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Data-driven Solution for Agri-SMEs Optimization in Albania: A Framework Using C# and .NET

Dejsi Qorri[1]*, Irida Gjermeni[2], János Felföldi[3]

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A B S T R A C T
The Albanian economy relies heavily on the agricultural sector. However, the lack of comprehensive farm management data reduces Albanian agricultural enterprises' competitiveness in global markets. The purpose of this article is to propose the building of a data gathering, analysis, and visualization application utilizing the C# programming language and the.NET framework. Big data in agriculture can help businesses improve their efficiency, competitiveness, and performance. Drawing on current challenges in Albanian agri-SMEs, it presents a logical structure for a web application designed to improve small and medium-sized enterprises (SMEs) in the agricultural sector by easing sales and purchase monitoring while optimizing profitability. The study suggests that data-driven solutions are essential for agricultural optimization in Albania, with guidelines for future refinement and implementation.

1. Introduction

Agriculture generates 18.92% of GDP in 2022, and represents a vital and strategic sector in Albania's economy. (STATISTA, 2023) Thus, contributing significantly to GDP and providing livelihoods for a substantial portion of the population. However, the absence of robust data tracking mechanisms impedes the sector's ability to adapt and thrive in the era of globalization. With globalization, agricultural markets are becoming increasingly competitive. Data-driven solutions enable SMEs to make informed decisions, optimize processes, and stay competitive in both domestic and international markets. (Allioui & Mourdi, 2023) By leveraging technology for data collection and analysis, SMEs can identify market trends, optimize pricing strategies, and improve supply chain management, ultimately enhancing their competitiveness. Furthermore, sustainable agricultural practices are essential for long-term viability. SMEs can adopt more sustainable practices while maintaining profitability. (Kamble et al., 2020)

Furthermore, leveraging data-driven insights empowers SMEs to make strategic decisions based on real-time information. Through the analysis of sales data, market trends, and financial metrics, SMEs can establish opportunities for growth, allocate resources effectively, and mitigate risks. Notably, 87.5% of agricultural businesses in Albania utilize software with a predominant focus on financial programs like Financa 5 and Alfa. (Ahmeti & Gjermeni, 2016) However, this statistic underscores a notable gap in operational management, emphasizing a limited view centered on financial aspects rather than holistic considerations within the value chains.

Profit-oriented business, commonly known as productivism model in farming, increasingly recognize the significant value of big data in shaping both short and long-term strategies within agriculture.

[1] *Dejsi Qorri
Department of Logistics Management, Faculty of Economics and Business, University of Debrecen, Hungary
dejsi.qorri@econ.unideb.hu *correspondent author
[2] Irida Gjermeni
Department of Mathematics and Informatics, Faculty of Economy and Agribusiness, Agricultural University of Tirana, Albania
igjermeni@ubt.edu.al
[3] János Felföldi
Department of Logistics Management, Faculty of Economics and Business, University of Debrecen, Hungary
felfoldi.janos@econ.unideb.hu

(Wilson, 2008) Big data, delineated across five dimensions: volume, velocity, variety, veracity, and valorization, encompasses the scale, timeliness, diversity, quality, and transformation into actionable insights. (Grover, Chiang, Liang, & Zhang, 2018) This multifaceted nature underscores its vital role in enhancing decision-making processes and driving efficiency in agriculture. Beyond agriculture, industries like banking have successfully leveraged big data analytics to gain insights and effectively engage customers. (Skyrius, Giriūnienė, Katin, Kazimianec & Žilinskas, 2018) The application of big data has been an important topic, with a good influence and attention in various areas of agriculture. (Kamilaris, Kartakoullis & Prenafeta-Boldú, 2017)
The article delves into the significance of the big data on agriculture, particularly focusing on its importance for agricultural businesses and value chains in Albania. Furthermore, the article proposes a logical framework for a web application designed to assist agricultural SMEs in optimizing their profit margins while providing a comprehensive overview of their sales and purchases. This framework, leveraging C# programming and .NET technologies, aims to empower Albanian agricultural SMEs with data-driven solutions to enhance competitiveness and sustainability.

2. Material and Methodology

Firstly, a use-case model (UML) is built to demonstrate how different users interact with the system to solve a particular problem. It defines the goals of users, the interactions between users and the system, and how the system behaves to accomplish these goals. (Bittner & Spence, 2003) The UML model includes actors and their relationships, as illustrated in Figure 1. This use-case scenario explains how an agricultural SME owner/manager in Albania can use the suggested framework, which uses C# programming and .NET technologies, to optimize sales and operations in their business. It describes particular activities and interactions between the SME owner/manager and the system. Moreover, illustrating how the framework makes it easier to track sales, handle inventory, manage staff, analyze data, and make decisions.
Secondly, the framework utilizes several technologies, including: CSS for styling, ASPX elements, HTML for application structure, ASP.NET and C# language for development, Microsoft SQL Server for database management, JSON for interactive graphics, and the Ajax Toolkit for retrieval from the server.

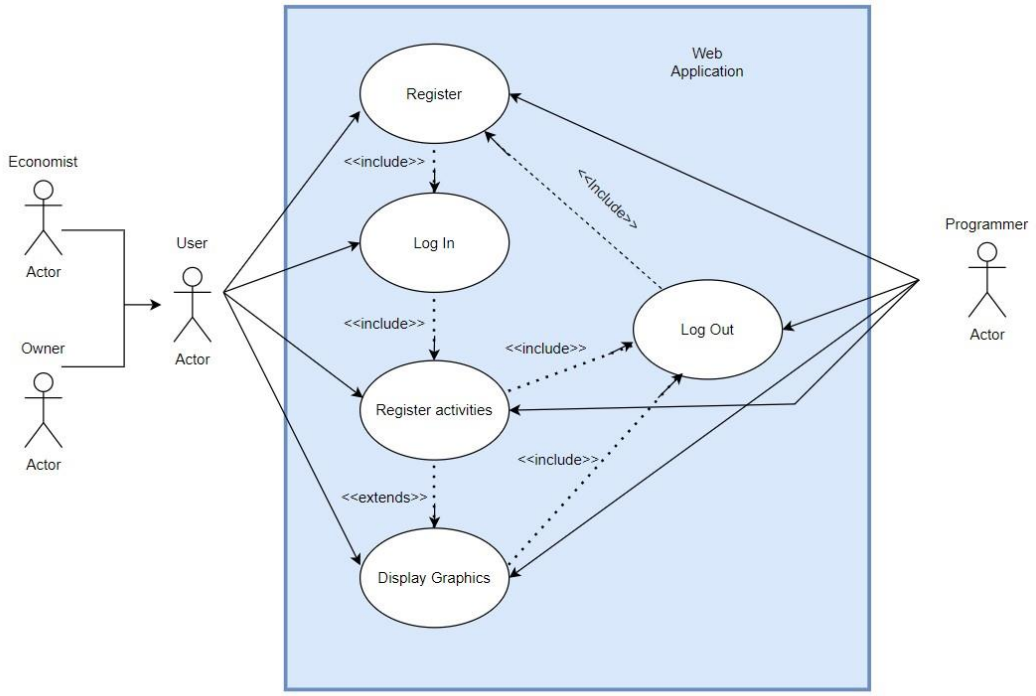

Figure 1: UML of the Web API (application) **Source:** authors' work.

3. Results

Notably, a staggering 87% of Albania's population engages with the internet, indicating a widespread adoption of online connectivity among individuals in the nation. (The World Bank, 2022) Moreover, according to Ahmeti & Gjermeni (2016) in their study, nearly all respondents at 98.8% acknowledge that the internet facilitates product information. Furthermore, a significant majority, representing 91.3% recognizes the crucial contribution of computer science in automating tasks within enterprises. Additionally, a substantial proportion, 95% agree on the software's efficacy in direct bill creation, while 90% acknowledge its assistance in direct profit calculations. Lastly, 100% affirm that software expedites data processing. (Ahmeti & Gjermeni, 2016) Further insights from their study can be found in Table 1, recognizing the role of computer science and software in automating tasks highlights the potential for improving business processes and streamlining operations. It indicates a willingness to embrace technology-driven solutions for enhancing efficiency and competitiveness, and the internet's ability to facilitate product information (Su, Zhang & Wu, 2023), and the usefulness of digital platforms in marketing and sales operations. (Gupta, Leszkiewicz, Kumar, Bijmolt & Potapov, 2020)

Table 1: Reasons for using Computer Science (CS) in Albanian agricultural sector. **Source:** Ahmeti & Gjermeni, 2016

Reasons	Yes	No
Security of saved information	100%	0%
Possibility to publish at internet world	98.8%	1.3%
Possibility to automatize work	91.3%	8.8%
Direct bill creation	95%	5%
Direct profit calculation	90%	10%
Direct expenses calculation	86.3%	13.8%
Direct data process speed	100%	0%
Fast response to different clients	96.3%	3.8%
GPS usage	93.8%	6.3%

We can take example dairy farms in Albania characterized by various challenges, but some of them are associated with limited access to modern technology and resources, issues with quality, and a lack of monitoring resulting in low competitiveness in European markets (Qorri, 2022). Technology can help to address these difficulties optimizing processes, lowering costs, and increasing supply chain efficiency. (Ivanov, Dolgui, & Sokolov, 2019) Automating daily activities allows Just-In-Time (JIT) monitoring of inventory levels, orders and production plans, resulting in better decision making and response to changing market needs. (Hofmann & Rüsch, 2017; Hoque, 2000) Perceiving the internet as a source of product knowledge emphasizes the significance of collaboration and information exchange across supply chain participants, driving more collaboration and coordination. (Li & Lin, 2006)

The web application is created with interfaces in the Albania language; however, the coding is documented in English. The application has been assigned the hypothetical name "Small AgriBusiness Daisy". Moreover, starts with a Login interface, as depicted in Figures 2 on the left, ensuring that all functionalities are securely locked behind an authentication process. The SME's owner gains entry to the system's features by signing in using their unique login details. After successfully logging in, the users are directed to the Application Interface which is shown on the right side of Figure 2, which serves as the central hub for cataloging pivotal data spanning sales, procurement, and employee records.

Figure 2: Log In Page on the left and the Application Interface on the right. **Source:** authors' work.

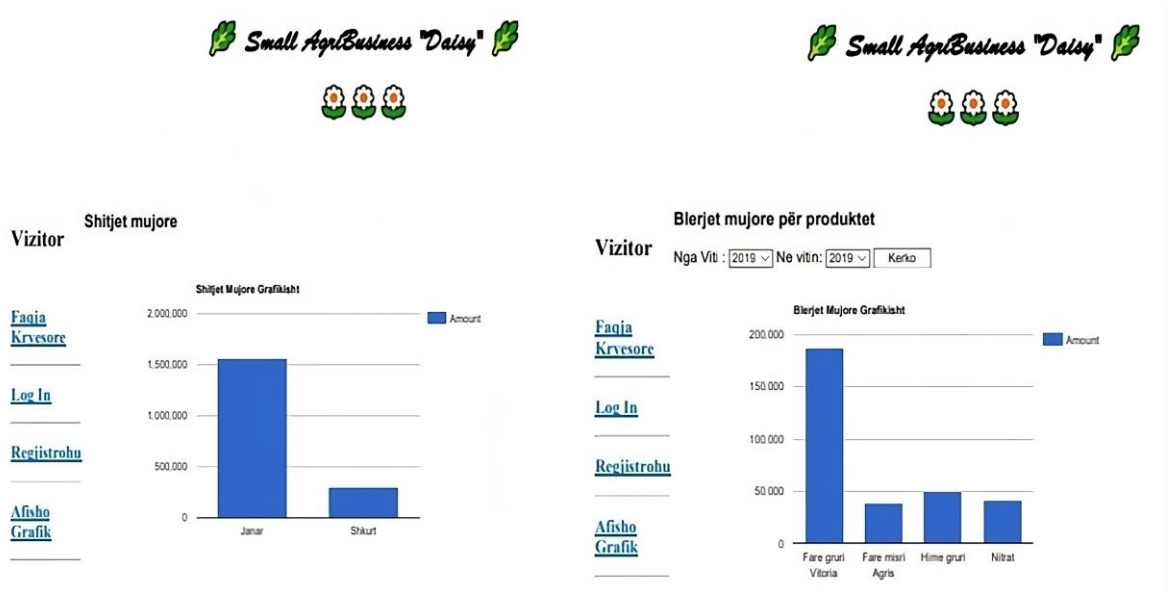

Figure 3: Data visualization for Sales on the left and Purchases on the right. **Source:** authors' work.

The 'Small AgriBusiness Daisy' web application is designed to meet the needs of SME owners, particularly in the agriculture sector. Within this tracking module, the owner has the ability to observe real-time sales metrics as depicted in Figure 3 on the left side, which are neatly categorized by product and delineated monthly. Real-time sales metrics, offer the SME owner a detailed view of their business performance. Such insights are vital for identifying top-selling products, deciphering sales patterns, and capturing the consumer behavior. In parallel, the application's procurement module delivers crucial insights into monthly buying patterns, enriching the owner's grasp on inventory management as shown on the right side of Figure 3. This module tracks stock levels, enabling precise monitoring of inventory turnover. The strategic utilization of this data is key to optimizing inventory, minimizing holding costs, and ensuring timely product availability to meet market demands. This is also displayed in the Application Layer depicted in Figure 5, analogous to the Business Logic Layer,

serves as the central operational hub within 'Small AgriBusiness Daisy'. It bridges essential functions, including:

- *Data Entry* which allows users to enter the recent data into the system.
- *Data Query* enables the retrieval of the requested information from the underlying database.
- *Data Login* administering user authentication and session security.
- *Analytics and reporting* include converting data into meaningful insights via comprehensive visualizations.
- *Data Visualization* by using graphics to improve the digestibility of data that is complex.
- *Inventory Management* consists of monitoring and managing the movement of products, including inventory levels, orders, and delivery.
- *Human Resource Management* includes overseeing personnel-related operations such as payments and recruiting operations.

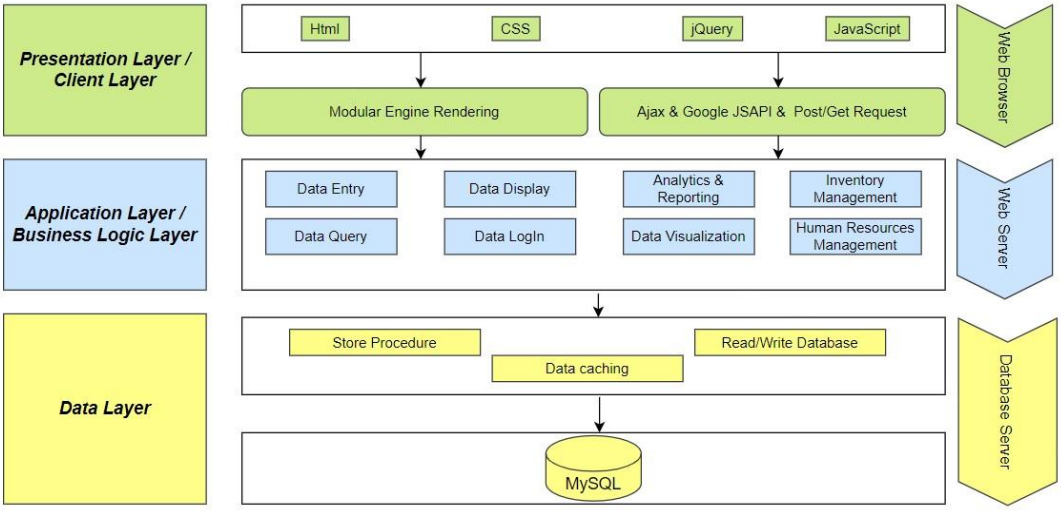

Figure 4: Logical Architecture Diagram of the System. **Source:** authors' work derived from Long, Deng, & Wang, 2020.

The proposed system architecture visualized in Figure 5, rooted in C# and the .NET framework, is engineered to deliver an intuitive user experience while handing data analytics, ultimately striving to elevate the profit margins of agricultural SMEs in Albania through smart and strategic user of the data. The Logical Architecture Diagram of the System based on Long, Deng, & Wang, (2020), is simplified in 3 (three layers): presentation layer (client layer), application layer (business logic layer), and data layer. Presentation layer is known as the front-end, and it is what the users interact with directly in their web browsers. Moreover, the process of retrieving data from a server-side database using AJAX, performing necessary processing, creating a DataTable to organize the data, and then using a visualization library such as Google Visualization to generate and display a graphical representation on a web page.

1. *Data specification* means deciding what data to present in your visual. This might be numerical data, category data, or other types of organized information. A web method is a method or function in a web application that handles requests for visual data retrieval. It involves retrieving information from a server-side database or other data source.
2. *AJAX (Asynchronous JavaScript and XML)* is a web development technique that allows users to share and receive data asynchronously, without having to reload the entire page. (Batra, 2006). It uses server data in a format similar to JSON (JavaScript Object Notation), which is widely used for data transmission between a server and a web application. (Afsari, Eastman & Castro-Lacouture, 2017).

3. *Google JSAPI (Google JavaScript API)* is a collection of JavaScript libraries made available by Google that allow developers to embed different Google services, such as charts and maps, into web pages. (Król, 2016)
4. *Google Visualization Library* is a JavaScript library that enables interactive data visualizations on the web. It provides a range of chart styles, including line charts, bar charts, and pie charts, as well as options for editing and designing them. Library for Graphic itself refers to any additional JavaScript libraries or frameworks used for creating and manipulating the graphic such as D3.js (Data-Driven Documents) or Chart.js, which provide additional features and flexibility for building charts and graphs. (Murray, 2017)
5. *DataTable Initialization* is a data structure for storing and manipulating tabular data. To initialize a DataTable, create an instance of the object and provide its structure (for example, columns) and data. Column specification is the process of establishing the structure of a DataTable by describing the columns it includes. Each column is normally assigned a name, a data type, and optional attributes such as formatting choices. Once the DataTable has been started and filled with data, it can be used to generate and display a chart or graphic on a web page. Thus, providing the DataTable a relevant visualization function supplied by the Google Visualization Library or other graphic libraries. (Adelfio & Samet, 2013).

Furthermore, the Application Layer process user requests, application data and overall business logic. It includes data entry, data query, data display, data login, analytics and reporting, data visualization, inventory management, and Human resource management. Furthermore, Data Layer is the foundational database layer where data is stored and managed. The Figure 5, also denotes the 'Web Browser' as the medium through which the Presentation Layer is accessed and the 'Web Server' and 'Database Server' as the back-end components that handle the application and database services, respectively. The arrows indicate the flow of data and control between the layers, highlighting how the user's action in the web browser traverses down through the application and data layers to retrieve or manipulate data.

3.1 User Authentication: Connecting Interface and Backend Logic

Constructing the project as a web application involved designing the user interface within a master page. This page serves as a structure for other pages, ensuring consistency and user-friendliness. Acting as the foundation, MasterPage.Master.aspx provides a uniform layout for all pages, including elements such as the header with the application's logo and title, a navigation menu for easy access, and a footer containing essential information. Within the master template, there's a dynamic area called 'ContentPlaceHolder' where unique content from child pages, like text, forms, or images can be inserted while maintaining the overall layout. LogInForm.aspx is a page designed for user authentication, inheriting its structure of the master page to maintain consistency. It includes user interface elements such as 'UsernameField' and 'PasswordField' for entering login credentials, while the latter masking the password for security. The 'LogInButton' initiates the authentication process when clicked, triggering the 'ValidateUser()' method from the 'LoginForm.apsx.cs'. This method verifies the entered credentials against the application's user database, redirecting the user to another page upon successful login or displaying an error message for incorrect credentials. The server-side logic within 'LoginForm.aspx.cs' ensures access is granted only to verify users by checking the provided credentials against the database records. If the credentials match, the user is redirected to the homepage; otherwise, as 'Invalid credentials' message is displayed.

3.2 Monthly Sales and Purchases Analysis using SQL Queries

The query selects the "Month" column and computes the total sales amount by multiplying the "price" column with the "quantity" column for each row, and then aggregates these values. The outcome is named as "Amount". The clause "FROM Sales" specifies that the data is retrieved from a table named "Sales". GROUP BY Month" organizes the results based on the "Month" column, implying that the query calculates the sum of the sales amounts for each distinct month. The analysis of sales was carried out using JSON. Moreover, to determine monthly sales, the query was constructed as following:

```
SELECT Month, SUM (price*quantity) AS Amount
    FROM Sales
GROUP BY Month;
```

Similarly, the analysis of purchases was carried out using JSON, and to specify the timeframe for analysis, two dropdown lists with years, and a search button was utilized. The following query was built to ascertain the monthly purchases:

```
SELECT Product, SUM (price*quantity) as Amount
    FROM Purchases
GROUP BY Product;
```

Conclusions

The current state of Agri-SMEs in Albania necessitates the development of an application able to track data, manage profit and costs, develop efficient strategies, to detect and observe patterns, and manage inventory optimally. We suggest a web application due its advantages, including accessible from any internet-connected computer, it does not need a specific operating system, and neither needs any other package installation. The owner can use the data analysis and visualization features to develop insights and reports based on the acquired data. They may provide customized reports, examine sales patterns, and pinpoint areas for development. By employing data-driven insights, the owner can make well-informed decisions to improve sales tactics, streamline operations, and increase profitability. Furthermore, depending on the data analysis results, the owner can make strategic adjustments to improve sales and operations. This could involve changing price strategies and/or extending choices for products. By constantly evaluating performance measures and iterating plans, the owner promotes continuous improvement and long-term growth for the SME.

Recommendations

We recommend for the adoption of modern technologies in order to improve the application's efficiency, User Interface (UI), and User Experience (UX), allowing for customization based on unique agricultural areas and training needs. This provides a good foundation for a long-term approach to assist the agricultural farmers. Furthermore, in order to fully realize the benefits of data-driven optimization, coordinated efforts are required to enhance digital literacy, and stimulate information-sharing among agricultural stakeholders. Collaboration between government agencies, academic institutions, and industry partners is essential for promoting innovation and scaling solutions across the sector.

Conflict of interest

The authors declare no conflicts of interest.

References

Adelfio, M.D. & Samet, H., 2013. Schema extraction for tabular data on the web. Proceedings of the VLDB Endowment, vol. 6, no. 6, pp. 421-432. doi: https://doi.org/10.14778/2536336.2536343.

Afsari, K., Eastman, C.M. & Castro-Lacouture, D., 2017. JavaScript Object Notation (JSON) data serialization for IFC schema in web-based BIM data exchange. Automation in Construction, vol. 77, pp. 24-51. doi: https://doi.org/10.1016/j.autcon.2017.01.011.

Ahmeti, A. & Gjermeni, I., 2016a. The Impact of Computer Science in Albanian Agribusiness Sector. Albanian Journal of Agricultural Sciences, vol. 15, no. 4, pp. 172.

Ahmeti, A. & Gjermeni, I., 2016b. The Impact of Computer Science in Albanian Agribusiness Sector. Albanian Journal of Agricultural Sciences, vol. 15, no. 4, pp. 172.

Allioui, H. & Mourdi, Y., 2023. Exploring the full potentials of IoT for better financial growth and stability: A comprehensive survey. Sensors, vol. 23, no. 19, pp. 8015. doi: https://doi.org/10.3390/s23198015.

Batra, S., 2006. AJAX-Asynchronous Java Script and XML. ITS-Information Technology and Systems Management.

Bittner, K. & Spence, I., 2003. Use case modeling. Addison-Wesley Professional.

Grover, V., Chiang, R.H., Liang, T. & Zhang, D., 2018. Creating strategic business value from big data analytics: A research framework. Journal of Management Information Systems, vol. 35, no. 2, pp. 388-423. doi: https://doi.org/10.1080/07421222.2018.1451951.

Gupta, S., Leszkiewicz, A., Kumar, V., Bijmolt, T. & Potapov, D., 2020a. Digital analytics: Modeling for insights and new methods. Journal of Interactive Marketing, vol. 51, no. 1, pp. 26-43. doi: https://doi.org/10.1016/j.intmar.2020.04.003.

Gupta, S., Leszkiewicz, A., Kumar, V., Bijmolt, T. & Potapov, D., 2020b. Digital analytics: Modeling for insights and new methods. Journal of Interactive Marketing, vol. 51, no. 1, pp. 26-43. doi: https://doi.org/10.1016/j.intmar.2020.04.003.

Hofmann, E. & Rüsch, M., 2017. Industry 4.0 and the current status as well as future prospects on logistics. Computers in Industry, vol. 89, pp. 23-34. doi: https://doi.org/10.1016/j.compind.2017.04.002.

Hoque, Z., 2000. Just-in-time production, automation, cost allocation practices and importance of cost information: an empirical investigation in New Zealand-based manufacturing organizations. The British Accounting Review, vol. 32, no. 2, pp. 133-159. doi: https://doi.org/10.1006/bare.1999.0125.

Ivanov, D., Dolgui, A. & Sokolov, B., 2019. The impact of digital technology and Industry 4.0 on the ripple effect and supply chain risk analytics. International Journal of Production Research, vol. 57, no. 3, pp. 829-846. doi: https://doi.org/10.1080/00207543.2018.1488086.

Kamble, S.S., Gunasekaran, A. & Gawankar, S.A., 2020. Achieving sustainable performance in a data-driven agriculture supply chain: A review for research and applications. International Journal of Production Economics, vol. 219, pp. 179-194. doi: https://doi.org/10.1016/j.ijpe.2019.05.022.

Kamilaris, A., Kartakoullis, A. & Prenafeta-Boldú, F.X., 2017. A review on the practice of big data analysis in agriculture. Computers and Electronics in Agriculture, vol. 143, pp. 23-37. doi: https://doi.org/10.1016/j.compag.2017.09.037.

Król, K., 2016. Data presentation on the map in Google Charts and jQuery JavaScript technologies. Geomatics, Land Management and Landscape. doi: 10.15576/GLL/2016.2.91.

Li, S. & Lin, B., 2006. Accessing information sharing and information quality in supply chain management. Decision Support Systems, vol. 42, no. 3, pp. 1641-1656. doi: https://doi.org/10.1016/j.dss.2006.02.011.

Long, R., Deng, C., & Wang, M., 2020. Design and Implementation of River Data Acquisition and Storage System Based on Cloud Platform. In IOP Conference Series: Materials Science and Engineering (Vol. 794, No. 1, p. 012011). IOP Publishing. doi: 10.1088/1757-899X/794/1/012011.

Murray, S., 2017. Interactive data visualization for the web: an introduction to designing with D3. " O'Reilly Media, Inc.". ISBN: 978-1-491-92128-9.

Qorri, D., 2022. Poultry sector analysis in Albania. Applied Studies in Agribusiness and Commerce, vol. 16, no. 1. doi: https://doi.org/10.19041/APSTRACT/2022/1/4.

Skyrius, R., Giriūnienė, G., Katin, I., Kazimianec, M. & Žilinskas, R., 2018. The potential of big data in banking. Guide to Big Data Applications, pp. 451-486. Part of the book series: Studies in Big Data ((SBD, volume 26) SU, J., ZHANG, Y. and WU, X., 2023. How market pressures and organizational readiness drive digital marketing adoption strategies' evolution in small and medium enterprises. Technological Forecasting and Social Change, vol. 193, pp. 122655. doi: https://doi.org/10.1016/j.techfore.2023.122655.

Statista, 2023 https://www.statista.com/statistics/444090/albania-gdp-distribution-across-economic-sectors/ Published: December, 2023; Accessed: March, 2024.

The World Bank, 2022 https://data.worldbank.org/indicator/IT.NET.USER.ZS?locations=AL Accessed: March, 2024.

Wilson, G.A., 2008. From ‘weak’to ‘strong’multifunctionality: Conceptualising farm-level multifunctional transitional pathways. Journal of Rural Studies, vol. 24, no. 3, pp. 367-383. doi: https://doi.org/10.1016/j.jrurstud.2007.12.010.