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Kun Liao, Ozden Bayazit, Pingping Tang

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Artificial intelligence in trucking industry: a triple-win environmental, social and governance approach

Kun Liao* and Ozden Bayazit

Department of Finance and Supply Chain Management,
College of Business,
Central Washington University,
Lynnwood, WA, 98036, USA
Email: Kun.Liao@cwu.edu
Email: Ozden.Bayazit@cwu.edu
*Corresponding author

Pingping Tang

Department of Finance and Management Science,
Carson College of Business,
Washington State University,
Pullman, WA, 99164, USA
Email: pingping.tang@wsu.edu

Abstract: This study examines a triple-win approach introduced by an artificial intelligence (AI) technology service company in Shenzhen, China, that is analysed through the environmental, social and governance (ESG theory) factors. This approach is promising because it may improve the operational efficiency as well as the financial performance of the insurance company and the trucking logistics company. More importantly, technology and service can vastly decrease the accident rate of logistics companies, resulting in positive social impacts. Hence, this study proposes a framework for adopting AI in logistics and classifies success factors of AI projects into three categories based on findings from the innovative Chinese startup and other previously implemented AI projects: viable technology, profitability, and positive social impact.

Keywords: artificial intelligence; autonomous driving; social responsibility; insurance; trucking industry; success factors.

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Biographical notes: Kun Liao is a Professor of Supply Chain Management at Central Washington University. He received his PhD in Manufacturing Management from the University of Toledo. He has published in *International Journal of Production Economics*, *Information Systems Management*, *Journal of Manufacturing Technology Management* and *Journal of Purchasing and Supply Management*. His research interests include manufacturing strategy and supply chain management. He received the Best Paper Award at the National Decision Sciences Annual Conference in 2014. He served as Editor/Guest Editor and editorial board member of several US and international journals.

Ozden Bayazit currently works as a Professor of Supply Chain Management at Central Washington University. Her work has been published in *Benchmarking: An International Journal*, *International Journal of Production Economics*, *Journal of Manufacturing Technology Management*, and others. Sustainable supply chains, artificial intelligence, and blockchain are among her research interests. Currently, she serves on the editorial board for the *International Journal of Analytic Hierarchy Process*.

Pingping Tang is PhD candidate in Operations Management at Washington State University. She is a certified public accountant in Washington State. She received a Bachelor's degree in Supply Chain Management and Accounting from Central Washington University and a Master's degree in accounting from Washington State University. Her research interests include dynamic pricing, quantity discount, and supply chain management in e-commerce.

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1 Introduction

According to the G7 big data platform, 2018, there were 13.6 million trucks in China compared to 15.5 million in the USA, 6.6 million in the EU, and 5.0 million in Japan (PwC China, 2020). The accident rate of freight trucks is 3.7 per million km in China compared to 1.3 in the USA (PwC China, 2020). The leading causes of fleet accidents are linked to driver behaviour, specifically aggressive and fatigued driving, accounting for 37% of accidents, devices such as blind spots accounting for 35%, environmental factors including weather and traffic conditions accounting for 15%, and emergencies such as natural disasters and passive accidents accounting for 9% (PwC China, 2020).

The total insurance premium for heavy-duty trucks is about 100 billion RMB yuan, 15.4 billion USD, assuming the exchange rate is 6.5 yuan per dollar. Chinese insurance companies experienced a significant decline in the truck insurance business, with approximately 90% of them losing out on premiums, as insurance companies covered around 80% of the total premium costs (PwC China, 2020). The trucking industry's high accident rate results in significant economic losses for the company, affecting its profitability with an average annual premium of approximately 30,000 RMB yuan per truck. The 6 to 7-day outage also causes a loss of revenue of approximately 35,000 RMB yuan (PwC China, 2020). Moreover, the mortality rate of truck drivers is one per thousand drivers in China, which is significantly higher than in developed countries. The death and injuries of drivers, passengers and pedestrians caused by truck accidents also pose significant social issues in China. The high accident rate of trucks in China calls for urgent solutions to decrease economic and social losses. As an example, the autonomous driving capabilities of trucks have become possible due to advanced driver-assistance systems (ADAS) and AI technologies. This innovation can reduce the likelihood of accidents by changing driver behaviour, increasing truck driver visibility through different cameras, and alerting drivers through driving sensors.

Despite the potential of AI technologies, AI-related projects have a surprisingly high failure rate of around 85% (Vyas, 2019). Scientists, engineers, and business managers are eager to know the answers to the following questions to improve the success rate of AI projects.

- 1 What are the success factors of AI applications in logistics?
- 2 What factors limit the application of AI applications in logistics?

In order to respond to the aforementioned inquiries, the authors conducted an interview with a thriving AI startup called LSZ, in Shenzhen, China, which is often regarded as China's 'Silicon Valley' and provides commercial packages with ADAS and AI technologies. A framework for implementing AI in logistics is proposed by this study, which combines the findings from LSZ and other findings from AI technology and business communities. The success factors and constraints of the AI project were also systematically identified.

2 Literature review

Automotive artificial intelligence is experiencing significant growth due to the immense potential of AI in the automotive industry. The emergence of more research on the impact of this phenomenon on the trucking sector is a clear indication of its growing importance. There are many articles available that delve into the various challenges faced by the freight transportation industry as a result of increasing demand and intricate global operations. Moreover, these articles also shed light on the potential of AI technologies in mitigating these challenges and providing effective solutions.

Rubocki (2018) explores how AI can help address the truck driver shortage and reduce associated risks in the trucking industry. The paper presents that AI offers a potential remedy for the truck driver shortage. AI-enabled trucks could alleviate stress, enhance safety, and improve driver retention and recruitment. The study suggests that AI systems can boost driver productivity, potentially decreasing the need for as many drivers in the trucking industry (Rubocki, 2018).

Similarly, Abduljabbar et al. (2019) discuss that automated vehicles offer numerous advantages for the future, such as enhanced road safety, decreased congestion, shorter travel times, reduced car ownership, and improved fuel efficiency. The combined oil consumption of trucking companies in the USA, EU, and China represents one-fifth of global demand, making the potential fuel savings quite substantial (Korićanac, 2020). It is not just about fuel savings; the environmental impact of AI technologies in trucking is significant too. Since freight transportation significantly contributes to climate change, pollution, and the country's economy, even minor enhancements in fuel efficiency and emissions reduction will aid freight companies in saving money and minimising environmental impact (Katreddi et al., 2022). The study also reports the findings of a global survey conducted among passengers to determine the factors that increase the attractiveness of cognitive intelligent vehicles. Passenger feedback indicates that self-healing (a vehicle's capability to self-detect and correct its own errors) and self-socialising (a vehicle's ability to communicate with infrastructure, vehicles, and humans in natural language) garnered more interest than the self-driving technology. Attention is drawn to the positive social impact and acceptance through this finding (Abduljabbar et al., 2019).

Mustapha and Mustapha (2020) report that transportation companies benefit from risk management implementation by monitoring drivers, controlling bus maintenance costs, and planning routes during slack periods. Consequently, AI looks to be a viable solution for increasing trucking company efficiency by decreasing inherent industry risks. According to Plus.ai, an automated trucking company, one of its trucks successfully completed a coast-to-coast commercial freight run without any human intervention. Equipped with the company's advanced autonomous driving system, the truck employed multimodal sensor fusion and deep learning visual algorithms. It is undeniable that AI technologies hold promise for the trucking industry and that AI-powered trucks are expected to completely transform the logistics industry in the coming years.

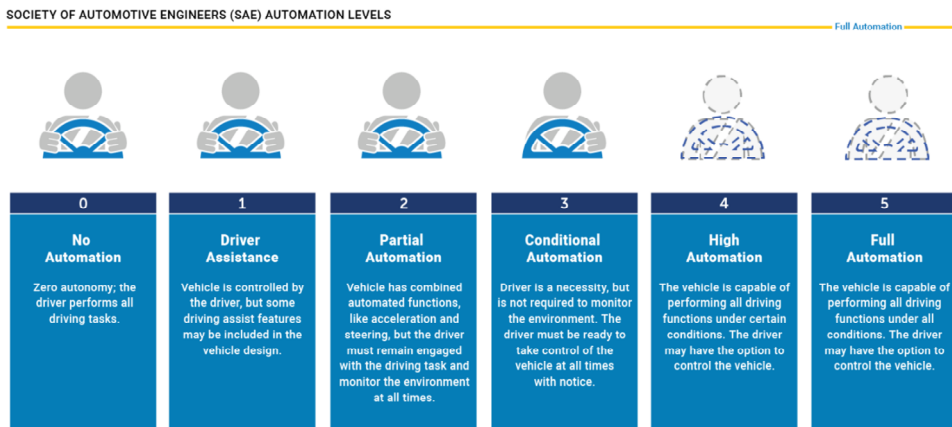
3 The case of an AI company in Shenzhen, China

A single company was chosen for this study to gain an in-depth understanding of AI implementations in the trucking industry. The selected company represents a successful AI implementation, demonstrating significant positive effects in both the trucking logistic company and the insurance company.

3.1 Current outlook of the trucking industries in China

The trucking industry in China has experienced rapid growth with a significant increase in commercial vehicles. However, managing the associated risks has been challenging, leading to frequent traffic accidents and posing a hidden danger to social harmony and stability. The Ministry of Communications and the Provincial and Municipal Transportation Commissions in China have issued specific policies and standards mandating the installation of intelligent safety driving assistance systems, such as 2G and 3G GPS. Recently, logistics companies have increased the installation of active vehicle safety management systems for commercial vehicles.

Figure 1 The six automation levels of vehicle by Society of Automotive Engineers (SAE) (see online version for colours)



Source: <https://www.nhtsa.gov/technology-innovation/automated-vehicles-safety>

With the explosion of AI and other technologies, Figure 1 lists six levels of automation for vehicles defined by the Society of Automotive Engineers (SAE) (NHTSA, 2020). The current mature one is level 2 (L2) autonomous driving, which can significantly reduce the rate of traffic accidents and decrease socioeconomic losses.

From a vehicle insurance company's standpoint, the annual losses in the fleet business pose a serious problem. However, as a unique financial enterprise, the insurance company should bear the responsibilities such as loss sharing, economic compensation, disaster prevention, loss prevention, and other social obligations. Therefore, the role of the insurance company must shift from risk compensation to risk intervention. Insurance companies desire to explore new technologies and business models to enhance their risk control and management. According to a report by the National Bureau of Statistics of China, 74% of vehicle accidents are caused by driver fatigue. However, if a driver is alerted, 1.5 seconds before a potential accident, it could lead to a 90% reduction in collision accidents. Thus, the driving risk control and monitoring system plays a significant role in accident prevention.

3.2 Company background

Authors use on-site interviews and follow-up phone interviews to collect data and information. Also, one founder of the company sent documents to one of the authors of this case study.

The case company is located in Shenzhen, China, known as a major IT hub in the country. Due to being in the early stage of business expansion, the company prefers to remain anonymous. The name LSZ has been assigned to it by the authors in this scenario. LSZ Company applies artificial intelligent technology extensively in trucking logistics and auto insurance. The company's AI product is based on a self-developed intelligent driving control system, combined with advanced algorithms of terminal hardware products such as ADAS. This system uses result-oriented professional operations, online monitoring, offline management, terminal service, and other methods to analyse vehicle driving safety. The self-developed intelligent driving control system provides driving safety management and generates various analytical reports to assist auto insurance companies with services such as vehicle risk databases, pricing models, marketing programs, and the settlement of claims and damages. The company is dedicated to assisting the insurance company in expanding their business and reducing payouts by lowering the accident rate for trucking logistics companies.

The company LSZ has more than 300 service agents nationwide. Its teams possess strong operational capabilities and a deep understanding of the insurance, technology, and automotive electronics industries. They are capable of providing continuously accurate and stable hardware products based on industry needs.

3.3 Operational model of the company

Trucking logistics companies in China face challenges in effectively assessing and addressing unsafe driving behaviours among their drivers, with many accidents only being evaluated after they occur. Managing a vehicle fleet incurs substantial expenses, including insurance, freight, traffic fees, vehicle costs, etc., leading to financial pressure. Efficiently and effectively minimising operating costs is essential for the stable operation of enterprises. For logistics companies, besides the aforementioned expenses, there is a

significant collateral loss. This includes the partial or total loss of the value of goods carried by vehicles due to accidents. If the goods are hazardous materials, they can cause unpredictable damage to people and the environment around the accident site. This represents an immeasurable and substantial expenditure.

Conversely, when a trucking logistics company experiences a significant number of claims, it leads to increased costs for the insurance company. Despite substantial expenses and preventive measures, the accident rate remains largely unchanged, and the payout rate stays consistently high. In response, the company employs artificial intelligence to develop an optimal insurance plan for the insurer. Additionally, it offers self-developed hardware, an online platform, and an operational management system.

First, the hardware is developed based on an in-depth understanding of industry needs, hardware function, adaptability, and application scenarios, combined with leading algorithms. The hardware includes a host, ADAS camera, DVR camera, drivers status monitoring system (DSM) camera, and cables (Figure 2). The DSM detects driver fatigue through eye and facial changes, providing warnings for different levels of hazards, with an accuracy of over 95% for recognising yawning and closed eyes. The DSM is able to monitor and report unsafe driving behaviours, such as making phone calls, smoking, not wearing a seat belt, land shifts, and camera obstruction, with an accuracy of over 98%. The ADAS sends warning signals for land shifts and calculates the warning level of the front vehicle collision hazard based on real-time speed data collected by GPS, automatically determining when to change lanes.

Figure 2 The hardware of the integrated AI system (see online version for colours)



Source: Provided by the LSZ Company

The hardware also contains external functions, which can be extended based on vehicle models, such as passenger transportation, hazardous goods transport, dump trucks, etc. External hardware options include tire pressure monitoring, blind spot detection (BSD), a 360-degree surround view system, etc. Designed to be suitable for all weather conditions, the main function of this hardware system is to provide active security defence to ensure driving safety. The vehicle's sound system actively alerts the driver to fatigue, distraction, smoking, phone use, and other unsafe driving behaviours, as well as warns of hazards, such as lane shifts and potential collisions.

Another important function of the system is the intelligent management for driver assessment (Figure 3). The assessment control provides enterprises with real-time driving behaviour data, offering effective safety evidence for management. This enables timing training and correction of bad driving habits, thus reducing potential safety hazards.

Figure 3 The intelligent management system for driver assessment (see online version for colours)



Source: Provided by the LSZ Company

Based on the increasing scope of applications, accumulated databases, and development of platform functions, the hardware monitoring system helps enterprises effectively reduce accident rates. By conducting strong operational management through the platform, the full-term claim payout rate can be reduced by an additional 10%.

Second, the online platform includes a vehicle safety monitoring system and the Beidouyun service platform. Leveraging an in-depth understanding of the insurance industry, the company's platform generates various applicable reports and vehicle risk diagnostic reports, and analyses driver driving behaviours using robust platform

capabilities and hardware equipment. The platform can connect and process information for over one million terminals, meeting the requirements for massive data storage, statistics, and analysis, enabling cross-platform and cross-regional interactive communication. The platform possesses good openness: multi-level, multi-entry. The entire internal network transmission adopts the standard TCP/IP protocol, ensuring good openness. The communication protocols and data formats comply with the relevant technical requirements of national standards JT/T 809, JT/T 808, and JT/T 1078. The system automatically assesses the risk level in real-time, and video and pictures are stored for up to six months.

Figure 4 The intelligent management report for the logistics company (see online version for colours)



Source: Provided by the LSZ Company

Third, the company's operational management system generates various application-level reports, fleet risk diagnostic reports, and driver behaviour analyses based on industry understanding through strong platform capabilities and hardware equipment. By conducting strong operational management with an outcome-oriented approach, it collaborates with enterprises to build a safety culture and institutional framework. The ordinary functions of the operational management system include vehicle management, map management, system management, and fleet management. The featured functions include terminal control, real-time data monitoring, and data statistics and application. The terminal control function provides artificial voice alerts, route viewing, and real-time video monitoring. The real-time data monitoring function sends alert data, alert photos, alert videos, driver behaviour assessment, and alert data statistics and analysis to users. The data statistics and application function generates insurance application reports and insurance pricing references. Additionally, the system enables multi-dimensional data storage and extraction to meet the different needs of customers for risk management data. The insurance company can receive analytical reports on a weekly, monthly, quarterly, and yearly basis. These reports include proposed improvements based on driving risk

evaluations. The company also assists the insurance company in generating risk control reports for enterprises on a regular basis, enhancing corporate awareness and customer retention. Furthermore, big data is leveraged to support accident claim investigations, reduce on-site investigation costs, accurately determine losses, and significantly lower operating expenses for insurance companies. By utilising comprehensive accident data, the company helps insurers identify accident causes and detect insurance fraud.

3.4 Business model of the company

The first business model is based on government policies and its applicable vehicle types that include hazardous goods transport vehicles, long-distance passenger transport, and tour buses. To launch the business, LSZ Company determines the implementation time of local policies, plans the required business types in advance, conducts cost calculations, leverages LSZ's networks to engage with relevant government departments and local operators early, and have LSZ Intelligent Driving assist in business development. Due to national policy requirements, 'two passengers and one hazard' vehicles need to replace their 2G monitoring equipment with 4G intelligent monitoring devices and active safety equipment, leading to slightly higher first-year costs. The 'two passengers and one hazard' business has good claim quality and high individual premiums, which can fully cover costs. With the national policy direction and early deployment, the growth rate is fast. Insurance can be bundled for 2–3 years, with annual cost sharing accounting for about 10% of the premium. Combined with LSZ's related services and risk control, payouts are controllable and there is significant profit potential.

The second business model is oriented by large market size and encouraged by national policies and its applicable vehicle types include long-distance logistics (class 4 or freight vehicles over 12 tons). LSZ Company collects policy guidance from various regions, contacts existing customers for testing and installation, and mandates installation for high-claim customers. Leverage LSZ's networks to engage with relevant government departments and local operators early, then the company selects incremental business segments from the market and bundles insurance business by offering free equipment. The claim quality of long-distance logistics vehicles is variable, but the market size is large and individual premiums are high. These vehicles are likely to become subject to mandatory national policies in the future, so early deployment provides an advantage for future business development.

The third business model is grounded in a large market size and high claims and its applicable vehicle types include ride-hailing cars and freight vehicles (2–12-ton trucks). Typically, ride-hailing cars are operated on a leasing basis with operating licenses. Insurance is covered as operational insurance, and there are few individually owned vehicles. These ride-hailing cars should be a focus, with emphasis on active safety control to ensure manageable claims. On the other hand, most freight vehicles are affiliated with logistic companies. One strategy is to target the express delivery industry or fleets with fixed routes and businesses as key customers, combined with active safety control. Overall claims are relatively poor, but the market size is large, and the development trend is positive. Thus, active safety control measures will have a significant impact on overall claims. Especially, for small claims cases, the equipment can retain claim evidence, and with the continuous accumulation of data, a risk control model can be established to address claims issues fundamentally.

3.5 *The ESG measurement of this company*

The frequent occurrence of commercial vehicle accidents has led to the continuous rise in various expenses and caused tremendous hidden losses for society. Annual accident claims amount to approximately 156 billion RMB. The average loss rate for fleet vehicles is about 78%, with high-risk customers experiencing loss rates exceeding 200%. Despite substantial investments by insurance companies in customer relationship management and preventive measures, claim losses remain high. Therefore, LSZ examines the causes of accidents for one insured enterprise from the insurance company, they find that human factors account for 76% of accidents and nearly 80% of compensation payouts, indicating that human factors have a significant impact. Based on recent accident cases, among the causes of improper operation, there are also behaviours such as speeding, failing to maintain a safe distance, changing lanes, fatigued driving, and distracted driving. In terms of proportion, accidents caused by not maintaining a safe distance, not yielding to pedestrians, and not slowing down when turning are low in frequency but have high compensation costs.

In response to the above situation, there is significant room for overall risk reduction through strong operational management of human factors. Proper management of human factors can significantly reduce the occurrence of accidents. To address this, the company's AI system monitors human behaviour, providing real-time data and feedback to drivers.

The hardware component includes devices such as ADAS cameras, DSM cameras, and DVR cameras, which monitor driving behaviours and conditions. These devices detect and alert drivers to potential issues, such as fatigue, distraction, speeding, and improper lane changes. The data collected by these devices is transmitted to the online platform, where it is analysed and used to generate detailed reports.

The online platform serves as a central hub for data analysis and management. It provides enterprises with valuable insights into driver behaviour and vehicle performance. Through this platform, managers can access real-time data, view historical trends, and receive automated alerts about risky behaviours. This enables them to take proactive measures to correct unsafe driving habits and improve overall fleet safety.

Additionally, the operational management system integrates all these components, offering a user-friendly interface for managing the entire safety ecosystem. It includes features such as route planning, real-time monitoring, and driver performance assessments. By leveraging AI, the system can predict potential risks and suggest preventive measures, further enhancing safety.

Overall, the company's integrated approach to managing human factors in vehicle operation not only enhances safety and efficiency but also contributes significantly to environmental sustainability, social well-being, and sound governance practices. By prioritising these ESG aspects, the company demonstrates its commitment to responsible business practices and long-term value creation for the insurance company, the trucking logistics company, and society.

4 **The proposed framework of AI application in logistics**

The failure rate of AI projects is as high as 85% (Vyas, 2019). Various studies identify the reasons for failures in AI technologies. There are three categories of reasons, namely

technology, business, and social impact (Kaplan et al., 2020; Kidd, 2018; Internet of Business, 2019; Vyas, 2019).

4.1 Technology reasons

- Insufficient training data – the project demands more data than what you currently have, and your model complexity is too high. The lack of computational resources – your computers are just not powerful enough. Despite your clever algorithms, your lack of resources hinders your relevance. Insufficient computation power for training a neural network diminishes the significance of a clever startup idea (e.g., even universities sometimes do not have powerful enough computers to train an insane amount of computing whereas a super company like Google or Amazon.)
- Poor data quality – the data you have is not suitable for the project being discussed. The black-box effect-neural networks lack coherence due to their reliance on statistical learning algorithms rather than theory.
- Implementation difficulty – AI implementation is challenging when other methods prove to be more effective or efficient.

4.2 Business reasons

- Lack of a clear reason for implementation. Using AI for important business purposes requires valid reasons, not just personal desire. This pertains to the financial viability of the suggested AI projects. Lack of talent – there are only a few ‘seasoned’ AI experts for hire who can ensure the success of your product.
- Market bubbles could be propping up poor startups. Investors seeking their dream AI unicorn may inadvertently bolster unworthy companies. Most of them would fail.

4.3 User-related reasons

- Lack of user acceptance – users are hesitant to adopt AI technology due to the learning curve and time commitment. Job security is another concern for workers adopting AI technologies.

4.4 The framework of AI application in logistics

Following multiple in-depth interviews with business owners and technology staff, the proposed framework for AI in logistics is as follows. This framework condenses the above factors to prevent failure in a multitude of AI projects.

Step 1 Technology maturity

In this case, the L2 technologies have been used in many types of automobiles. The ADAS technologies are reliable based on feedback from industries and users.

Step 2 Technology effectiveness

Through a joint pilot study by the company and one logistics company, the integrated AI technologies are very effective in terms of decreasing accidents through sending early warning of the truck, the road conditions, and the dangerous behaviours of the driver.

Step 3 Financial feasibility

When analysing the data from the operations of trucking companies, the insurance company has largely decreased the payout for accidents due to the decreased accident rate, resulting in a higher profitability for the insurance company as well as the trucking company.

Step 4 Positive social impact

AI technologies with operational efficiency and financial feasibility may not be adopted if there is no positive social impact. The automation and intelligence offered by the AI technologies are not easily to controlled if the technologies have negative side effects. Therefore, it is necessary to align the AI technologies with the social benefits of the technologies.

Step 5 User acceptance

AI technologies have been criticised to intervene into human being's activities; the technologies have caused nervousness of the people to be observed and analysed by the AI system. Moreover, there is a big concern for violating the privacy if the observations and analyses are not agreed upon by the person to be observed. In this case, the user acceptance is achieved through the education of social and financial benefits and positive examples of early driver adopters. According to the technology acceptance theory, ease of use is another important factor for the user to adopt it.

Step 6 Organic adoption expansion

Due to the high research and development costs of AI technologies, the financial breakeven or even profitability requires the economies of scale of the technology from the business success standpoint. The business model of promoting specific types of AI technologies depends on the industries. It depends on the business's creativity and implementation plan.

The above systemic framework provides a decision structure for the technology entrepreneurs and venture capital investment company with AI technology company. On the other hand, this framework may also help logistics company to decide the feasibility of the AI technologies.

5 Discussions

From the viewpoint of a business manager, this case provides an opportunity to gauge the likelihood of AI projects or startups being successful. In this case, all three companies - the AI service, logistics, and insurance companies - have seen notable improvements in

operational efficiency and financial gains. This strategy benefits three business entities with a triple-win.

5.1 The importance of social responsibilities with AI projects and startups

In the above framework, there are several success factors for AI applications, including technology maturity, technology effectiveness, easiness of the use, financial feasibility, and positive social impact. Based on this case and other AI projects or startups, the above success factors can be classified into three categories: viable technology, profitability, and positive social impact. Among those factors, technology and business factors are critical for the business success of AI projects or startups. However, the social impacts and responses of AI projects or startups have been largely ignored in AI research.

Social responsibilities of corporations have been studied since 1990s. Drumwright (1994) states that enterprises should consider both social and economic benefits. When the economic and social goals are combined, the enterprise may realise sustainable long-term benefits (Carter and Rogers, 2008).

From the investor's perspective, socially responsible investing (SRI) has been emerging as a mainstream investment strategy on 'doing good while doing well'. SRI focuses on the environmental, social, and governance consequences (ESG) of investments (EUROSIF, 2012). AI startups may have a higher possibility to raise funding when they integrate AI technologies with social responsibility, increasing the success rate of the AI projects taking social responsibilities through continuous funding from the investment funds.

5.2 The concerns of privacy with AI projects or startups

Through this case study, the biggest concern is the privacy issue when the driver adopts the system. The ADAS system is very welcomed by the driver and the logistics company, while the employer and driver have different views on the video camera monitoring the driver's behaviours. The employer appreciates the warning signals after the AI module processed the images taken from the camera while the employee feels uncomfortable about being monitored. In an attempt to overcome this barrier, the logistics company, the service provider, and the insurance company organised safety seminars and even established legal agreements among the different parties. This often challenged the AI service company, slowing the speed of the business expansion of the AI service provider.

6 Conclusions, limitations, and future studies

This study proposes a framework for implementing AI technologies based on interviews of one AI company and the findings of other researchers and managers working on AI projects. The success factors in technology, profitability, and social responsibilities are also identified. The concern of privacy is one significant obstacle to the implementation the AI technologies, slowing the business expansion of AI technologies.

The limitation of this research is that the information is from one single logistics AI company in one country. More cases from different industries in different countries are expected to further validate the framework, the success factors, and the constraints of AI implementations.

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