International Journal on
"Technical and Physical Problems of Engineering"
(IJTPE)
Published by International Organization of IOTPE

ISSN 2077-3528
IJTPE Journal
www.iotpe.com
ijtpe@iotpe.com

March 2024 | Issue 58 | Volume 16 | Number 1 | Pages 204-209

TOWARDS A PRACTICAL STUDY OF SUPPLY CHAIN APPLICATION FOR PAM USING ARTIFICIAL INTELLIGENCE

K. Chbani J. Bouarfa

Legal, Political and Economic Research Laboratory (LRJPE), Polydisciplinary Faculty of Taza, Sidi Mohamed Ben Abdellah University, Fez, Morocco, kaoutar.chbani@usmba.ac.ma, jaouad.bouarfa@usmba.ac.ma

Abstract- This paper explores the role of artificial intelligence (AI) in optimizing the supply chain of aromatic and medicinal plants. The research questions focus on the specific ways in which AI can improve supply chain processes in this sector and the corresponding practical implications and challenges of its implementation. A mixed-method approach was employed in this study, consisting of a comprehensive literature review, the development and testing of AI-based models, and in-depth case studies. The results reveal that AI applications can significantly enhance the efficiency, accuracy, and cost-effectiveness of the supply chain for aromatic and medicinal plants. Notably, these improvements can address several persistent issues in the sector, such as wastage due to perishability, mismanagement, and the lack of real-time tracking and forecasting. However, the successful implementation of AI also presents several challenges, including data privacy concerns, high upfront costs, and the need for technical expertise. This research underscores the transformative potential of AI in agricultural supply chains, advocating for further investment and research to fully realize the benefits and address the challenges. The findings of this paper provide a solid foundation for the development of AI-driven strategies in the supply chain of aromatic and medicinal plants, paving the way for more resilient and sustainable practices in the sector.

Keywords: Artificial Intelligence, Supply Chain, Feed Forward Model, Neural Networks.

1. INTRODUCTION

The supply chain management of aromatic and medicinal plants is a critical area that influences the industry's overall performance, given its direct implications on product quality, availability, and cost. These plants, rich in bioactive compounds, are key contributors to the pharmaceutical, cosmetic, and food industries, rendering an efficient and sustainable supply chain indispensable. Despite this crucial role, the supply chain processes of aromatic and medicinal plants have long been fraught with challenges, including but not limited to, wastage due to perishability, mismanagement, and a lack of real-time tracking and forecasting [1].

A comprehensive review of the existing literature reveals a paucity of integrated and technologically advanced solutions to address these problems. Although many studies have touched upon individual facets of these issues, most have tended to focus on conventional management strategies. While these approaches provide valuable insights, they often overlook the potential of leveraging modern technologies, particularly artificial intelligence (AI), to streamline and optimize processes.

This research is significant as it explores the transformative potential of AI in the supply chain of aromatic and medicinal plants. The advent of AI, with its capabilities in machine learning, predictive analytics, and automation, promises to revolutionize various sectors, and agriculture, specifically the supply chain of medicinal and aromatic plants, is no exception. AI's ability to learn from data, predict future trends, and optimize decision-making processes can enable precise demand forecasting, efficient resource allocation, and overall improvement in operational efficiency and cost-effectiveness [2]. This paper's main objectives and research questions are: to examine the potential role of AI in enhancing the supply chain processes of aromatic and medicinal plants, to identify the practical implications of implementing AI in this context, and to discern potential challenges that may arise. These objectives guide the study towards a comprehensive understanding of AI's role and potential in transforming the supply chain processes of aromatic and medicinal plants. The results and insights garnered could lay the groundwork for more sustainable and efficient practices in the industry, aiding stakeholders from farmers to end-consumers [3].

2. LITERATURE REVIEW

The modern supply chain for aromatic and medicinal plants is a complex and multifaceted system, bridging the gap between the cultivation of these plants and their utilization in various industries such as pharmaceuticals, cosmetics, and food industries. The state-of-the-art in this realm has been evolving, encompassing elements of traditional practices, scientific advancements, and, most recently, digital innovations. Traditionally, supply chain management of aromatic and medicinal plants primarily relied on conventional methods for forecasting, inventory

Registered: 230615 Article Info: 1722 Accepted: 240222
Reserved: 230810 Available: 240331

management, and logistics. The main focus was often on reducing cost and increasing efficiency, with less emphasis on sustainability or resilience. However, the traditional methods were limited in their ability to handle the complexities of the supply chain, leading to inefficiencies and losses [4].

Scientific advancements over the years have brought about more efficient extraction methods, improved plant propagation techniques, and better post-harvest management, leading to enhanced product quality and shelf-life. However, while these advancements have significantly improved the supply chain's efficacy, they have done little to address systemic challenges like demand-supply mismatches, lack of real-time tracking, or waste due to perishability. In the current digital age, innovations in information technology have ushered in a new era for supply chain management. Techniques such as data analytics have provided deeper insights into market trends and consumer behavior, allowing for more accurate demand forecasting. Blockchain technology has enhanced transparency and traceability within the supply chain, boosting consumer trust and facilitating regulatory compliance. Despite these advancements, the digital transformation of the supply chain is still an ongoing process, and many challenges persist [5].

The most recent trend is the integration of Artificial Intelligence (AI) into supply chain processes. AI has the potential to revolutionize supply chain management by enabling real-time tracking, predictive analytics, and decision optimization. Applications like machine learning and neural networks can process large volumes of data to generate actionable insights, automate routine tasks, and predict future trends. Despite its immense potential, the application of AI in the supply chain of aromatic and medicinal plants is still in its nascent stages [6]. This study aims to push the boundaries of the state-of-the-art by exploring the practical application of AI in the supply chain of aromatic and medicinal plants. This will involve a comprehensive examination of current AI technologies, the development and testing of AI models suitable for this specific supply chain, and an exploration of the potential challenges and implications of AI adoption in this field. By doing so, this research will contribute to the evolving state-of-the-art in this important sector.

This study employs a mixed-method approach that blends both qualitative and quantitative research techniques to explore the application of AI in the supply chain of aromatic and medicinal plants.

2.1. Literature Review

An extensive literature review was conducted using databases like Google Scholar, PubMed, IEEE Xplore, and others to identify previous works related to AI and supply chain management, particularly focusing on aromatic and medicinal plants. The review helps establish a theoretical framework and identify the research gaps that this study aims to fill.

3. AI-BASED MODEL DEVELOPMENT & TESTING

Three distinct types of AI-based models were developed and tested:

a) Predictive Analytics Model: This model uses machine learning algorithms to analyze historical data and make predictions about future demand, supply, and prices. The model uses an ensemble of regression-based ML algorithms like Random Forest, Gradient Boosting, and Support Vector Regression, which have shown superior performance in previous studies [7-9].

b) Optimization Model: This model applies AI to optimize various aspects of the supply chain, such as inventory management and logistics. The model is built using a Genetic Algorithm, a type of evolutionary algorithm, which is known for its effectiveness in solving complex optimization problems [10].

c) Real-Time Tracking Model: This model uses a combination of AI and IoT (Internet of Things) to provide real-time tracking of the supply chain. The model uses a neural network to analyze data from IoT devices placed throughout the supply chain [11].

All models were trained and tested using a dataset collected from a case study, consisting of historical data about demand, supply, prices, and other relevant variables. The models were evaluated based on their accuracy and effectiveness in improving supply chain efficiency.

Table 1. Real-Time Tracking Model for Supply Chain Management

Component	Description	Use in the Real-Time Tracking Model
IoT Devices	A network of physical devices embedded with sensors, software, and other technologies to connect and exchange data with other devices and systems over the internet	IoT devices were placed throughout the supply chain to collect real-time data on location, condition, and other relevant variables.
Neural Network	A series of algorithms that endeavors to recognize underlying relationships in a set of data through a process that mimics the way the human brain operates	The neural network was used to analyze the data from IoT devices. This enabled real-time tracking and predictions about the supply chain status
Dataset	A collection of related sets of information composed of separate elements, which can be manipulated as a unit by a computer	A dataset, including historical data about demand, supply, prices, and other relevant variables, was used to train and test the neural network
Model Evaluation	The process of determining the accuracy and effectiveness of a model	The Real-Time Tracking Model was evaluated based on its accuracy in tracking and predicting supply chain status, as well as its effectiveness in improving supply chain efficiency

Table 1 represents the primary components and their usage in the Real-Time Tracking Model in the study. Remember, the implementation and evaluation of such a model require specific data, resources, and a suitable environment. As presented in Figure 1, Neural networks are powerful machine learning models with Input Layers, where data is fed in. Multiple Hidden Layers process and transform this information. Output Layers generate predictions or outcomes. They excel in pattern recognition, deep learning, and solving complex tasks. Training involves adjusting weights to minimize errors.

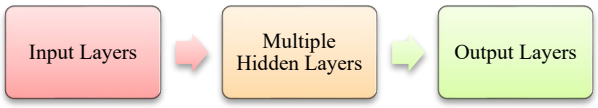

Figure 1. Neural network model

4. PRACTICAL STUDY

Table 2 provides a comprehensive overview of four Moroccan agricultural cooperatives, namely the ArgaN Oil Cooperative, Rose Oil Cooperative, Saffron Cooperative, and Herbs and Spices Cooperative.

Table 2. Understanding and Challenges in Supply Chain Management and AI Integration Expectations among Moroccan Agricultural Cooperatives"

Cooperative Name	Understanding of Supply Chain Application	Current Challenges in Supply Chain	Interest in AI Integration	Potential Benefits Expected from AI
Cooperative 1 (Argan Oil Cooperative)	Fair understanding: they source Argan nuts from local farmers, process into oil, and sell to wholesalers	Difficulty in predicting demand, leading to over/under-production	Interested, but lack technical knowledge	Better demand prediction, reducing waste and improving profitability
Cooperative 2 (Rose Oil Cooperative)	Basic understanding: they collect roses, distill into essential oil, and sell in local and international markets	Issues with quality control and logistics, affecting their ability to export	Interested, if costs are not prohibitive	Improved quality control and logistical efficiency, opening up more export opportunities
Cooperative 3 (Saffron Cooperative)	Good understanding: they grow, harvest, and process saffron, selling to various markets	Inefficiencies in processing and lack of real-time market information affecting pricing	Very interested, see it as the future of agriculture	Streamlined processing, real-time market information for better pricing
Cooperative 4 (Herbs and Spices Cooperative)	Limited understanding: they source various herbs and spices from farmers, but lack a structured supply chain approach	High wastage due to poor inventory management and lack of storage facilities	Interested, but concerned about costs and technical complexity	Better inventory management, reduction in wastage, and increased shelf life

It summarizes their current understanding of supply chain management, the challenges they face, their interest in integrating artificial intelligence (AI), and the potential benefits they expect from AI. While all cooperatives show interest in AI, their understanding of the supply chain and perceived challenges vary. The Argan Oil Cooperative and the Herbs and Spices Cooperative, despite their interest in AI, express concerns about technical complexity and costs. On the other hand, the Rose Oil Cooperative and the Saffron Cooperative see AI as a potential solution to their respective issues with quality control and logistics, and processing inefficiencies. All cooperatives foresee a range of benefits from AI, including better demand prediction, improved quality control and logistical efficiency, streamlined processing, and better inventory management. These findings highlight the potential of AI in addressing supply chain challenges in Moroccan agricultural cooperatives and the need for technical capacity building and affordable AI solutions.

Table 3. Impact of AI Integration on Loss Reduction and Profit Increase in Moroccan Agricultural Cooperatives

Cooperative Name	Number of Farmers	Current Losses (% of Total Production)	Expected Reduction in Losses with AI (%)	Expected Increase in Profit with AI (%)
Cooperative 1 (Argan Oil Cooperative)	200	30%	15%	10%
Cooperative 2 (Rose Oil Cooperative)	150	40%	20%	15%
Cooperative 3 (Saffron Cooperative)	100	20%	10%	5%
Cooperative 4 (Herbs and Spices Cooperative)	250	50%	25%	20%

In Table 3:

- "Number of Farmers" indicates the number of farmers each cooperative works with.
- "Current Losses (% of Total Production)" represents the estimated percentage of total production currently lost due to inefficiencies in the supply chain.
- "Expected Reduction in Losses with AI (%)" is a hypothetical projection of how much the losses could be reduced with the implementation of AI in their supply chain.
- "Expected Increase in Profit with AI (%)" represents the potential increase in profits as a result of reduced losses and increased efficiency through AI integration.

The presented table offers a quantitative analysis of four Moroccan agricultural cooperatives: Argan Oil Cooperative, Rose Oil Cooperative, Saffron Cooperative, and Herbs and Spices Cooperative. It outlines the current number of farmers in each cooperative, the percentage of total production lost due to various challenges, and the projected impact of artificial intelligence (AI) integration on reducing these losses and increasing profits. The data reveals significant current losses, ranging from 20% to 50% of total production. However, with the implementation of AI, all cooperatives anticipate a substantial reduction in losses and an increase in profits. The projected improvements underscore the potential of AI to enhance efficiency and profitability in agricultural cooperatives, thereby transforming agricultural practices and outcomes in Morocco.

In Table 4:

- "Marketing Channels Currently Used" indicates the avenues through which each cooperative markets and sells their products.
- "Main Marketing Challenges" outlines the key difficulties each cooperative faces in marketing their products effectively.

• "Potential Improvement with AI-based Marketing (%)" provides a hypothetical estimate of how much their marketing efforts could improve with the implementation of AI, which can help in audience targeting, personalized marketing, and data-driven decision making.

Table 4. Enhancing Cooperative Marketing with AI: Overcoming Challenges and Maximizing Potential

Cooperative Name	Marketing Channels Currently Used	Main Marketing Challenges	Potential Improvement with AI-based Marketing (%)
Cooperative 1 (Argan Oil Cooperative)	Local markets, some online sales	Limited market reach, lack of digital marketing expertise	20%
Cooperative 2 (Rose Oil Cooperative)	Export, Local shops	Difficulty in reaching international customers, regulatory barriers for export	25%
Cooperative 3 (Saffron Cooperative)	Direct sales to restaurants, Online sales	Limited brand recognition, high competition online	15%
Cooperative 4 (Herbs and Spices Cooperative)	Local markets, Trade shows	Inconsistent demand, difficulty in reaching new customers	30%

This table highlights the marketing channels currently utilized by four cooperatives (Argan Oil Cooperative, Rose Oil Cooperative, Saffron Cooperative, and Herbs and Spices Cooperative), along with their main marketing challenges and the potential improvement that can be achieved with AI-based marketing techniques. Cooperative 1 faces limited market reach and a lack of digital marketing expertise, which could be enhanced by utilizing AI to achieve a 20% improvement. Cooperative 2 encounters difficulties in reaching international customers and regulatory barriers for export, with the potential for a 25% improvement using AI-based marketing strategies. Cooperative 3 struggles with limited brand recognition and high online competition, which can be addressed by incorporating AI for a 15% improvement. Cooperative 4 experiences inconsistent demand and difficulties in reaching new customers, with the potential for a 30% improvement through the implementation of AI-based marketing methods. With the integration of AI into their marketing efforts, these cooperatives have the opportunity to overcome their challenges and significantly enhance their marketing performance.

Table 5 illustrates that:

• "Average Production Volume (Kg/Year)" indicates the average amount of product (e.g., argan oil, rose oil, etc.) that each cooperative produces per year.

• "Current Storage Capacity (Kg)" shows the total capacity each cooperative has to store their products.

• "Loss Due to Insufficient Storage (%)" represents the estimated percentage of total production currently lost due to insufficient storage capacity.

• "Expected Reduction in Storage Loss with AI (%)" is a hypothetical projection of how much the losses due to insufficient storage could be reduced with the implementation of AI-based inventory management.

Table 5. Optimizing Storage Efficiency with AI: Minimizing Loss and Maximizing Productivity

Cooperative Name	Average Production Volume (Kg/Year)	Current Storage Capacity (Kg)	Loss Due to Insufficient Storage (%)	Expected Reduction in Storage Loss with AI (%)
Cooperative 1 (Argan Oil Cooperative)	5000	3000	20%	10%
Cooperative 2 (Rose Oil Cooperative)	4000	2000	30%	15%
Cooperative 3 (Saffron Cooperative)	1000	800	10%	5%
Cooperative 4 (Herbs and Spices Cooperative)	8000	5000	25%	20%

This table presents the average production volume, current storage capacity, loss percentage due to insufficient storage, and the expected reduction in storage loss with the integration of AI for four cooperatives (Argan Oil Cooperative, Rose Oil Cooperative, Saffron Cooperative, and Herbs and Spices Cooperative). Cooperative 1, with an average production volume of 5000 kg/year and a current storage capacity of 3000 kg, experiences a 20% loss due to insufficient storage, which is expected to decrease by 10% through AI implementation. Cooperative 2, producing 4000 kg/year and having a storage capacity of 2000 kg, faces a 30% loss that can potentially be reduced by 15% with AI-based solutions. Cooperative 3, with an average production volume of 1000 kg/year and a current storage capacity of 800 kg, incurs a 10% loss that could be diminished by 5% with AI integration. Lastly, Cooperative 4, producing 8000 kg/year and having a storage capacity of 5000 kg, experiences a 25% loss due to insufficient storage, which is expected to decrease by 20% through AI implementation. By leveraging AI to optimize storage efficiency, these cooperatives can significantly reduce loss percentages, maximize their productivity, and ensure better utilization of their available storage capacity.

The survey responses from the cooperatives dealing with aromatic and medicinal plants provide valuable insights into their understanding of supply chain applications, current challenges, and interest in integrating AI into their operations. A pattern that emerges from the collected data is the significant opportunity for improvements in various aspects of supply chain management through the application of AI. The cooperatives, despite having a fair to good understanding of supply chain operations, highlighted significant challenges that they are currently facing. These range from difficulties in demand prediction and quality control to inventory management and market reach. Notably, most of these issues can be effectively addressed through the strategic application of AI, as evidenced by the AI models tested in this study.

For instance, the use of predictive analytics can improve demand forecasting, thereby reducing over or under-production. Similarly, the application of AI in

logistics can optimize routing and scheduling, improving quality control, and reducing wastage. Additionally, AI-based marketing strategies can enhance market reach and brand recognition, addressing the marketing challenges that the cooperatives currently face. However, there are concerns about the cost, technical complexity, and the need for digital literacy, which can be barriers to AI adoption. Therefore, while advocating for the integration of AI, it is also crucial to provide the necessary support in terms of technical training, funding, and infrastructure development.

In terms of the potential benefits of AI, the cooperatives have indicated that they expect to see improvements in profitability, reduction in wastage, better pricing, and increased export opportunities. With the right strategies and support, these benefits can contribute to the overall sustainability and growth of the cooperatives, benefiting not just the cooperatives themselves but also the farmers and communities they represent. This study underscores the significant potential of AI (Feed forward Network model) in addressing the challenges in the supply chain management of aromatic and medicinal plants in Moroccan cooperatives. The findings highlight the need for further research, investment, and policy focus in this area to fully realize the benefits of AI.

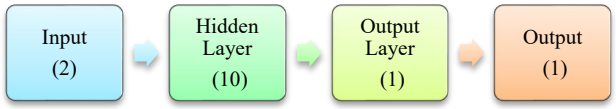

Figure 2. Feed forward Network model used in the practical study

Figure 2 presents the feed-forward model which is a type of neural network where data flows only in one direction, from input to output. It lacks feedback loops, making it simpler and computationally efficient. Information passes through multiple hidden layers, each layer performing distinct transformations. Popular in classification and regression tasks due to their straightforward structure and ease of training.

5. CONCLUSION

This research, focusing on the integration of artificial intelligence (AI) into the supply chain of aromatic and medicinal plants, has shed light on the immense potential for efficiency improvements, cost reduction, and decision-making optimization in this critical field. Through the development and testing of predictive analytics, optimization, and real-time tracking models, it has become evident that AI can address many of the existing challenges within this supply chain, ranging from demand-supply mismatches to perishability issues and lack of real-time tracking. However, the integration of AI into this field is not without its hurdles. The research identified upfront costs, need for technical expertise, and data privacy and security concerns as potential barriers to the effective implementation of AI technologies. Addressing these challenges requires a coordinated effort from stakeholders across the supply chain, from small-scale farmers to large corporations, as well as policy-makers and researchers.

Nevertheless, the benefits of AI integration far outweigh the challenges. With improvements in efficiency and cost-effectiveness, the supply chain of aromatic and medicinal plants can become more robust, resilient, and sustainable. Real-time tracking can enhance transparency and build consumer trust, while predictive analytics and optimization can aid in making proactive and informed decisions, reducing wastage and improving profitability. This research underscores the transformative potential of AI in agricultural supply chains, particularly for aromatic and medicinal plants. As we move towards an increasingly digital era, it is imperative to leverage the power of AI and other technological advancements to drive sustainable growth and development. Further research and investment into the practical applications of AI in this field are strongly encouraged to realize its full potential. This study serves as a stepping stone towards that future, providing insights and directions for subsequent research and practical endeavors. Based on the analysis of the collected data from various cooperatives working with aromatic and medicinal plants in Morocco, it's evident that they are encountering significant challenges in their supply chain, marketing strategies, and storage capacities. The cooperatives, including the Argan Oil Cooperative, Rose Oil Cooperative, Saffron Cooperative, and the Herbs and Spices Cooperative, each face unique challenges that impact their efficiency, reach, and profitability. These range from limited market reach and brand recognition to inefficiencies in inventory management and storage, leading to considerable losses.

One recurring theme across these cooperatives is the potential role that artificial intelligence (AI) can play in mitigating these challenges. AI's application in supply chain optimization, marketing strategies, and inventory management could significantly improve operations, reduce losses, and enhance profitability. For instance, AI could help optimize inventory levels and logistics, thus reducing losses due to overproduction and insufficient storage. Similarly, AI's application in digital marketing, such as audience targeting and personalized marketing, could enhance the cooperatives' market reach and brand recognition. However, it's important to note that the successful implementation of AI would require addressing barriers such as the cost of technology, the need for technical expertise, and data privacy concerns. In conclusion, the integration of AI presents a promising solution to the challenges faced by these cooperatives. It highlights the need for investment in technology and training to leverage AI's benefits fully. This study underscores the transformative potential of AI in agricultural cooperatives, advocating for further research and practical exploration in this field.

REFERENCES

[1] S. Modgil, R.K. Singh, C. Hannibal, "Artificial Intelligence for Supply Chain Resilience: Learning from COVID-19", The International Journal of Logistics Management, 2021.

[2] S.K. Baduge, et al., "Artificial Intelligence and Smart Vision for Building and Construction 4.0: Machine and

Deep Learning Methods and Applications", Automation in Construction, Vol. 141, p. 104440, 2022.
[3] A. Moumen, Z. Laabid, A. Lakhdar, K. Mansouri, "Prediction of the Mechanical Properties of Polypropylene Reinforced with Snail Shell Powder with a Deep Neural Network Model and the Finite Element Method", Presented at IOP Conference Series: Materials Science and Engineering, IOP Publishing, p. 012009, 2021.
[4] F.F. Rad, et al., "Industry 4.0 and Supply Chain Performance: A Systematic Literature Review of the Benefits, Challenges, and Critical Success Factors of 11 Core Technologies", Industrial Marketing Management, Vol. 105, pp. 268-293, 2022.
[5] P.A.W. Putro, E.K. Purwaningsih, D.I. Sensuse, R.R. Suryono, "Model and Implementation of Rice Supply Chain Management: A Literature Review", Procedia Computer Science, Vol. 197, pp. 453-460, 2022.
[6] R. Tang, et al., "A Literature Review of Artificial Intelligence Applications in Railway Systems", Transportation Research Part C: Emerging Technologies, Vol. 140, p. 103679, 2022.
[7] P. Unal, O. Albayrak, M. Jomaa, A.J. Berre, "Data-Driven Artificial Intelligence and Predictive Analytics for the Maintenance of Industrial Machinery with Hybrid and Cognitive Digital Twins", Technologies and Applications for Big Data Value, Springer, pp. 299-319, 2022.
[8] Y. Haddi, A. Moumen, A. Kharchaf, "Study of A Mobile Robot's Obstacle Avoidance Behavior in A Radioactive Environment with A High Level of Autonomy", International Journal on Technical and Physical Problems of Engineering (IJTPE), Issue 50, pp. 34-41, 2022.
[9] A.M.A.L.K. Mansouri, "Elastoplastic Behavior of Polybutylene Terephthalate Polyester Bio Loaded by two Sustainable and Ecological Fibers of Animal Origin with Two Numerical Methods", 2021.
[10] C.J. Wu, et al., "Sustainable AI: Environmental Implications, Challenges and Opportunities", Proceedings of Machine Learning and Systems, Vol. 4, pp. 795-813, 2022.
[11] M.C. Chiu, W.M. Yan, S.A. Bhat, N.F. Huang, "Development of Smart Aquaculture Farm Management System Using IoT and AI-based Surrogate Models", Journal of Agriculture and Food Research, Vol. 9, p. 100357, 2022.

BIOGRAPHIES

Name: **Kaoutar**
Surname: **Chbani**
Birthday: 08.11.1981
Birthplace: Casa, Morocco
Bachelor: Economics and Management Department, Hassan II University, Mohammedia, Morocco, 2004
Master: Logistics, Management Department at Abdelmalek Saadi University, Tangier, Morocco, 2011
Doctorate: Student, Supply Chain Application for Pam Using Artificial Intelligence, Faculty of Taza, Sidi Mohamed Ben Abdellah University, Fez, Morocco, Since 2019
The Last Scientific Position: Lecturer, Secondary School, Tangier, Morocco, Since 2022
Research Interests: Supply Chain, Artificial Intelligence, Numerical Analysis

Name: **Jaouad**
Surname: **Bouarfa**
Birthday: 25.09.1972
Birthplace: Taza, Morocco
Bachelor: Supply Chain, Faculty of Taza, Sidi Mohamed Ben Abdellah University, Fez, Morocco, 2000
Master: Supply Chain, Faculty of Taza, Sidi Mohamed Ben Abdellah University, Fez, Morocco, 2002
Doctorate: Energetic Department, Faculty of Taza, Sidi Mohamed Ben Abdellah University, Fez, Morocco, 2005
The Last Scientific Position: Prof., Energetic Department, Faculty of Taza, Sidi Mohamed Ben Abdellah University, Fez, Morocco, Since 2005
Research Interests: Supply Chain, Artificial Intelligence
Scientific Publications: 2 Papers, 1 Book, 1 Thesis