Critical Evaluation of AI System Implementation as a Source of Competitive Advantage

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Abstract

Over the years, there has been a gradual change in relation to how businesses conduct their daily business activities. Many of have deviated from the initial old methods to using AI as a means of having competitive advantage. This paper seeks to evaluate the effectiveness of integrating AI as a business strategy, cost effective, more efficient once the program has been set and also helps in effective business management. It also takes over repetitive and dangerous tasks. However, lacks out of the box thinking meaning that it only at times operates within the confines of the specific objectives. This may in turn be a negative aspect when where is need for critical business decisions to be made in business. It also lacks emotion when there is need to do so in addressing some of the customer's complaints and this may bring about customer dissatisfaction.

1.0 Introduction

Artificial intelligence (AI) technology is theoretically capable of becoming essential force multiplier in the upcoming business and military aptitudes. Various businesses across the globe have acknowledged AI as vital to improving their competitive edge. Accordingly, businesses are investing large sums into the AI infrastructure. AI has come with both benefits and drawbacks. The first section of this paper contains of the background of the study. The second section comprises the critical review of literature on AI while Sections 3 and 4 present the study findings and conclusions.

1.1 Background to the study

The applications of Artificial intelligence are typically applied to mimic human intelligence in either decision-making or problem-solving events. AI technology is associated with the advantages of stability, dependability, cost effectiveness and competitiveness while handling the complexity and rapidity in problem resolution or decision-making. AI has been applied in numerous fields including engineering, manufacturing, medicine, economics, linguistics and law, and also in various modelling, forecasting, and system support and management applications (Mellit & Kalogirou, 2008). The use of AI in the internet, for instance in the search engine has been regarded as its most promising development (Mellit & Kalogirou, 2008; Russell & Norvig, 2003). Although there are substantial efficiencies of AI like any other application, they are limited in both functionality, and capability. In institutions where human intelligence is only confined to a specific individual or a few certain people, AI technologies tend to offer stability which inhibits skills and expertise from being lost in the event that the person retires or has left from the institution(Russell & Norvig, 2003). This implies that with AI the organisations are capable of retaining expertise and skills throughout their life cycle. The lifespan of the expertise contained in the AI framework binds as long as the corresponding problems and decision parameters remain constant. AI enables the growth of learning capability that can be exploited to additionally enhance the lifespan and significance of applications. Taking real-world optimal performance and failure into consideration AI tools are useful as they enhance software effectiveness by increasing their use in real life applications (Russell & Norvig, 2003).

The universal usage of any AI technology normally arises after its consistency is established, and also after the technology has been confirmed to been consistent in various practical fields due to its capability to mimic human behaviour in the process of decision making. Similar to several automation technologies, the application of AI tends to support the minimization of costs as it facilitates time reduction for personnel. Making use of AI applications that are appropriate in the process of decision making can help reduce operational costs on a firm. Operational costs reduction process enables the firm to reduce its service charges, thus gaining a competitive advantage in the market.

Since decisions must always be taken under palpable doubts, AI methods are acceptable with inadequate and imperfect information if a clear cause and effect mathematical association cannot be ascertained. By combining available information with likelihoods and likelihood inference calculations, the models of AI apprehend the ambiguities between the cause-and-effect relationship for real life circumstances and developments(Patterson, 2011). AI methodologies are also able to handle qualitative and quantitative data, a lacking feature amongst most firmly analytical methodologies. The implementation of AI tools appears to stimulate faster decision-making

process through automating, with respect to the computation time in relation to the density of complexity of algorithmic processes and processor power. Through data collection and screening, processing, and decision-making, AI can easily solve problems that are of a complex nature (Fries, Chowdhury, & Brummond, 2015).The ability to guarantee quicker decision-making through AI systems serves as a basis of gaining competitive edge for businesses which have adopted AI systems (Mellit & Kalogirou, 2008; Chowdhury & Sadek, 2012).

In the transportation sectors around the world, a great deal of investigation and applications have confirmed many benefits of Automated Interactions generally, and a great deal of research have indicated numerous empirical evidences on the benefits of certain AI methods(Chowdhury & Sadek, 2012). Some of the AI tools recently being utilised include transforming traffic sensors into automated agents to robotically identify and file accidents and model traffic networks(Schleiffer, 2012). Recent studies have indicated that AI technology is more effective and powerful in evaluating and forecasting traffic conditions on the basis of small bits of traffic data, collated from in-transit vehicles, as envisaged in integration of vehicle set-up or the coupled vehicle program, relative to several other existing algorithms(Chowdhury & Sadek, 2012). Due to the utilizing microscopic traffic data, transportation security has been found as the one of the fields where AI technology is of significant use (Schleiffer, 2012). AI technology can be helpful in determining security breaches in the transport security industry, and in creation of automated response functions and control algorithms.

In development and management of transportation systems, the recognised benefits and efficacies of AI tools make them mostly useful (Patterson, 2011). Precisely, control, identification, real-time sensing, and reaction, are critical in intelligent transport systems. The utilisation of AI can be done efficiently in these applications. Indeed, distributed traffic sensor system and control networks maybe the future of real-time traffic management and control. The distributed sensor networks, comprising of various degrees of AI sensor networks, determine and react to instances automatically and monitor the road system as appropriate.(Russell & Norvig, 2003). The progression into the subsequent generation traffic management solutions can be supported by the implementation of an intelligent (smart) sensor network consisting of AI instruments. It is therefore a global anticipation of the broader application of AI instruments in various areas of transportation, with the many advantages.

However, similar to all machine learning tools, AI tools are subjected to a set of constraints. The main area of criticism for many Artificial Intelligence frameworks, for example neural networks, these are frequently considered as black boxes which simply tend to draw a correlation between input/output (I/O) variables based upon the training dataset (Zuylen, 2011; as cited in Chowdhury & Sadek, 2012). Consequently, some warnings were posted concerning the capability of the AI technology to generalize circumstances which were misrepresented in the dataset (Chowdhury & Sadek, 2012). The combination of several AI paradigms in creating hybrid, for instance, a combination of fluorescent sets and neural networks in neuro-fuzzy systems while integrating AI models with conventional solutions techniques has been advocated to handle a black box issue (Zuyln, 2011).

The fact that AI tools are not guaranteed to reaching the "optimal" solution is seen as an additional constraint of the AI-oriented search procedures, particularly the ant-colony optimization and genetic algorithms (Chowdhury & Sadek, 2012). In addition, it is always difficult to attain a real understanding to the challenge and how-to bring work out solutions, when applying the AI dependent search methods for solving problems (Mellit & Kalogirou, 2008). A significant example of this is the failure to conduct sensitivity analysis instantly (Patterson, 2011). However, the counter the reason for the failure to safeguard optimality is that a "solution" is better than "no solution" on hard optimization problems, which challenge solutions using mathematical programming algorithms and custom optimization. There is also considerable empirical evidence that AI-based search techniques in most instance provide "good" solutions (Schleiffer, 2012).To gain more understanding into the field understudy, the model may have to be recomputed iteratively or repeatedly to evaluate the sensitivity analysis for the solution subject to a set of constraints, assumptions, and parameters of the problem.

A third constraint in relation to the application of AI tools to address a certain problem is that there is currently little control for many AI techniques on how to acquire the best values to be used for the tuning parameters of that particular technique(Mellit & Kalogirou, 2008). For instance, it is imperative that the analyst make some critical design decisions when considering a neural network including the topological value of the neural network to be used, neurons to be used in the layer, number of hidden layers, as well as type of transfer function to be factored in the neurons prior to applying this approach to the problem in question (Chowdhury & Sadek, 2012). As such an analyst is expected to perform atria land error technique in order to choose suitable constants for these parameters. This is similar to genetic algorithms, where it is required for the analyst to evaluate number of generations, population size, and other control parameters for the algorithm, including implementation probability for applying the mutation and crossover operators(Fries, Chowdhury, & Brummond, 2015).

In general, the issue of potential liability is also considered as another restriction or obstacle for AIs (Schleiffer, 2012). For instance, if the AI methods can be used for the construction of partial or complete autonomous vehicles in future, then, when the individual vehicle crashes, who will be held accountable for that situation? Although this restriction is not theoretically important, it must be treated as a critical issue that needs more attention.

1.2 Global Overview in AI technologies and market

This section of the paper outlines a concise summary concerning the state of the global artificial intelligence market as well as the evolution of AI. In 2014, more than USD 1.9 billion was invested towards AI technologies globally, which was 50 percent more than an investment made in 2013(OSA_DC, 2018). In 2015, about US$2.7 billion of the investments or 5% of total VC investments amounting toUS$55 billion in 2015 was estimated(OSA_DC, 2018).The next disturbance to company applications is forecasted to be AI-driven technologies. Presently, nearly every industrial sector is affected by the penetration of AI. One of today's mottoes is artificial intelligence in which, John McCarthy coined the word in 1956(Mellit & Kalogirou, 2008).

Since the first boom that occurred in the early 1950s, there have been many "boom-glooms" periods where the second spike occurred in early 80s and the third one began early in 2010 when US corporate research laboratories such as Google and Facebook were created(Schleiffer, 2012; OSA_DC, 2018). A wider interest in AI technology has revived developments in the development of deep-learning technologies.

There has been another paradigm as AI now has the capability to analyse enormous quantities of data using sophisticated computers and advanced AI systems and learn from designs themselves rather than attempting to schemes computers to behave intelligently (Schleiffer, 2012; OSA_DC, 2018). AI is not a novel approach but the fundamental technologies have gotten to the modulation point (OSA_DC, 2018). The interruptive influence of Artificial Intelligence technologies force hardware manufacturers, including automobile manufacturers, to trail the AI companies' path, as the software tends toplay a significant role in the future of manufacturing industries(OSA_DC, 2018).

The are many projections regarding the scale of the artificial intelligence market. The global AI solutions market was expected to increase to US$70 billion by 2020 from US$8,2 billion in 2013 (Bank of America Merrill Lynch, 2015). A rising degree of government funding and a strong technological foundation are expected to increasingly affect the international AI market. Due to its leading position in machine learning, the US controls the global AI market. Artificial intelligence is based on machine learning technology and it is used in all major fields of use. The most significant segment of AI was machine learning in 2015 (OSA DC, 2018). There are also other big AI markets which include Japan, Europe and China. Recently, China presented an artificial intelligence growth over a three-year period. The goal of the programme was to develop AI technology and AI industries, worth at least 100 billion yuan (US$15.2 billion) (OSA DC, 2018).

This paper seeks to critically evaluate the significance of AI implementation on financial performance in the car manufacturing industry with special focus on Japan.

Several analysts have shown that the AI industry in Japan is not competitive on the international scale as of recent years. As such, a great deal of research on AI between 2008 and 2013 come from Western nations and China. The findings from previous study show that only 2 percent of AI research papers come from Japan (OSA_DC, 2018). However, Japan's AI-market was projected to grow from JPY 3.7 trillion in year 2015 to JPY 87 trillion by 2030.In 2015, 39 percent (JPY 1.45 trillion) of the combined market value of the wholesale and retail sectors, comprised of AI's largest sub-segment. The transport sector (driverless taxis and trucks) is anticipated to rise to JPY 30.48 trillion by 2030. These two industries together have a market value of JPY 42.65 trillion or 49 per cent of the overall market value projection, including driverless vehicles (the generating sector) (OSA_DC, 2018).

1.3 Methodology

The main aim of this study was to evaluate the contribution of implementing AI-systems towards exports revenue for 12 major car manufacturers in Japan using the paired samples t-test. The paired samples t-test procedure was carried out to assess whether AI systems implementation resulted in significant improvement in export revenue among 12 major car manufacturers in Japan. The study sample was made up of 12 major car manufacturers in Japan with reported trade data in the UN Comtrade database for the period2012 to 2018. The data are attained from UN Comtrade (at the 4-digit level of SITC Rev. 2). The data was divided into two subsamples based on the AI-periods; that is the Before-AI and the After-AI period data. The before-AI period covered 2012 to 2014 while the after-AI period covered 2015-2018.

The study conducted a preliminary investigation on the data to determine underlying trends in exports for Japanese car manufacturing firms before and after the application of the AI systems. The second part of the analysis involved the paired samples t-test procedure to assess the influence of AI systems towards export trade for the 12 car manufacturing companies.

1.3.1 Paired Samples t-test Procedure

The Paired Sample T-test is a statistical technique used to compare two population means when two samples are related. In 'before-after' studies, a control group and matched pairs samples are used in a paired sample t-test.
The formula for a paired sample t-test is shown below:

$$t = \frac{\sum d}{\left(\dfrac{\sqrt{n(d^2 - (\sum d)^2)}}{n-1} \right)}$$

A. Testing the differences in Exports Before and After Implementation of AI systems

The analysis of the data was done in three stages.

A1: First stage: Examine the underlying trends in the data before and after the implementation of AI systems in Japan's car manufacturing firms in 2015. This preliminary investigation of the data involved calculating averages before and after the implementation of AI systems.

A2: Second stage: calculate standard deviations before and after the implementation of AI systems.

A3: Third stage: analyse export trade performance differences that occurred using paired t-test with a significance level (α) = 0.05/2

1.4 Empirical Findings

1.4.1 Preliminary investigation of the data

The time series plots display observations on the y-axis against equally spaced time intervals on the x-axis. They are used to note patterns, information on the general trend and seasonal behaviours in data over time. The time series plots of yearly values of exports for the car manufacturing companies are displayed in Figure 4.1 below:
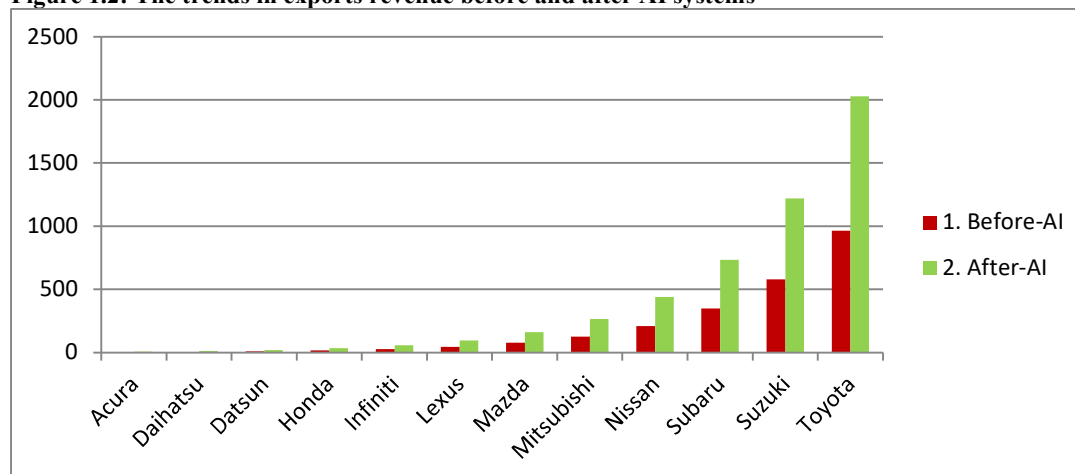
Figure 1.1: The trends in exports revenue before and after AI systems
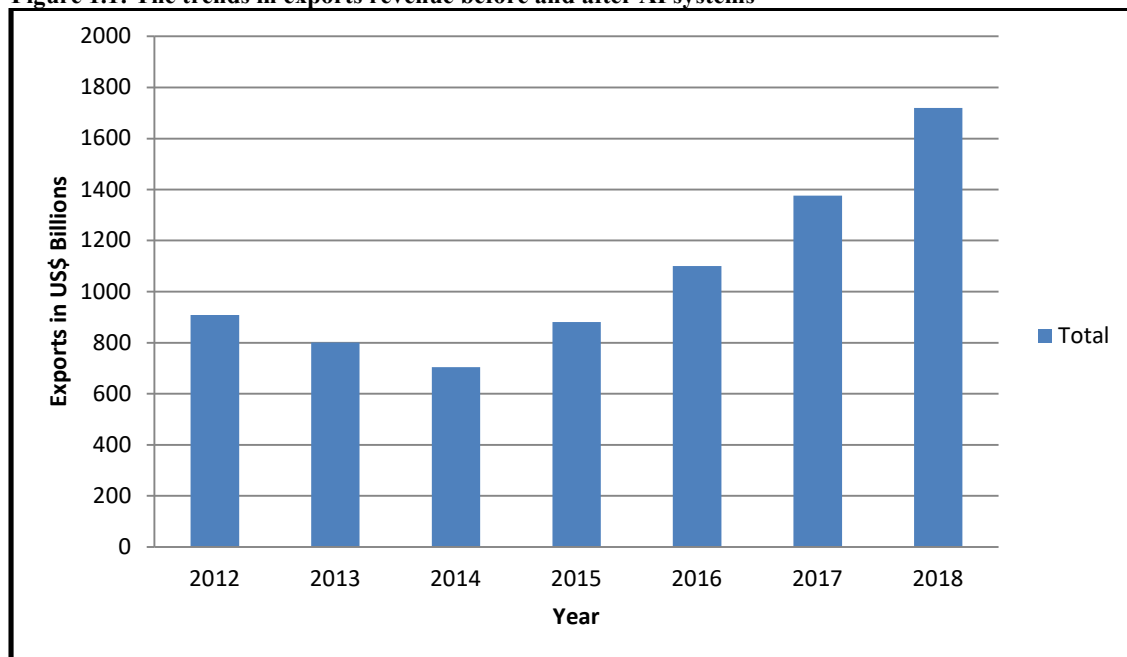
Source: *UN Comtrade (Japan manufacturing industry)*

Results shown in Figure 1.1 reveal that for the prior implementation period, which is 2012 to 2014, the value of exports from Japanese manufacturing firms declined considerably. There was a significant change in export trade performance for the manufacturing companies in 2015, the year in which substantial investments were channelled towards adoption of AI systems in Japanese manufacturing firms. The same findings are displayed in the clustered bar chart below.

Figure 1.2: The trends in exports revenue before and after AI systems

Source: UN Comtrade (Japan manufacturing industry)

Findings shown in Figure 1.2 reveal that exports after the implementation of AI systems has persistently been higher than for the prior implementation period implying that AI systems had resulted with competitive advantage on international trade for Japanese car manufacturers.

The subsequent section shows how the paired samples t-test procedure was carried out to test the significance of change in export revenue before and after the full establishment of AI systems in Japan.

1.4.2 To evaluate the impact of AI systems on exports trade

The outcome of the paired samples t-test are shown below.

Table 1.1: t-Test: Paired Two Sample for Means

	Before-AI	After-AI
Mean	201.183878	423.00798
Variance	88462.177	391082.5
Observations	12	12
Pearson Correlation	1.00	
Hypothesized Mean Difference	0.00	
df	11	
t Stat	-2.343	
P(T<=t) one-tail	0.019	
t Critical one-tail	1.796	
P(T<=t) two-tail	**0.039**	
t Critical two-tail	2.201	

Source: MS Excel computations

Findings shown in Table 1.1 show the results of the paired samples t-test. The probability value (P(T<=t) two-tail) is 0.039. This result implies that there was a significant change in export trade performance for Japanese car manufacturers due to the implementation of AI systems.

1.5 Conclusions

From the study findings it can be safely concluded that for the Japanese manufacturing firms the implementation of AI systems had resulted with improved export revenues. There is therefore sufficient empirical evidence from the data that AI system implementation is a source of competitive advantage for manufacturing firms.

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