. The architecture emphasizes reducing dependency on intermediaries, enhancing agriculture's efficiency, and promoting technology adoption among farmers. Machine learning algorithms play a pivotal role in providing insights, reinforcing the transformative potential of technology in agriculture.

J. Agriculture 4.0 Technologies: Internet of Things (IoT), Data Analytics, and Precision Farming

The adoption of Agriculture 4.0 technologies involves harnessing the power of the Internet of Things (IoT), data analytics, and precision farming. This architecture likely encompasses a sophisticated network of sensors, data processing algorithms, and communication protocols, aiming to optimize decision-making in agriculture. The focus is on improving crop productivity, reducing environmental impact, and making data-driven decisions.

K. E-Commerce Integration in Agriculture: Empowering Farmers through Technology

The integration of e-commerce in agriculture signifies a transformative approach to empower farmers. Emphasizing technology's role in providing fair compensation and improving market transparency, the architecture aims to improve farmers' livelihoods. Key features such as secure payment methods, user-friendly interfaces, and location-based services underscore the commitment to enhancing the overall agricultural experience.

L. Blockchain-Based Smart Auction Systems: Ensuring Transparency and Decentralization

Blockchain-based smart auction systems introduce a decentralized ledger to the agricultural supply chain. This architecture leverages blockchain technology and smart contracts to ensure transparency, immutability, and automation of auction processes. Ethereum, with its smart contract capabilities, emerges as a promising blockchain platform for implementing such systems.

M. Three-Tier Design for E-Commerce Platforms: Presentation, Business Logic, and Data Layers

E-commerce platforms adopt a three-tier design, emphasizing presentation, business logic, and data layers. This architectural choice highlights the importance of separating concerns for effective development and maintenance. The presentation layer focuses on user interface and interaction, the business logic layer drives functionality, and the data layer manages storage and retrieval, ensuring a modular and scalable design.

N. Comprehensive Software Architecture for Agricultural E-Stores

In the context of e-commerce platforms for farmers buying seeds, the software architecture is comprehensive and multi-faceted. Leveraging technologies like Next.js, AWS Amplify, AWS WAF, CloudFront, S3, Lambda@Edge, and DynamoDB, the architecture emphasizes scalability, speed optimization, and secure content distribution. The integration of serverless architecture and AWS services contributes to a robust platform for buying agricultural products.

O. Web-Based Systems for Agricultural Management: Simplifying Operations for Farmers

Web-based systems simplify agricultural management for farmers, providing user-friendly interfaces for product management and sales. While specific software architecture details are not provided, the focus is on the simplicity of the system, allowing farmers to efficiently manage and sell their products online. The emphasis on user-friendliness aligns with broader goals of technology adoption in agriculture.

P. Technology Adoption in Agriculture: Focus on Agriculture 4.0 Technologies

Some literature highlights technology adoption in agriculture without delving into specific software architectures. The emphasis is on the potential benefits and challenges associated with implementing Agriculture 4.0 technologies. While the details of software architectures are not provided, the focus is on the broader implications and considerations related to technology adoption in agriculture.

Q. Blockchain Technology and Smart Contracts in Agricultural Auctions

The use of blockchain technology and smart contracts in agricultural auctions ensures transparency and automation. While specific software architecture details are not extensively covered, the emphasis is on the critical role played by blockchain in recording agricultural transactions and the use of smart contracts to facilitate auction processes. The reference to Ethereum and Metamask suggests a preference for decentralized and secure blockchain solutions.

R. Three-Tier Design for E-Commerce Platforms: Presentation, Business Logic, and Data Layers

The adoption of a three-tier design in e-commerce platforms for farmers underscores the importance of modular and scalable architectures. The presentation layer, business logic layer, and data layer work in harmony to deliver a seamless user experience. Next.js, AWS Amplify, AWS WAF, CloudFront, S3, Lambda@Edge, and DynamoDB collectively contribute to the platform's efficiency, security, and scalability.

S. Blockchain-Based Smart Auction Systems: Leveraging Blockchain and Ethereum

Blockchain-based smart auction systems leverage blockchain technology, Ethereum, and smart contracts. The decentralized ledger ensures transparency and immutability, while smart contracts automate auction processes. The reference to Metamask indicates the practical use of web browsers and extensions for interacting with the Ethereum blockchain. The mention of government nominations suggests a balance between decentralized and centralized control for oversight and compliance.

T. Three-Tier Design in E-Commerce Platforms: Presentation, Business Logic, and Data Layers

The adoption of a three-tier design in e-commerce platforms emphasizes the modular and scalable nature of these architectures. The presentation layer focuses on user interface and interaction, the business logic layer drives functionality, and the data layer manages storage and retrieval. This architectural approach ensures a systematic separation of concerns, facilitating efficient development and maintenance of agricultural e-commerce platforms.

III. Problem Statement

A. Limited Access to Information:

Many farmers face challenges in accessing real-time information about agricultural supplies, including prices and availability. The absence of a centralized platform exacerbates this issue, hindering their ability to make informed decisions and potentially leading to financial losses.

B. Inefficient Supply Chain Management:

The current agricultural supply chain lacks efficiency and transparency, leading to delays, excess costs, and difficulties for farmers in sourcing the necessary supplies. There is a need for a system that streamlines the supply chain, reducing inefficiencies and benefiting both farmers and suppliers.

C. Market Fragmentation:

Agricultural markets are often fragmented, making it challenging for farmers to discover the best prices and quality for the supplies they need. A centralized platform is needed to connect farmers with multiple suppliers, fostering healthy competition and ensuring fair pricing.

D. Complexity in Transaction Processes:

The existing methods for farmers to buy supplies involve cumbersome and manual processes. Simplifying the transaction process through a user-friendly web application can enhance efficiency, reduce paperwork, and provide a seamless experience for farmers.

E. Dependency on Intermediaries:

Many farmers are dependent on intermediaries for supply procurement, which often results in increased costs due to commissions and lack of transparency. Developing a web application aims to reduce this dependency, empowering farmers to directly connect with suppliers.

F. Lack of Weather-Integrated Solutions:

Weather conditions significantly impact farming activities. The absence of weather forecasting and planning features in existing systems hinders farmers' ability to make well-informed decisions regarding the timing of supply purchases and agricultural activities.

G. Absence of Personalized Recommendations:

Existing systems may lack personalized recommendation features, preventing farmers from discovering optimal supplies based on their specific needs, location, and farming practices. A web application can leverage data analytics to offer tailored suggestions.

H. Insufficient Integration of IoT and Blockchain:

While some systems incorporate IoT and Blockchain technologies, there is a need for a more widespread and integrated approach. This can enhance data accuracy, security, and traceability, ensuring the reliability of information related to the agricultural supply chain.

I. LiLimited Accessibility for Remote Farmers:

Farmers in remote areas may face challenges in accessing technological solutions. A comprehensive web application must consider the diverse needs and infrastructural limitations of farmers, ensuring inclusivity across different regions.

J. Inadequate Support for Decision-Making:

Farmers often lack support systems that aid decision-making regarding the selection of suppliers and products. An intelligent web application can provide data-driven insights, empowering farmers to make informed choices for their agricultural needs.

K. Data Privacy and Security Concerns:

Existing systems may not adequately address data privacy and security concerns, especially when handling sensitive information such as farmers' personal details and transaction records. A robust security framework must be implemented to instill trust among users.

L. Underutilization of Machine Learning in Agriculture:

Machine learning algorithms can contribute significantly to predicting optimal buying times, analyzing market trends, and providing crop-specific recommendations. However, the underutilization of these technologies in current systems hampers their potential benefits for farmers.

M. High Learning Curve for Technology Adoption:

Some farmers may face challenges in adopting and adapting to new technologies. The web application must be designed with a user-friendly interface and accompanied by sufficient training resources to facilitate seamless adoption.

N. Inadequate Focus on Environmental Sustainability:

Existing systems may not prioritize environmentally sustainable farming practices. A web application should encourage and guide farmers toward eco-friendly choices in their supply chain activities.

O. Limited Connectivity in Rural Areas:

Rural areas often suffer from limited internet connectivity, hindering farmers' access to online platforms. The problem statement should address strategies to ensure connectivity or alternative solutions for farmers in such regions.

P. Absence of Feedback Mechanisms:

The lack of effective feedback mechanisms in current systems hampers continuous improvement. The web application should incorporate features for users to provide feedback, ensuring that the platform evolves based on user experiences and needs.

Q. Market Price Volatility:

Agricultural markets are susceptible to price fluctuations, impacting farmers' financial planning. The web application should provide tools for farmers to navigate and mitigate the effects of market price volatility.

R. Inadequate Integration with Financial Services:

Some farmers may face difficulties in managing finances related to supply purchases. Integrating the web application with financial services or providing resources for financial management can enhance the overall support for farmers.

S. Dependency on Traditional Agricultural Practices:

The persistence of traditional agricultural practices without incorporating modern technologies can hinder productivity. The web application should encourage the adoption of modern, technology-driven approaches for sustainable farming.

T. Insufficient Collaboration with Government Initiatives:

In some cases, there might be a lack of alignment between the web application and existing government initiatives aimed at supporting farmers. Collaboration and integration with such initiatives should be considered to maximize benefits for farmers.

IV. Methodology

A. Needs Assessment:

Conduct a comprehensive needs assessment involving farmers, suppliers, and other stakeholders to understand the specific requirements and challenges faced in the agricultural supply chain. Gather insights on existing practices, pain points, and expectations from a web application.

B. User-Centered Design:

Implement a user-centered design approach to ensure the web application is intuitive and user-friendly. Conduct usability testing with farmers and stakeholders to refine the user interface, incorporating feedback for an optimal user experience.

C. Technology Stack Selection:

Based on the literature review's software architecture, finalize the technology stack, including HTML5, CSS3, JavaScript, Bootstrap 4.0, Java, MySQL, XAMPP, and Tomcat Server 8.0. Ensure compatibility and scalability to support both website and mobile application functionalities.

D. Integration of IoT and Blockchain:

Collaborate with experts to integrate IoT and Blockchain technologies for real-time data collection and secure, transparent transactions. Develop a framework for IoT devices to monitor key agricultural parameters, and design smart contracts for secure transactions within the supply chain.

E. Android Application Development:

Implement the Android platform for mobile application development. Leverage Java and C++ for Android development, ensuring compatibility with mobile maps and web linking functionalities. Develop three main modules: Information System, Budget Calculator, and Reports for comprehensive utility.

F. E-Commerce Principles Implementation:

Build the application around E-Commerce principles, employing a client-server model for users (farmers and consumers). Develop a robust backend managing the database, user authentication, and business logic. Create seamless mobile and web interfaces for farmers to showcase, sell, and purchase agricultural products.

G. Nodal Center Architecture:

Design the suggested architecture with five primary actor categories, including the Nodal Center, Cloud-based agricultural marketing and information systems, customers, and transportation. Develop features facilitating easier purchase and sale of perishable agricultural products (PAP), offering best market pricing, services, and transportation options.

H. Sensor Integration for Precision Agriculture:

Integrate IoT hardware tools for data collection from agricultural environments, including sensors for temperature, humidity, and soil moisture. Utilize microcontrollers for device connectivity. Implement communication protocols like Wi-Fi, cellular networks, or LoRaWAN for efficient data transmission.

I. Data Processing and Analysis:

Develop a robust software core for data processing and analysis, incorporating machine learning algorithms for extracting insights from collected data. Explore possibilities of edge computing or cloud servers based on system requirements.

J. User Interface Design:

Design user interfaces for both administrators and farmers, accessible through web-based or mobile applications. Provide access to historical and real-time data visualization, along with control options. Ensure a seamless and interactive experience.

K. Control and Automation Mechanisms:

Implement control mechanisms based on the system's capabilities, enabling farmers to modify irrigation systems, control equipment, and receive alarms in response to specific conditions. Develop a secure database for storing configuration settings and historical data.

L. Security Implementation:

Address security concerns by implementing access restrictions, data encryption, and user authentication. Ensure the security of agricultural data, considering the possibility of remote control functionalities.

M. IoT Platform Integration:

Choose and integrate a suitable IoT platform to act as the hub for connectivity, device management, and data collection. Evaluate the feasibility of local or cloud-based installations based on infrastructure and accessibility considerations.

N. Integration with External Systems:

Develop interfaces to seamlessly connect with other farm management systems, weather forecasting services, or relevant data sources. Ensure thorough integration to provide comprehensive insights to users.

O. Reporting and Alerts System:

Implement a reporting and alerts system based on data analysis. Utilize email, SMS, and push notifications to deliver alerts to users, keeping them informed about critical updates and insights.

P. Model-View-Controller (MVC) Pattern:

Apply the MVC pattern for efficient code organization and modularity. Ensure that the evolutionary acquisition and interdisciplinary research project management principles are followed throughout the development process.

Q. User Feedback Mechanism:

Develop a robust user feedback database to gather insights and opinions from farmers and users. Create a mechanism for continuous improvement based on user feedback, ensuring the application meets evolving needs.

R. Machine Learning for Crop Prediction:

Implement machine learning algorithms for crop prediction and forecasting. Leverage data parameters such as fertilizers, diseases, research work, and market trends to empower farmers in making informed decisions about crop selection and pricing.

S. Smart Farm System Implementation:

Follow the architecture and design principles outlined in literature for a Smart Farm System that utilizes Big Data Appliance and Machine Learning. Focus on improving crop productivity and increasing farmers' income through actionable insights.

T. Blockchain-Based Smart Auction System:

Explore the detailed ideas highlighted in the literature for a blockchain-based smart auction system. Develop the system using Blockchain Ethereum, smart contracts, and web browsers with extensions like Metamask. Ensure transparent and automated auction processes.

U. Three-Tier Design for E-Commerce Platform:

Implement a three-tier design for the e-commerce platform, with presentation, business logic, and data layers. Ensure proper functionality and logic implementation, effective data storage and retrieval, and regulation of the user interface and interaction.

V. PHP and Laravel Framework for Backend:

Utilize PHP, particularly the Laravel framework, for back-end development. Leverage HTML, CSS, Bootstrap, and JavaScript for front-end design. Ensure smooth communication between the front-end and back-end.

V. Result Analysis

Discuss about your implementations and results and find Economical, Environmental, and Social Sustainability with the implementations and results.

A. Some Common Mistakes

- The word "data" is plural, not singular.
- The subscript for the permeability of vacuum μ_0, and other common scientific constants, is zero with subscript formatting, not a lowercase letter "o".
- In American English, commas, semicolons, periods, question and exclamation marks are located within quotation marks only when a complete thought or name is cited, such as a title or full quotation. When quotation marks are used, instead of a bold or italic typeface, to highlight a word or phrase, punctuation should appear outside of the quotation marks. A parenthetical phrase or statement at the end of a sentence is punctuated outside of the closing parenthesis (like this). (A parenthetical sentence is punctuated within the parentheses.)
- A graph within a graph is an "inset", not an "insert". The word alternatively is preferred to the word "alternately" (unless you really mean something that alternates).
- Do not use the word "essentially" to mean "approximately" or "effectively".
- In your paper title, if the words "that uses" can accurately replace the word "using", capitalize the "u"; if not, keep using lower-cased.
- Be aware of the different meanings of the homophones "affect" and "effect", "complement" and "compliment", "discreet" and "discrete", "principal" and "principle".
- Do not confuse "imply" and "infer".
- The prefix "non" is not a word; it should be joined to the word it modifies, usually without a hyphen.
- There is no period after the "et" in the Latin abbreviation "et al.".
- The abbreviation "i.e." means "that is", and the abbreviation "e.g." means "for example".

An excellent style manual for science writers is [7].

B. Authors and Affiliations

The class file is designed for, but not limited to, six authors. A minimum of one author is required for all conference articles. Author names should be listed starting from left to right and then moving down to the next line. This is the author sequence that will be used in future citations and by indexing services. Names should not be listed in columns nor group by affiliation. Please keep your affiliations as succinct as possible (for example, do not differentiate among departments of the same organization).

VI. Challenges Faced

The following sections is to give an insight of the boundaries that have been faced during the ongoing research period.

A. Sample Section

Write a paragraph here before starting. Difficulty to distinguish the work breakdown structure. Listing out all the initiatives that can be done in the project. Determining the start date, due date of the initiatives done in the project in Gantt Chart. Finding a proper library for all the sensors. Calibrating all the sensors. Establishing smooth UART communication between PMS5003 and MH-Z19B sensors. Troubleshooting the python application to decrease errors in serial communication. Unavailability of components due to pandemic situation. Sudden increase of cost and shipping charge due to lockdown and pandemic. Unable to go to the lab and do the project together. Virtual screening of the project.

B. Environmental, Social, Ethical issues

We declare no conflict of interest. The environmental impact given by the product we made. Pestle Web Analysis is presented below that shows the environmental, social, and ethical issues.

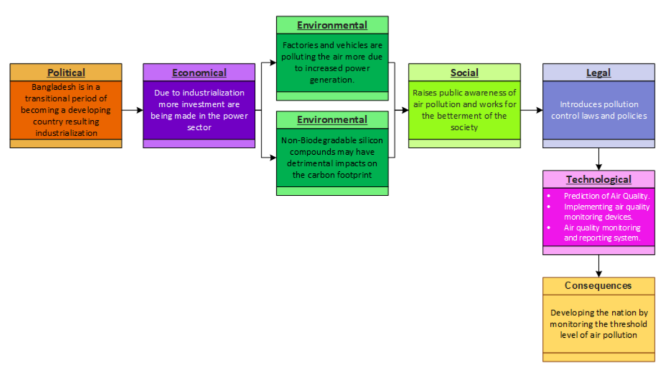

Fig. 1. Example of a Pestle Web Analysis.

C. Identify the Headings

Headings, or heads, are organizational devices that guide the reader through your paper. There are two types: component heads and text heads.

Component heads identify the different components of your paper and are not topically subordinate to each other. Examples include Acknowledgments and References and, for these, the correct style to use is “Heading 5”. Use “figure caption” for your Figure captions, and “table head” for your table title. Run-in heads, such as “Abstract”, will require you to apply a style (in this case, italic) in addition to the style provided by the drop down menu to differentiate the head from the text.

Text heads organize the topics on a relational, hierarchical basis. For example, the paper title is the primary text head because all subsequent material relates and elaborates on this one topic. If there are two or more sub-topics, the next level head (uppercase Roman numerals) should be used and, conversely, if there are not at least two sub-topics, then no subheads should be introduced.

D. Figures and Tables

a) Positioning Figures and Tables: Place figures and tables at the top and bottom of columns. Avoid placing them in the middle of columns. Large figures and tables may span across both columns. Figure captions should be below the figures; table heads should appear above the tables. Insert figures and tables after they are cited in the text. Use the abbreviation “Fig. **??**”, even at the beginning of a sentence.

TABLE I
TABLE TYPE STYLES

Table Head	**Table Column Head**		
	Table column subhead	***Subhead***	***Subhead***
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[a]Sample of a Table footnote.

VII. CONCLUSION

Please number citations consecutively within brackets [1]. The sentence punctuation follows the bracket [2]. Refer simply to the reference number, as in [3]—do not use “Ref. [3]” or “reference [3]” except at the beginning of a sentence: “Reference [3] was the first . . .”

Number footnotes separately in superscripts. Place the actual footnote at the bottom of the column in which it was cited. Do not put footnotes in the abstract or reference list. Use letters for table footnotes.

Unless there are six authors or more give all authors’ names; do not use “et al.”. Papers that have not been published, even if they have been submitted for publication, should be cited as “unpublished” [4]. Papers that have been accepted for publication should be cited as “in press” [5]. Capitalize only the first word in a paper title, except for proper nouns and element symbols.

For papers published in translation journals, please give the English citation first, followed by the original foreign-language citation [6].

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