

SMART LOGISTICS AND ARTIFICIAL INTELLIGENCE PRACTICES IN INDUSTRY 4.0 ERA

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ABSTRACT

The purpose of this paper is to analyze the factors that affect success of logistics companies adopting AI by studying the application of AI in the logistics industry. Although the application of technology and artificial intelligence has been widely studied, the factors affecting the adoption of Artificial Intelligence (AI) are still unknown in the existing literature. Therefore, the main research in this paper is to explore the influence of success factors on AI by integrating technology, organization and environment (TOE) framework. The framework is judged by case analysis of logistics companies. This study provides some suggestions on successful adoption of AI technology for their logistics operations.

KEYWORDS

Smart Logistics, Artificial Intelligence, Industry 4.0, Hong Kong

1. INTRODUCTION

1.1. Background

The future development trend of industry is smart manufacturing, which leads to the enhancement of smart logistics, often called industry 4.0. The adoption of knowledge and technologies towards industry 4.0 is crucial to maintain Hong Kong's function as the leading regional and global logistics hub.

Benefits of Digital Transformation & industry 4.0 are:

- Real time integrated process optimization
- Reduce the delivery time by advanced forecasting approaches
- New transport concepts to manage the last mile delivery efficiency
- Leverage the human planner for the disruptive events

Moreover, a lot of companies and organizations choose to use artificial intelligence (AI) for various purposes, because AI is now a very powerful tool, which can help these companies to stand out from their competitors and reduce the chance of making mistakes. AI enables the system to automatically make wise decisions and perform tasks without human intervention. With the rise of AI and big data, many industries are in the transition period from manned to unmanned, and logistics industry is also undergoing the transition from fully manned to fully automated. In recent years, with the rapid development of economy and increase of application scope of AI, more logistics companies try to adopt AI technology to optimize logistics operations to enhance their performance.

1.2. Objectives

The objective of this study is to provide a detail literature review and explore how to address the importance of digital transformation& AI as well as identify the factors affecting successful implementation of AI in Logistics Service Providers (LSPs). Besides, some policy recommendations and practical measures will provide in this study.

2. LITERATURE REVIEW

2.1. Importance of Digital Transformation with Smart Logistics

In view of intense market competition and the need for industrial transformation and upgrade, Mainland China and Hong Kong are encouraging enterprises to enhance their product R&D capabilities and production technologies, while adopting innovative supply-chain management practices. In October 2017, the State Council issued its Guiding Opinions on Actively Promoting Supply Chain Innovation and Application. By Year 2020, this initiative will see all of China's major industrial sectors benefitting from new technologies and new supply chain development business models, as well as having access to smart supply-chain systems. (HKTDC, 2021)

What is smart logistics?

Smart logistics is the enhancement of the distribution element of the supply chain through advanced and intelligent technology. Not only do smart logistics technologies aim to improve efficiency, but also to reduce the environmental impact of global trade.

Specific to the logistics industry is smart software that will automate many different levels or steps of the chain as well as flag any potential issues from the use of predictive analytics. Smart logistics software utilizes real time data streaming from a vast variety of sources thanks to the Internet of Things to give highly accurate and automated processes, such as the initial scheduling and route planning of a consignment, the allocation of available vessels and vehicles, when to dispatch the consignment and under what conditions, and calculating the cost of a particular journey based on these variables and more. Factoring in external influences, such as weather patterns, predictive analytics can say whether a vessel will be delayed in arriving at a port due to a storm at sea.

Benefits of smart logistics

As with all smart initiatives, the main benefit and driving force is increased efficiency resulting in the provision of a better service and decreased overall costs.

The functionality of smart logistics leads to many benefits regardless the size of the company:

- By using available technology to automate parts of the supply chain it is possible to reduce the number of tasks carried out by people. This can help reduce monthly overheads such as wages which can often be crippling to SMEs.
- Improved operational efficiency as a result of automated sections of the logistics chain which will also lead to reduced overall costs and a reduction in waste.
- Improved communication and flow of goods through the supply chain will provide a more efficient service to end users.
- Improved customer service and experience will effect repeat business, with the aim of increasing it.

2.2. Artificial Intelligence

In the Dartmouth Research Project, AI is defined as the problem of making a machine run in a way that would be called intelligent if a human did the same (McCarthy et al., 1955). AI, sometimes referred to as machine intelligence, is the intelligence expressed by machines, which is opposite to the natural intelligence expressed by human being and other animals (Abdullayeva, 2019). In other words, this is a field of computer science, which emphasizes the creation of intelligent machines that work and react like humans being (Abdullayeva, 2019).

A more accurate definition is given by Coccia (2019), which identifies AI as the same ability of human beings to perform specific roles and tasks that would otherwise be performed by human beings in public places and social life. And this ability is stilling growing, which is comparable to human beings, even stronger than human beings in some cases. Kaplan & Haenlein (2019) considered that AI is the system's ability interpret external data correctly, he ability to learn from such data, and the ability to achieve specific goals and tasks by flexibly adapting to the use of such learning.

2.3. Major Factors for AI adoption

In this study, Technology, Organization and Environment (TOE) framework (Tornatzky & Fleischer, 1990) was applied, which illustrates the factors that influence technology adoption. A review of the research on the adoption of AI shows that the TOE framework provides a good starting point for the research on the adoption of AI (Chen & Chen, 2020). It not only emphasizes the specific background of the adoption process, but also can be used to evaluate the factors that affect the adoption of AI.

In this paper, the TOE framework (Rogers 2003) is used to explain at the organizational level the factors that impact the decision to adopt AI. With many scholars have cited the importance of this framework through many research, this study uses the TOE framework (Figure 1) to evaluate such practice in logistics companies in Hong Kong.

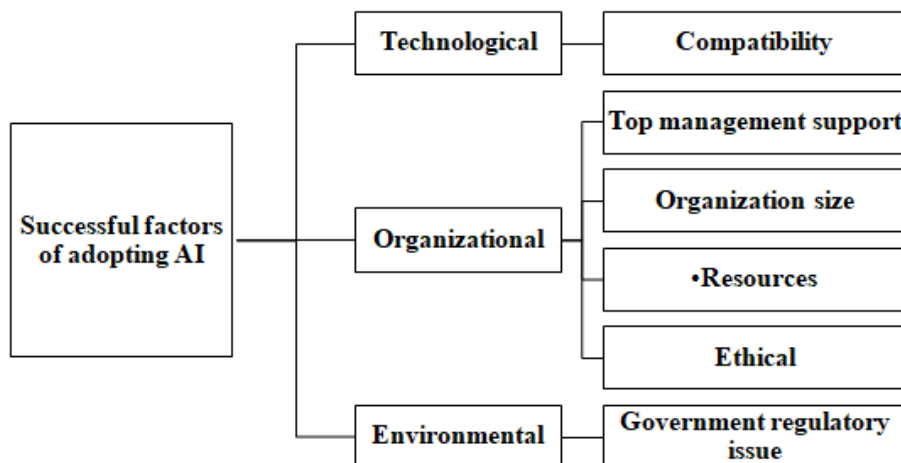


Figure 1. Research framework for AI adoption

Under this framework, there are mainly three perspectives. In terms of technology, it is compatibility. In terms of organization, there are top management support, organization size, resources and ethics. In terms of environment, there is government regulatory issue. The details of each factor will be described as follows.

2.3.1. Compatibility

Compatibility is an essential decisive factor of adoption innovation (Azadegan & Teich, 2010). It pointed out that advanced compatibility can lead to better adoption, which means that the higher compatibility, the higher adoption. If it is considered that the current work practice is compatible with AI technology, the company only needs to make some minor changes and adjustments, which can be used by employees. Incompatibility usually requires major changes to the process, which usually requires a mass of learning, which also means more resistance (Chen & Chen, 2020). Besides, technological capabilities are tangible assets that are essential to the adoption of innovation, such as computer hardware, data and networks (Aboelmaged, 2014).

2.3.2. Top Management Support

Top management support refers to the participation of top leaders in the implementation of information systems or information technology (Ifinedo, 2005). The resource-based theory considers top management support as a moderating factor and points out that the lack of support not only cannot improve the competitive position of companies but also rises their failure to adopt innovation (Wade & Hulland, 2004). In addition, the manager's commitment is the key factor of any significant company change, because it affects the allocation of resources and the integration of services (Co et al., 1998). AlSheibani et al. (2018) stated that the support of the top management has a positive effect on the readiness of AI. Therefore, the top management's support for the adoption of AI affects whether the company successfully applies AI.

2.3.3. Organization Size

The size of the organization directly influences the adoption of innovation (Rogers, 2003). Thiesse et al. (2011) observed that large organizations have more resources than small organizations, and large companies can bear more innovation risks. Duan et al. (2010) discovered that large corporations have a more comprehensive capacity to adopt technology. According to the research of Garrison et al. (2015), the research evaluates the size of a company based on the number of employees. In addition, Abolmaged (2014) stated that large corporations have more financial and technical resources. AlSheibani et al. (2018) hypothesized that the size of the organization has a positive impact on the readiness of AI.

2.3.4. Resources

Iacovou et al. (1995) mentioned that human resources, enterprise and information technology resources are also key to the adoption of new innovations at the enterprise level. Aboelmaged (2014) pointed out that technology resources refer to the computer hardware, network and data required for adopting new innovations. Besides, AlSheibani et al. (2018) assumed that human, enterprise and technological resources have a positive impact on the readiness of artificial intelligence.

2.3.5. Ethical

Frankish and Ramsey (2014) mentioned that the current AI system has no moral status. The computer program may be changed, copied, terminated, deleted, or used at will. Thomsen (2019) believed that artificial intelligence should be subject to the same ethical rules as human beings, both in terms of cognitive skills and in terms of actual physical or influencing abilities like robots. According to a survey conducted by Liu (2020), when adopting AI, the ethics surrounding the use of AI is the third factor affecting the adoption of AI, and 29% of respondents mentioned that this

is very important. Another ethical issue is the unemployment caused by automation, which is the biggest problem for AI at present (Kantarci, 2021).

2.3.6. Government Regulatory Issue

Regulatory refer to the support afforded by government authorities to encourage the adoption of AI innovation at the company level. (AlSheibani et al., 2018). For example, in Hong Kong, the government has listed AI as one of Hong Kong's key technology areas (Yang, 2018). The framework set by the government is very significant because the adoption of new technology is a complicated process. AI, as an influential technology, contains many issues such as safety, privacy and social morality. Therefore, (Stoica et al. (2005) believed that AI requires a legislative or regulatory environment.

3. RESEARCH METHODOLOGY

The semi-structured interviews with qualitative research were carried out between January and May 2021. Interviewees and professionals were invited to share their views on AI and technology adoption in logistics companies. Qualitative research has the advantages of flexibility and ease of adaptation to environmental changes, and it can be carried out at minimal cost (Crossman, 2020). In addition, this research will use the case study method to analyze and find two famous logistics companies, namely DHL and Kerry Logistics. Secondary data sources were used to collect related information such as academic journals, company reports.

4. FINDINGS AND ANALYSIS

4.1. Compatibility

In terms of technological perspective, if AI technology is compatible with the current information technology conditions, the expected cost and time involved in its adoption will be reduced. Thus, AI can be adopted more easily (Chen & Chen, 2020). AI application is compatible with DHL's current hardware environment, infrastructure and computerized data resources. Because DHL already has digital transformation, robotics, computer vision and Internet of Things technologies to support DHL's logistics and distribution.

4.2. Top Management Support

In terms of organizational perspective, top management support, organization size, resources and ethics are the characteristics that can significantly impact AI adoption. For top management support, when top managers recognize AI and the whole company's work on AI, they can decide whether and how to use AI. Besides, when top managers distinguish AI applications as the highest priority, they will be more committed and agreeable to earmark funds and resources for their implementation. DHL is already using AI, such as DHL Parcel - Seamless, Voice-enabled Customer Interactions and DHL Resilience360 (Gesing et al., 2018). These show the support of DHL management for adopting AI. It may be an important asset for top managers in a company to support new technologies and the changes it brings.

4.3. Organization Size

For organization size, the size of a company will affect the adoption of AI, because large companies have more resources and funds than small companies, and they can take greater risks. For example, the cost of automatic general warehouse: the fully automated solution is at least 25

million dollars, the semi-automated solution is 5 to 15 million dollars, and the mechanized solution is 1 to 5 million dollars (Allen, 2020). These show that adopting AI requires high cost, so it is easier for large companies to adopt AI. DHL and Kerry Logistics are the global third-party logistics company, which are large-scale companies, and it can afford expensive AI costs. For example, Comboxx cooperated with Kerry Logistics to build it into an automated warehouse in Hong Kong - SuperHub one. Therefore, the size of the organization will affect whether the company has sufficient funds to support the adoption of AI.

4.4. Resources

Regarding resources, resources can be divided into existing staff and technology. Most companies focus more on technology than on adequate skills and implementation methods. For instance, the first hackathon organized by Kerry Logistics in 2019 combined robotics, machine learning and AI, and the team designed applications for autonomous drones to improve operational efficiency and accuracy. It shows that the existing personnel and technology of Kerry Logistics can support the development of AI. Therefore, resources help Kerry Logistics develop AI better.

4.5. Ethical

For ethical issue, according to research findings, some literatures emphasize that AI should follow the same ethical rules as human beings, especially the use of robots (Thomsen, 2019). For example, Kerry Logistics has introduced six robot butlers in its flagship factory in Hong Kong to speed up the delivery process, which is in line with the trend of e-commerce. These robots work 24 hours a day, 7 days a week, and can pick 280 items per hour, compared with 50 items under normal circumstances, which is four times faster. Besides, DHL mentioned that ethical concerns are vital for using AI.

4.6. Government Regulatory Issue

In terms of environmental perspective, government regulatory issue is also considered as one of the factors that companies need to consider adopting AI. Government regulations are policies on using AI applications, as well as rules, regulations and standards for using AI. However, a clear and accurate guideline related to security and privacy can avoid argument and disputes in the future.

5. CONCLUSION AND RECOMMENDATIONS

To sum up, the application of AI in logistics industry was discussed in this study. Six factors that should be paid attention to adopt AI successfully; namely Compatibility, Top management support, Organization size, Resources, Ethical and Government regulatory issue. There is no significant relationship between ethics and government regulation with AI adoption, however, more support with government and industrial professionals are vital to achieve successful AI practices. Through case analysis, it can identify the importance of those factors in the TOE framework. The sources of case analysis are based on semi-structured interviews and secondary data. The limitations of research are based on scholars' research and reports of some companies, which may be biased at times. Future research directions will focus on quantitative research, such as survey questionnaires to find out logistics companies' adoption of AI and related technologies.

REFERENCES

- [1] Abdullayeva, A. (2019). Impact of Artificial Intelligence on Agricultural, Healthcare and Logistics Industries. *Annals of Spiru Haret University. Economic Series*, 19(2), 167-175. <https://doi.org/10.26458/1929>
- [2] Allen, W. (2020). Factors to consider when moving to an automated warehouse - 6 River Systems. *6 River Systems*. Retrieved 20 February 2021, from <https://6river.com/considerations-for-moving-to-an-automated-warehouse/>.
- [3] Azadegan, A., & Teich, J. (2010). Effective benchmarking of innovation adoptions: A theoretical framework for e-procurement technologies. *Benchmarking: An International Journal*, 17(4), 472-490.
- [4] Chen, H., Li, L., & Chen, Y. (2020). Explore success factors that impact artificial intelligence adoption on telecom industry in China. *Journal Of Management Analytics*, 8(1), 36-68. <https://doi.org/10.1080/23270012.2020.1852895>
- [5] Coccia, M. (2019). Artificial Intelligence Technology in Cancer Imaging: Clinical Challenges for Detection of Lung and Breast Cancer. *Journal of Social and Administrative Sciences*, vol. 6, n. 2, pp. 82-98.
- [6] Crossman, A. (2020). *An Overview of Qualitative Research Methods*. ThoughtCo. Retrieved from <https://www.thoughtco.com/qualitative-research-methods-3026555>.
- [7] Gesing, B., Peterson, S., & Michelsen, D. (2018). *Artificial Intelligence in Logistics*. Matthias Heutger. Retrieved from http://www.globalhha.com/doclib/data/upload/doc_con/5e50c53c5bf67.pdf.
- [8] HKTDC (2021). *Internet Technology Company Builds Global Logistics Network in Hong Kong*. Retrieved from <https://research.hktdc.com/en/article/NjczMzc2MTk5>.
- [9] Kaplan, A., & Haenlein, M. (2019). Siri, Siri, in my hand: Who's the fairest in the land? On the interpretations, illustrations, and implications of artificial intelligence. *Business Horizons*, 62(1), 15-25. <https://doi.org/10.1016/j.bushor.2018.08.004>
- [10] McCarthy, J., Minsky, M. L., Rochester, N., & Shannon, C. E. (1955). *A proposal for the Dartmouth summer research project on artificial intelligence*. Retrieved from <http://www-formal.stanford.edu/jmc/history/dartmouth/dartmouth.html>
- [11] Rogers, E. M. (2003). *Diffusion of Innovations* (5th ed.). New York: Free Press.
- [12] Thomsen, K. (2019). Ethics for Artificial Intelligence, Ethics for All. *Paladyn, Journal of Behavioral Robotics*, 10(1), 359-363. <https://doi.org/10.1515/pjbr-2019-0029>
- [13] Tornatzky, L. & Fleischer, M. (1990). *The process of technology innovation*. Lexington, MA: Lexington Books.