Agri-Food System and Artificial Intelligence: Reconsidering Imperishability

Siddhartha Vadlamudi

AT & T Services Inc., Vintech Solutions, Plano, TX, **USA**

*Corresponding Email: vadlamudisiddhartha@gmail.com

ABSTRACT

This research work aims to investigate the function of artificial intelligence (AI) in agri-food industry, considering their effects in the sustainable development of the environment and society, as well as to understand the role of stakeholders in its supply chain. For more than a decade, scholars, technology experts and practitioners have paid rapid attention to artificial intelligence (AI) technologies innovations and their roles in operational processes management and its challenges for new business models, in a sustainable and socially responsible perspective. Therefore, these stakeholders of agri-food organization can now assume a proactive or marginal role in the value creation for business based of their individual environmental awareness. Although the issues associated to the adoption of new technologies still appears "open" in some industries, such as the agri-food system, rethinking and redesigning the whole business model is required for sustainable development. Methodologically, an in-depth survey and review of the scholar's literatures of relevant information about this subject matter was carried out following two major phases: firstly, was the extraction of related articles from scientific databases (Web of Science, Scopus, and Google Scholar) while the second phase involved analyzing the selected articles. The findings denoted major issues about Artificial intelligence towards a "space economy" to achieve sustainable and responsible business models.

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INTRODUCTION

For the past decades, extensive progress in the improvement of human welfare, sustainability and other development has been achieved worldwide and hence, the society has observe radical changes thanks to the quantum leaps in technology, rapid growth in urban centers and revolution in various production system. Yet with these various innovations and technological enhancements, so much more remain to be done to fulfill the vision of the food and agriculture organization of the United Nation (FAO) which are aimed to create a world totally free from hunger and malnutrition. In order to create such world, food and agriculture has to be the major contributing factors to improve the

standard of living of all, especially the poorest of the poor, and this has to be done in an economically, socially and environmentally sustainable manner.

Billions of people are faced with pervasive poverty, gross inequality, joblessness, environmental degradation, diseases and deprivation while dwelling in great plenty, hence hunger and malnutrition remains a huge challenge in many parts of the world. Expanding food production and agricultural growth has become a challenge that has threatened the sustainability of food system and underlines the world capacity to meet its food needs. With the various challenges facing agricultural growth and food production, there is a crucial need for more advanced method in solving the multiple problems facing agriculture and other food production system.

In the past decades, due to growing need in technological advancement various scholars and other expects have taken a more thorough interest in artificial intelligence (AI) technologies. Several of these scholars have made notable attempts to provide a more suitable definition for artificial intelligence (AI). Some authors defines AI as the ability of a "machine" to develop "clever" understanding of the inputs provided by the environment, or better still it's ability to decipher the external variables by a flexible mechanical configuration (Donepudi, 2017). By this definition, AI represents a very unique way to create and manage the available information in a business model properly (Mikalef et al., 2017; Donepudi, 2014a), including the link between innovation and sustainability (Donepudi, 2014b). For some scholars, AI referred to a set of technology designed to successful carry out functions that we traditional thinks only requires human intelligence. Artificial intelligence are computer systems that are designed to identify objects, allocate resources optimally, recognize patter and anomalies, predicts failure, solve problems, navigate through complex system, make personalized recommendation and it also has the ability to learn.

Due to the unprecedented threats from global problems such as climate change, and growing demands from food and other agricultural products, technologies that gives valuable impact to sustainability and deliver greater benefit to the environment and society has to be of utmost importance. Sustainable business models (SBMs) is the alternative strategy tool to enable the society address these challenges and position them to thrive in the future. However, these sustainable business models (SBMs) have to include three key dimensions, which are namely, economic, environmental, and social (Elkington, 2013), and these three dimensions are all interdependent on each other. The need to ensure that there is adequate nutrition for the growing human population depends on the system ability to guarantee sustainable agricultural and food production, and as such increases the efficiency of the production processes as well as reduces their negative effects on the environment (Donepudi, 2014b).

It is important to note that a growing number of enterprises are creating solutions for agri-food systems, depending on the capacity of artificial intelligence to solving multiple problems and saving valuable resources while also reducing environmental damage. The used of AI technologies in process management requires the use of business models that include sustainable and socially responsible issues. Hence, sustainable business model can be defined as a business model that effectively creates, delivers, and captures the value for all its stakeholders without effectively reducing the natural, economic, and social capital it relies on. These sustable business models create a very competitive advantage for various enterprises without having any advert effect on the environment and society (Vadlamudi, 2015).

In this suitable business models, the stakeholders can assume different roles inorder to create value. One of such role is the proactive behavior that deals with the adoption of AI and sustainable practices in operational processes; or marginal behavior, that has no relevant compared to artificial machine technologies).

The role of these stakeholders (e.g., technical equipment suppliers, customers' associations, public institutions, suppliers, etc.) in the supply chain could be as a result of environmentally aware toward the realization of sustainable organizations, which is in line with sustainable development (SD) approach that may include digital, and training dimensions, economic, social and environmental dimensions (Donepudi, 2017). Finding the balance between technology and responsible business seem as the "open" issues in the agri-food industry. Therefore, the used of AI technologies requires a deep and critical rethinking in order to develop a more suitable "way" to carry out business, especially those involved in operational processes, and, others in general. This Artificial intelligence technology is identified as the main technological tool that can effortlessly aid sustainability during pandemic, and this is characterized by its capacity in managing the pandemic by enforcing social distancing measures.

To achieve an in-depth understanding of this topic under consideration, we can try to bridge the research gap by answering these few research questions that are aimed to give tangible insight into the subject of study. The research questions are;

- What are the main functions of Artificial intelligence in the agri-food business models from a sustainable perspective?
- What is the new role of the stakeholder in the agri-food supply chain?

The structural organization of this study composes of six main sections, which includes; Section 1: introduction to Artificial intelligence, sustainable business model and other relative terms. In Section 2 discusses theoretical framework on the issues proposed. Section 3 documents methodology. In Section 4: findings and main theoretical insights of the research is discussed. In 5, theoretical and managerial implications of the research are done while section 6 has conclusions, limitations, and future research perspectives.

THEORETICAL BACKGROUND

The discovery of Artificial intelligence and its potential in the various sectors of the society determine the assessment of its effects and contribution to sustainable development (Vadlamudi, 2017). This is possible because various companies are required to face the challenge of sustainability, while trying to improve the scope of innovations and preserve the integrity of the ecosystem at the same time these companies has to improve the use of natural resources (Joyce and Paquin, 2016). Agriculture as we known is at the center of profound renewal and its focus is on digital technologies, mainly Artificial intelligence, machine learning and others to realize traceability of supply chains (Sun et al., 2018). These technologies is an important mode designed to protect consumers and improve the quality of agricultural production, especially in its application in the agri-food sector of AI, which acts combines the modern sensory technologies with the ability of computer processing.
In agriculture, these technological innovations has application as; 1) mobile apps "enhanced" by Artificial intelligence that are supplied to agronomists are able to immediately identify problems in framed plants and solution of such problem can also be identified and administered. 2) Robots (physical and software) are very sophisticated machines designed to solve more or less complex problems, some are designed to speeds up

the most repetitive tasks, such as weed and fruit harvesting or packaging. 3) Drones and self-driving tractors allow precision farming models to be translated into practice. 4) Robots can effectively calculate the exact condition of soil and crops and has the ability to connect to satellites in order to understand how much water is really needed by crops or livestock without wasting resources. There are increase in the importance of Artificial intelligence role in food industry due to its ability to aid in food storage, improve the hygiene and safety of production sites, and in the cleaning up of food processing equipment; therefore, there are many use of artificial intelligence and machine learning in the food industry.

The development of technologies such as Artificial Intelligence has made it possible to perform various activities, such as; reduction of waste, toxic impact of surpluses, poverty, and malnutrition, hence enterprises that are oriented to perform some of these activities can do so effectively and as such economic growth and sustainable development can be achieved. Enterprises using Artificial Intelligence for sustainable development goals may also not be able to manage its long-term impact, and this become a challenge especially in the case of privacy issues due to AI application data (Donepudi, 2014a). For such challenges, new concepts are introduced, such as "space economy" and "environmental space" and this new economy looks to the future for a new environment in which to develop new technologies that can be useful on Earth and for precision agriculture. This is a reality that is shaping the global market serving as an ecosystem in which both public and private sectors coexist, and this system involves new players (shareholders) such as farmers, processors, distributors and investors who propose business models that has to be included in all sustainability and responsibility issues.

METHODOLOGY

The methodology used in this research was the qualitative approach which made emphasis on various Artificial intelligence article's contents and in particularly, the sustainable business models adopted by agri-food industries. We conducted the analysis using the contributing literatures of scholars in order to analyze and systematize the state of art on Artificial intelligence and Sustainable Business Models towards Sustainable Developmental Goals, and more focus was on the concept of "social distancing". In the course of this methodology approach, various phases were planned and these phases are as follow; Firstly, we researched, extracted and studied relevant documents, using literature contribution of scholars; secondly, we critically analyzed these selected articles drawing relevant information that was of important to this work.

The first phase of this methodology was in three steps. 1) Research and extraction of related articles from various library databases (extraction step), 2) Identification of the main relevant articles (identification step), 3) Manually conducting the localization of the articles cited (localization step). The second phase involved critical analysis of the identified articles to point out and systematize the most important research paths. In addition, it should also be noted that in order to identify all documents useful for this research, cut-off combinations of two classes of search strings was adopted and this classes included the articles about AI and agriculture industry and the articles on AI, business models, and sustainability. Various important key words were used in line with the aims of our research. Specifically, "business model" and "Artificial Intelligence", "sustainability", and "social responsibility" were among those significantly used. These words were combined with the following key words: "stakeholder", "environmentally aware", "SDGs", "agri-food industry", and "uncertain environment", in order to extracted relevant articles for identification.

In order to effectively identify the relevant articles that were previously extracted, the abstracts of each article had to be read to guarantee their relevance with the study aims. The basic understanding of the abstracts of each extracted articles allowed us to highlight their relationship with the investigated topic. Moreover, all articles extracted and identified were studied separately to highlight the critical and relevant aspects useful for our study while those not useful were removed. By the end of this phase, our database included 60 articles with relevant information useful for this study.

FINDINGS

From the analysis of articles extracted and identified in our data collection phase, the results showed that the word that occurs most frequently are "business model", "Artificial Intelligence", "sustainability", and "social responsibility" and these are represented in order of occurrence, "business model" occurred more frequently while "social responsibility" occurred least. When the words above were variously combined with "stakeholder", "environmentally aware", "SDGs", "agri-food industry", and "uncertain environment", the findings had no significant result.

The combination of words among "business model", "Artificial Intelligence", "sustainability", "social responsibility", and "agri-food industry" provided results that allowed for the identification of relevant need for coordination and communication in the food industry.

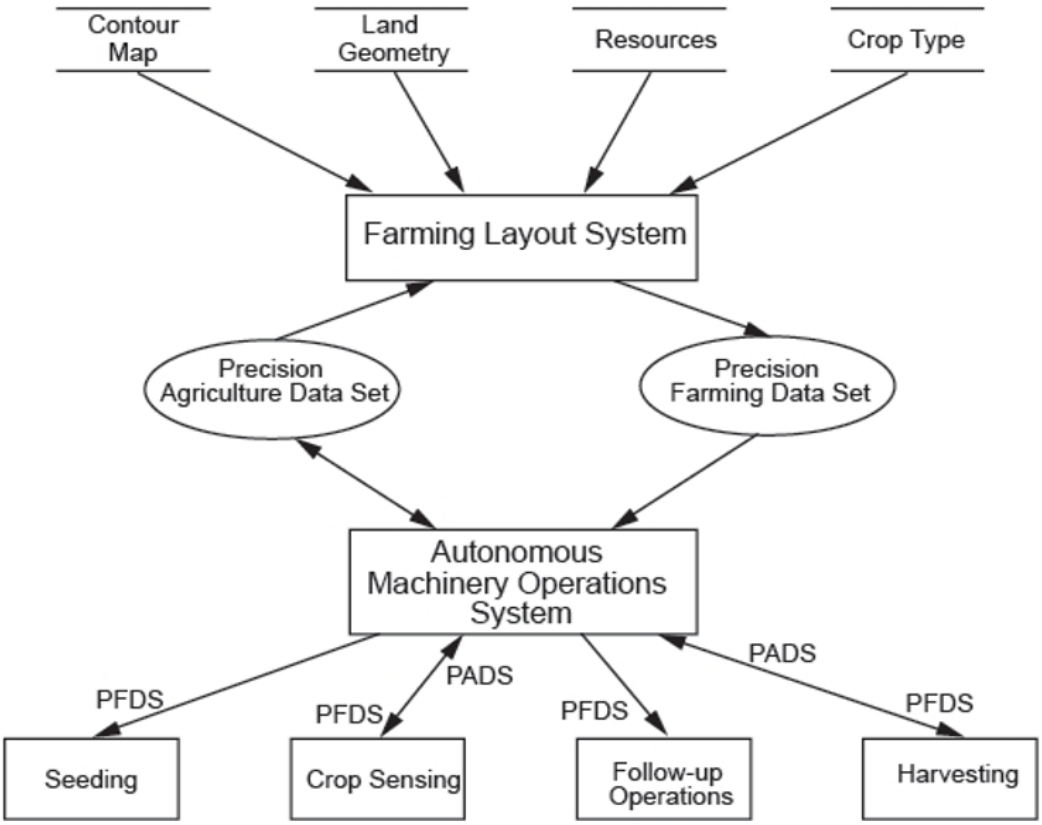

Figure 1: AI and Agriculture: Application and Challenges

Some scholars have proof that AI technology has since been considered as an application that increases the levels of efficiency and production in food industry, especially when it's aimed to fill the shortages as a result of labor scarcity and reduce the environmental impacts of the various operating systems that are related to agri-food practices. Therefore, the integration of technological innovation with Artificial intelligence seem to be a significant change for business models, whose main aim is to be able to respond to challenges required by environmentally and socially sustainable issues. Indeed, the used of Artificial intelligence in fertilizers, pesticides, and systemized irrigation processes also allows great achievement in the reduction of environmental effects. These findings showed that Artificial intelligence technology has its merit in terms of productivity, efficiency, as well as its ability to reduce production cost. As a result, Artificial intelligence technology changes the operation modules and their management in farms.

From the study it was also observed that some scholars has proof of the relationship between Artificial intelligence and sustainable business models and also proof that sustainability has become a significant field in many commercial operations (Filho, 2017; Orriols-Puig et al., 2013). Research also showed that Artificial intelligence aid in making better decisions and policy regulations (Wirtz and Müller, 2018).

Conclusively, it becomes a fundamental practice for enterprises to used Artificial intelligence and sustainable business models in identifying strategies to dominate their respective competitive sector as well as extract new valuable information from large sets of data that could be useful to guide decision making and proper company management (Orriols-Puig et al., 2013). The findings from this research also showed increasing scholars interest on Artificial intelligence from the content of various articles examined.

DISCUSSION AND THEORETICAL AND MANAGERIAL IMPLICATIONS

The research carried out on scholars main contributing literatures on Artificial Intelligence operational processes in agri-food sector using sustainable development perspective showed some highlighted paths still not defined, and from the analytical findings it was observed that; 1) Since Artificial intelligence technology is regarded as the solution to improving the efficiency and the productivity of the agri-food sector, and has an important role in its ability to recognize the technology contribution in reaching sustainable developmental goals, the analysis of the involvement of stakeholders and also on their importance in this process is still missing. 2) If the general and new technological issues of Artificial intelligence direct scholars to consider agri-food sector as an ecosystem, allowing both public and private sectors to coexist in the same area, at the same time, all stakeholders involved in the supply chain (i.e., farmers, processors, investors, and so on) are considered as actors of business models founded on sustainability and responsibility themes. However, the findings showed that in the literature analyzed, the attention ascribed to the roles of stakeholders in the changing developmental processes, which involves rethink and redesign business models for sustainability, is still under-researched. Even so, some scholars articles on sustainability issues, especially those divulge topic, have drawn to conclusions that academic debate is still missing on sustainable practices adopted by the enterprises to obtain sustainable organization models (Donepudi, 2017). Thus, the result from the subject under consideration is in line with other previous studies.

It is important to note that the "environmental awareness" of the enterprises, and most importantly of all stakeholders involved in agri-food supply chain, remains still an open issue as the literatures analyzed during the course of this study, considering the rethinking

and redesigning of business models, has provided a clear guide to thoroughly investigate all its dimensions in a systemic perspective towards the achievement of Sustainable Developmental Goals.

Agri-food organizations uses Artificial intelligence in addressing and identifying solutions to improve the competitiveness of business, and also in limit the negative effects of such organization on the environment (Donepudi, 2014b) leading to the achievement of its developmental goals. Nevertheless, Artificial intelligence has the ultimate potential to address some of the most pressing challenges for the future of humanity, such as the achievement of Sustainable Developmental Goals (Vadlamudi, 2015).

According to Donepudi (2014b) the success of an Enterprise will depend largely on its ability to innovate operations, products, and services, via human capital. Therefore even if Artificial intelligence will eliminate some jobs as human services will be reduced by the use of such technology in the next decade, it can also create new opportunities for the collaboration between man and machine. However, some scholars have examined the ethical and social aspects relating to the use of Artificial Intelligence and it was observed that the advancement in company automation could accentuate the growing difference between less technological counties and more developed ones (Vadlamudi, 2016). Hence, the goal of this study is to encourage enterprises to adopt sustainable practices that aid in supporting developing countries, thereby improving the scientific and technological capabilities of such counties, and also aiding them to develop and implement more sustainable models alongside with production and consumption tools to monitor the impacts of sustainable development.

From this research and as underlined by main researcher, the role of all stakeholders is fundamental for the development of the entire agri-food system, and specifically for both technological innovation and sustainable evolution of the system, and it's also important for the creation of advanced management methods. Innovations and technological adaptation in the agri-food sector are needed in order to also create a more productive and sustainable food supply. The dissipation of global retailers and the establishment of modern channels of both distribution and sourcing in combination with affluent domestic demand for higher-quality products, have resulted in the significant transformation in food retail systems everywhere. Hence, agri-food sector needs evolutionary rather than revolutionary changes to reshape its institutions. The major significant of multiple social views as well as stakeholder involvement in agri-food innovation has become clearer, therefore, flexible goals are of more important to process-oriented management of innovation, but the essential role of profit in anchoring sustainable development in business is also of utmost important. There is still no best solution for assuring that the agri-food sector are more sustainable all over the world, but a combination of ranges of solutions and approaches is likely to provide the best way forward. The factor that was not properly investigated so far and should be investigate and added to the basic literatures of information is the decisive role that stakeholders can play in the identification, development, and promotion of new Artificial intelligence technologies and they must be able to direct the agri-food system towards new dimensions in the near future, both in economic terms and also in terms of sustainability and business management, according to what is in the innovative possibilities also dictated by the new space economy.

CONCLUSIONS, LIMITATIONS, AND FUTURE RESEARCH PERSPECTIVES

The findings from the analysis conducted denoted that the literature of scholars developed only some aspects in sustainable development through Artificial intelligence. However, digital technologies can help create sustainable business models yielding increase

productivity; production costs reduction and also decreases intensity of production process resources while improving correspondence in markets (Donepudi, 2014a). It gives answer to the research question that highlights the role of Artificial Intelligence in the agri-food business models, in correspondence to the sustainable perspective. It is important to note that Less attention has been paid to guidelines established for companies with interest in facing the challenge of the correlation between human health and health of natural systems; same level of attention had also been given in addressing the roles in which each stakeholder can assume in the changing of business models in the agri-food sector, and this give answer to the second research question.

However, the promotion of the sustainable development goals of a business is not the only issues that should be addressed, other factors like the evolution of disruptive technology should be managed by adopting organic vision of culture in order to potentially reduce the it's harmful uses for man and society. It is observed that globally various politicians, researchers, and companies are cooperating to develop a common principles that should ensure a guided response to the application of all relative Artificial Intelligence technologies. It is also important that the cooperation of scholars, professionals, and institutions should drive their effort towards "environmental awareness", in order to analyze and find solutions to the issues in this study, in order to successfully implement a public–private partnership network, and also in anticipating and managing the profound social changes linked to the digital revolution.

The main limitation of this study is as a result of the analysis that is only based on articles researched on the basis of specific key words and on the combination among them. However, this limitation has an advantage point because it create avenue "to open" the topic to future research thereby providing elements for a new approach to Artificial Intelligence technologies accepted into the agri-food sector.

With the rapid spread of the pandemic, the attitude and interest of food consumers has also changed rapidly, hence, companies had to forcefully respond to the already changing needs of the population as a result of the pandemic, thereby changing their production activity. In order to control the spread of the pandemic, markets had to deal with the changes that occurred as a result of the change in population needs and this has highlighted the necessity for a very rapid rethinking in management and business models. This rethink in business models overhauling the following dimensions: environmental, economic, technological, educational and training, and social.

Following the urgent need to maintain social distance for the health of all players due to the current pandemic, the agri-food system can adopted the used of Artificial Intelligence to both represent and aid all levels of the agri-food sectors including both for agriculture, food industry and for large-scale distribution.

REFERENCES

Donepudi, P. K. (2014a). Technology Growth in Shipping Industry: An Overview. *American Journal of Trade and Policy, 1*(3), 137-142. https://doi.org/10.18034/ajtp.v1i3.503

Donepudi, P. K. (2014b). Voice Search Technology: An Overview. *Engineering International, 2*(2), 91-102. https://doi.org/10.18034/ei.v2i2.502

Donepudi, P. K. (2017). AI and Machine Learning in Banking: A Systematic Literature Review. *Asian Journal of Applied Science and Engineering, 6*(3), 157–162. http://doi.org/10.5281/zenodo.4109672

Elkington, J. (2013). Enter the triple bottom line. In *The Triple Bottom Line*; Routledge: London, UK, pp. 23–38.

Filho, N.D.P.A. (2017). The agenda 2030 for responsible management education: An applied methodology. *Int. J. Manag. Educ.* **15**, 183–191.

Joyce, A. and Paquin, R.L. (2016). The triple layered business model canvas: A tool to design more sustainable business models. *J. Clean. Prod.* **135**, 1474–1486.

Mikalef, P., Framnes, V.A., Danielsen, F., Krogstie, J. and Olsen, D. (2017). Big Data Analytics Capability: Antecedents and Business Value. In Proceedings of the Pacific Asia Conference on Information Systems, Langkawi Island, Malaysia, p. 136.

Orriols-Puig, A., Martínez-López, F.J., Casillas, J. and Lee, N. (2013). Unsupervised KDD to creatively support managers' decision making with fuzzy association rules: A distribution channel application. *Ind. Mark. Manag.* **42**, 532–543.

Sun, Q., Zhang, M. and Mujumdar, A.S. (2018). Recent developments of artificial intelligence in drying of fresh food: A review. *Crit. Rev. Food Sci. Nutr.* **59**, 2258–2275.

Vadlamudi, S. (2015). Enabling Trustworthiness in Artificial Intelligence - A Detailed Discussion. *Engineering International*, *3*(2), 105-114. https://doi.org/10.18034/ei.v3i2.519

Vadlamudi, S. (2016). What Impact does Internet of Things have on Project Management in Project based Firms?. *Asian Business Review*, *6*(3), 179-186. https://doi.org/10.18034/abr.v6i3.520

Vadlamudi, S. (2017). Stock Market Prediction using Machine Learning: A Systematic Literature Review. *American Journal of Trade and Policy*, *4*(3), 123-128. https://doi.org/10.18034/ajtp.v4i3.521

Wirtz, B.W. and Müller, W.M. (2018). An integrated artificial intelligence framework for public management. *Public Manag. Rev.* **21**, 1076–1100.

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https://journals.abc.us.org/index.php/ajase/issue/archive