INTERNATIONAL JOURNAL OF ACADEMIC RESEARCH IN BUSINESS & SOCIAL SCIENCES

Vol 14, Issue 12, (2024) E-ISSN: 2222-6990

Establishing Relationships Between Innovation Adoption and Country of Origin: A Study of Chinese Mobile Operating System

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To Link this Article: http://dx.doi.org/10.6007/IJARBSS/v14-i12/24104 DOI:10.6007/IJARBSS/v14-i12/24104

Published Date: 12 December 2024

Abstract

The Mobile Operating System (MOS) industry is dominated by the duopoly of Apple's iOS and Google's Android, with both being American companies. The lack of alternative MOS outside the US raises concerns about technological dependence and geopolitical vulnerability. During the US-China trade war, Huawei was banned and forced to introduce HarmonyOS. However, Chinese MOS is still facing consumer rejection and market share loss today. This paper discusses the industrial background of MOS, highlighting the emergence of Android-based Chinese MOS and the attempts to develop non-Android-based Chinese alternatives. Then, it reviews academic theories on product innovation, with more specific focus on technology adoption. Academic gaps have been pointed out with the lack of studying the theories in MOS industry, as well as the lack of incorporating geopolitical factors like country of origin (COO). This paper underscores the urgency for academic research to explore consumer attitudes towards Chinese MOS and the role of COO in shaping adoption decisions. By integrating geopolitical risk variables into MOS adoption studies, researchers can offer valuable insights for policymakers and industry stakeholders navigating global technological dynamics.

Keywords: Smartphone, Mobile Operating System, Chinese, Adoption, Country of Origin

Introduction

As technology advances, smartphones have been playing a crucial role in our daily lives, hence Mobile Operating System (MOS) has also been increasingly important because it enables the usability of smartphones. Currently, there is a duopoly in the MOS industry, as the MOS market share has been dominated for decades by Apple's iOS and Google's Android (StatCounter, 2024; Statista, 2024). The major smartphone makers like Apple, Samsung, Xiaomi, Oppo, Vivo, and almost all other makers are using MOS licensed by Apple and Google. This has led to a spectacular scenario that the MOS industry is currently monopolized by the US, as both Apple and Google are technology companies based in the US.

The lack of having an alternative replacement on MOS has become a weakness to other countries from the geopolitical perspective. During the trade war between the US and China, the technological competition was one of the key targeted areas, hence the dominance of MOS was utilized by the US as one of its geopolitical weapons. In 2019, the US banned Huawei, one of the top Chinese smartphone makers on the global market, from obtaining the license of Android (Kharpal, 2020; Swanson, 2020).

As a result, Huawei was forced to introduce its own MOS to substitute Android. Huawei used its own developed HarmonyOS in its latest smartphone models to continue compete in the smartphone industry (Kharpal, 2019). However, it was not welcomed by the consumers as Huawei lost its market share substantially from 20% in 2020 to 4% in 2021, as illustrated in Figure 1 (Canalys, 2022; Swingle, 2021). The US has successfully suppressed Chinese companies, and such geopolitical risks have been continuously rising after the most recent Russia-Ukraine conflicts and Israel-Palestine conflicts.

Although the situation is serious, there is a lack of academic research over this incident based on literature review by the researcher of this paper. Academic research should be carried out to study the consumer behaviour in the MOS industry and study the possible variables that affect the smartphone user in the adoption of new MOS, especially the possible variables regarding geopolitical risk in the case of a new Chinese MOS, for examples, Country of Origin.

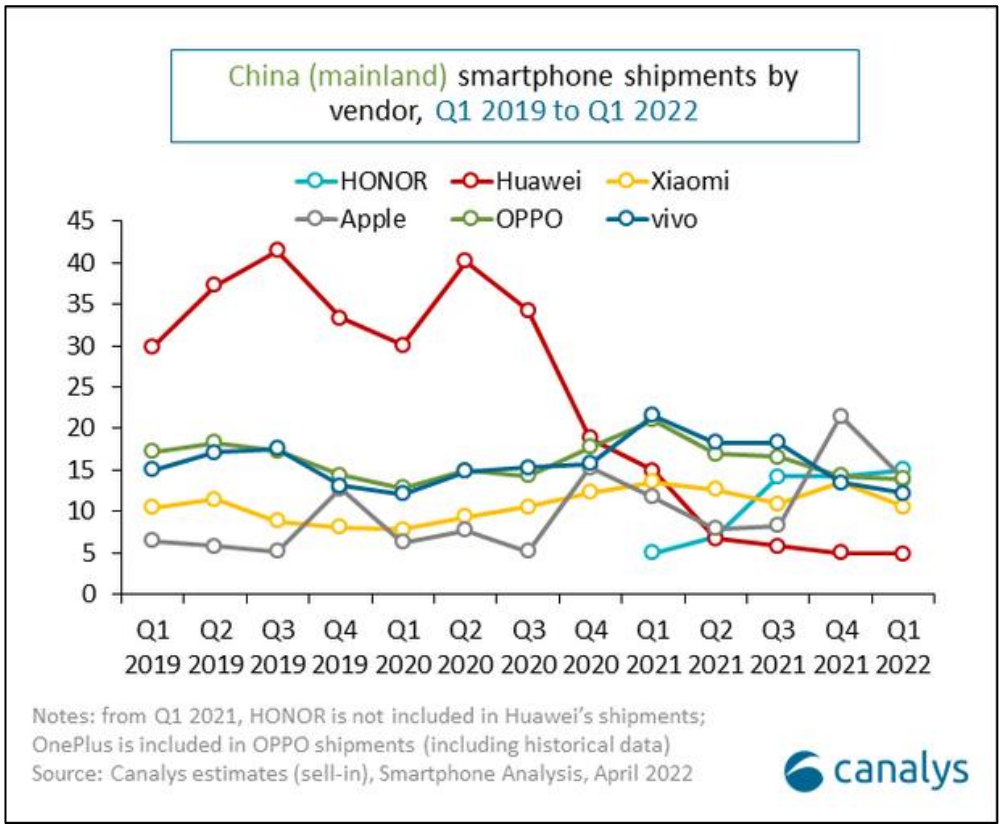

Figure 1. The Changes of Huawei's Market Share after Introducing HarmonyOS (Canalys, 2022)

Research Process and Research Method

The researcher of this paper has conducted literature review from various databases available including but not limited to Emerald, ScienceDirect, Scopus, SpringerLink and Google Scholar. The literature survey was started by first searching the terms "Mobile Operating System" and "Chinese Mobile Operating System". Then, the terms "Innovation Adoption" and "Country of Origin" were being searched, including the related terms such as "Product Innovation" and "Innovations Diffusion" which match the contexts of this study. A quick screening through title and abstract was done, followed by the full-text assessment for the relevance.

After an initial search and analysis of the literature, the researcher has found plenty of literature covering the topic of Innovation Adoption. However, the researcher found them as insufficient resources to cover the MOS industry, especially on the topic of Chinese MOS and its relationship with Country of Origin. Further search has been conducted online via Google to carry out extensive review on the topics, hence relevant information found online has also been reviewed and included in this paper. Figure 2 below summarises the research process and method of this paper.

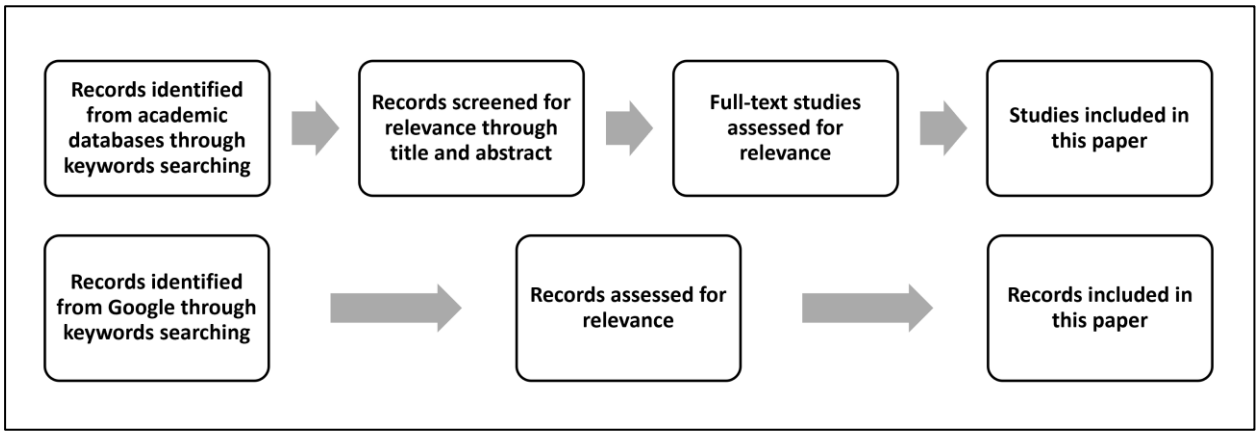

Figure 2. The Research Process and Method of this Paper

Mobile Operating System

The term Mobile Operating System (MOS) originated from Operating System (OS), which refers to the technology software that plays as an intermediary between the hardware and the user (Novac et al., 2017). For instance, Windows and MacOS are two well-known OS that are designed to run on personal computers. As opposed to the original OS, MOS by definition refers to the OS that are designed to run on mobile devices, such as smartphones, tablets, smartwatches, and other handheld devices (Okediran et al., 2014).

Looking back in history, MOS began to come into the headlines of the world by Palm OS in 1996, which was one of the first MOS that initially designed for the personal digital assistants (PDA) by Palm Inc (Fried, 2010). In the same year of 1996, Microsoft also announced Windows CE which originated from its dominant product Windows but optimized for mobile devices (Crystal, 2022). It was later rebranded as Windows Mobile, and then replaced by a more modern Windows Phone system.

Mobile phones have been a necessity since the early 2000s, with Nokia was the dominant player in the industry. During the dominance of Nokia, Symbian OS was one of the major MOS

because it was the MOS built into the Nokia mobile phone (Morales, 2022). Another key player in the mobile phone industry was the BlackBerry phone developed by Research in Motion (RIM), hence BlackBerry OS also became one of the major MOS as it was built into the BlackBerry mobile phone (Rouse, 2011).

A key milestone of the MOS industry was in 2007 when Apple revolutionized traditional mobile phones by introducing iPhone with a new MOS called iOS. Subsequently in the next year, Google also announced its MOS called Android, which is open-source and available for licensing usage by any other smartphone makers (Okediran et al., 2014). Both iOS and Android became pronounced throughout the 2010s and they continue to dominate the MOS industry till today (StatCounter, 2024; Statista, 2024).

The MOS industry was having a more intense competition before the dominance of iOS and Android. Several reputable tech companies developed their own MOS to compete with Apple and Google. For example, Windows 10 Mobile by Microsoft, BlackBerry 10 by BlackBerry, Firefox OS by Firefox (Rafaelle, 2022), Bada and Tizen by Samsung (Bunton, 2022), webOS by LG (Banerjee, 2023), Ubuntu Touch by Canonical (Wohlscheid, 2020). However, all of them failed to grab significant market share.

Android-based Chinese MOS

The traditional mobile phone industry was predominantly occupied by non-Chinese companies like Nokia, Motorola, BlackBerry, Sony Ericsson. However, the modernized smartphone industry is actively participated by Chinese companies like Huawei, HONOR, Xiaomi, OPPO, Vivo, and so on. Therefore, the MOS industry, which is developing together with the smartphone industry, is also actively participated by these Chinese smartphone makers.

Google's Android is an open-source MOS, and it has been widely accepted by other smartphone makers like Samsung, LG, Sony, and even Microsoft. However, they will customize the MOS to incorporate their original ideas, and then rebranded into their own names of MOS. For instance, Samsung branded its Android-based MOS as TouchWiz, Samsung Experience, and One UI (Okpanachi, 2024; Rao, 2017). The latest One UI version 6.0 has been released based on Android version 14 (Mishra, 2023).

Similarly, Chinese smartphone makers have also chosen Android to be the default MOS that build into their smartphones. One of the top Chinese smartphone makers, Xiaomi, was built up from its well-known customization of Android, named as MIUI. Followed by its successful debut of MIUI in 2010, Xiaomi only launched its first smartphone one year later (Brown, 2023). The latest MIUI version 14 is available to be upgraded up to Android version 14 (Abdullah, 2023).

Other Chinese smartphone makers have come up with a variety of MOS brandings under their own customization of Android. For example, EMUI by Huawei (Rutnik, 2019), MagicOS by HONOR (Michail, 2024), ColorOS by OPPO (Dayaram, 2023), Funtouch OS and OriginOS by Vivo (Sagar, 2023; Yordan, 2023), and so on. Despite the same Android basis, the user interfaces of these Chinese MOS have been customized for added differentiation among others.

Non-Android-based Chinese MOS

Geopolitical tensions between China and the Western countries have been bringing significant influences on the technology industry over past decades. Since the 2000s, China has been blocking the access to Western social media like Facebook, YouTube, Twitter via its legislative firewall (Barry, 2022). In addition to that, China has been censoring the content of its domestic internet, which caused the leaving of Google in 2010 due to unable to provide censored search results (Carlson, 2010).

Despite the hatred against Western technology, China did not ban the usage of Android for its Chinese smartphones, hence all the Chinese smartphone makers are able to use Android as their MOS. However, Google has bundled Android with Google Mobile Services (GMS), which is unable to function in China due to the censorship. The Chinese smartphone makers had to replace GMS by bundling their own native applications in the China region (Leber, 2012; Whitwam, 2012).

The nationalism of Chinese has soon expanded its influences over the Chinese policies on MOS. In 2013, the Chinese government issued a white paper that specifically spelled out the concern of over-reliance on Android, condemned Google on preventing a new Chinese MOS, and complimented Chinese companies to develop their own Chinese MOS (Lee, 2013; Lomas, 2013). This had set the government stand of promoting a non-Android-based Chinese MOS.

The Chinese government themselves already attempted to develop Chinese MOS via several state-owned companies. For instance, the state-owned network carrier, China Mobile, developed a MOS called “Open Mobile System” in 2010 (Kan, 2010). Another state-owned network carrier, Liantong, also worked with the state-owned Chinse Academy of Sciences to develop a MOS called “China Operating System” in 2014 (Lee, 2014). However, both MOS had been discontinued (Brodkin, 2014; Limongello, 2010).

The Chinese private sectors had also attempted to develop Chinese MOS. Three Chinese technology companies, often referred as “BAT”, namely Baidu, Alibaba, Tencent, are three dominant technology leaders in China. Baidu had its MOS called “Baidu Yi” (Lee, 2011), Alibaba had “Aliyun OS” (Kan, 2011), and Tencent had “Tencent Operating System” (Singleton, 2015). However, all these MOS had been discontinued (Lee, 2019; Cheh, 2017; Millward, 2015).

After the ban by the US in 2019, Huawei introduced its own MOS called “HongmengOS”, also known as “HarmonyOS” (Kharpal, 2019). The urgency of such ban did not give Huawei ample time to produce an overhaul new Chinese MOS, hence HarmonyOS had been criticized due to its similarity with Android (Amadeo, 2021). Huawei had to continuously remove Android codes, and they claimed to release “HarmonyOS Next” in 2024 to totally remove the codes (Deng, 2024).

In 2023, Xiaomi unveiled a new MOS called “PengpaiOS”, also known as HyperOS, which will be replacing its original MIUI. However, Xiaomi itself admitted that HyperOS is a combination of its own Vela system and Google’s Android (Schoon, 2023). Xiaomi smartphone users will be using their HyperOS-based smartphones just like using any Android smartphones.

Therefore, there is still a long way for the MOS industry to have a totally independent Chinese MOS.

Adoption of Technology

Since the Industrial Revolution began and followed by the Digital Revolution that consumer technologies have been advanced over past decades, the academic research community has been studying technological innovations, especially the factors that affect the consumers to adopt the technology. Remarkable research results have been presented with several academic theories and models.

One of the earliest academic theories is the theory of "Diffusion of Innovations (DOI)" proposed by Rogers as early as 1962. Despite its distant proposal date, Rogers' DOI theory is still widely accepted by researchers today. The DOI theory is a comprehensive theory that explains the diffusion process by four elements, including the characteristic of innovations, the communication channels, the adopter categories, and the social system (Rogers, 1962).

Another stream of academic research that investigates the adoption of technology comes from the "Theory of Reasoned Action (TRA)" proposed by Fishbein and Ajzen in 1975. The TRA theory originated from the sociological and psychological area of academic research, but soon it was used to investigate the technological area. The TRA theory suggests that the intention to adopt technology is determined by Attitude and Subjective Norm (Fishbein & Azjen, 1975).

One of the original researchers from the TRA theory, Azjen, further developed the theory into the "Theory of Planned Behaviour (TPB)" in 1985. The difference between TRA and TPB is the addition of the third factor, which is Perceived Behavioural Control. Moreover, Azjen suggested that the Perceived Behavioural Control not only has direct impact to the intention, but also has indirect impact to actual behaviour through intention (Ajzen, 1985).

Another variation of TRA theory is the "Theory of Interpersonal Behaviour (TIB)" proposed by Triandis in 1977. The difference between TRA and TIB is the addition of three factors, namely Affect, Facilitation conditions, and Habits. Moreover, Triandis suggested that Affect has direct impact to the intention, while Facilitation Conditions and Habits not only have direct impact to the behaviour but also moderating impact between intention and behaviour (Triandis, 1977).

One of the most influential variations of TRA theory is the "Technology Acceptance Model (TAM)" proposed by Davis in 1986. Davis restructured the model by using the variables of Attitude, Behavioural Intention, and Actual Usage. Moreover, Davis presented a simplified model by suggesting that two factors have impacts to the consumers' attitude towards a new technology, which are Perceived Usefulness and Perceived Ease-of-use (Davis, 1986).

The original research of the TAM theory, Davis, further extended the theory with Venkatesh in 2000, and they named the extended model "TAM 2". The TAM 2 theory incorporates five factors that have impact to the Perceived Usefulness, including Subjective Norm, Image, Job Relevance, Output Quality, Result Demonstrability. Moreover, Davis and Venkatesh also suggested two moderating variables of the Subjective Norm, namely Experience and Voluntariness (Venkatesh & Davis, 2000).

In 2008, Venkatesh further extended the TAM 2 theory with Bala, and they named the second extended model "TAM 3". The TAM 3 theory incorporates two categories of factors that have impact to the Perceived Ease-of-use, namely Anchor and Adjustment determinants. The former includes Computer self-efficacy, Perceptions of external control, Computer anxiety, Computer playfulness, while the latter includes Perceived enjoyment and Objective usability (Venkatesh & Bala, 2008).

Venkatesh also worked with other researchers and proposed their own variation of the original TRA theory in 2003, called the "Unified Theory of Acceptance and Use of Technology (UTAUT)". The UTAUT theory identifies four factors to the behavioural intention, namely Performance expectancy, Effort expectancy, Social influence, Facilitating conditions. Four moderating factors are also identified, namely Gender, Age, Experience, Voluntariness of use (Venkatesh et al., 2003).

In 2012, Venkatesh and others further extended the UTAUT theory, and they named the extended model "UTAUT 2". The new factors are included in the UTAUT 2 theory, namely Hedonic motivation, Price value, and Habit (Venkatesh et al., 2012). Another group of researchers, Farooq et al., developed the "UTAUT 3" theory in 2017. They restructured the factors from UTAUT 2, and additionally incorporated a new factor, namely Personal Innovativeness in IT (Farooq et al., 2017).

In conclusion, extensive research has been conducted on the adoption of technologies as proven by large varieties of academic theories over past decades. Subsequently, numerous researchers have tested the above-mentioned theories in various contexts and industries, including the adoption of smartphones (Yoo et al., 2021; Jamalova & Constantin, 2020), or the adoption of mobile applications (Nezamdoust et al., 2022; Srivastava & Fernandes, 2022; Kaur et al., 2020; Min et al., 2018).

Adoption of MOS

The MOS industry has been developing together with the era of smartphones and mobile applications, as elaborated in previous section. Despite the adoptions of smartphones and mobile applications have been extensively studied, there is a lack of research that has tested the adoption theories on the MOS industry. The researcher of this paper has conducted literature review from various databases available including but not limited to Emerald, ScienceDirect, Scopus, SpringerLink.

The closest research that can be found is the one by Mehra et al. (2022), who investigated the adoption of the latest Android version compared to older Android versions. The researchers used a combination of factors from the theories of DOI, TAM, and UTAUT. The study presented inconsistent results that only eight hypotheses were supported out of the total of ten hypotheses. Some factors were found to have insignificant relationships with the intention to adopt the latest Android version.

However, Mehra et al. (2022) studied the adoption of the latest Android version, which is slightly different to the adoption of totally different MOS, hence there is still academic gap on the adoption of MOS. Nevertheless, Mehra et al. (2022) provided several recommendations to future researchers, for example, different geographical locations or different variables.

They also emphasized that there will always be automatic gaps in the MOS academic research due to new MOS version being introduced every year.

The most recent shock to the MOS industry was the ban of Huawei during the US-China trade war, as Huawei was forced to introduce its own HarmonyOS to substitute US-based Android. The failure of HarmonyOS was proven by Huawei's low market share in the international market; hence the adoption of MOS is increasingly critical to the smartphone industry. More importantly, it is now necessary to include variables that can reflect the geopolitical risk in the MOS industry.

Country of Origin

Country of origin (COO) has been a widely studied academic research area since last century. The origin of the COO concept can be traced back as early as Schooler (1965). Past researchers have concluded that COO leads to a certain stereotyping among consumers, who will categorize the products based on origins. Such stereotypes can be positive or negative, which will then affect the consumers' evaluation of the products without fully understanding the products (Al-Sulaiti & Baker, 1998).

The impacts of COO on the product evaluation or purchase intention of smartphones have already been studied by previous researchers (Coudounaris, 2018; Banerjee & Chaudhuri, 2014). The researcher of this paper has conducted literature review from available databases, but no research paper has been found to study the specific impact of COO on the adoption of MOS. Considering the rising geopolitical risks and its impact on the MOS industry, this can be an important academic gap for future researchers.

Past researchers have also concluded that products from developing countries or emerging economies are perceived as lower quality (Napathorn, 2020). As a developing country with great amount of exported goods, Chinese goods have been studied as a case study to counter the impacts of negative Chinese COO image (Islam & Hussain, 2022; Niammuad, 2016). Future researchers can extend the research and examine the academic findings in the MOS industry, by comparing Chinese MOS to non-Chinese MOS.

COO has been widely discussed on its impact on consumers' evaluation of product quality. However, this does not help in mitigating geopolitical risks that the consumers are not rejecting products due to perceived low quality but rejecting them due to the geopolitical tensions among countries. After conducting literature review on relevant academic topics, the researcher of this paper believed that the factor of "Animosity" can better illustrate the issue and fill the academic gap.

The importance of Animosity in consumer behaviour has been rising and the impact of Animosity has been studied (Fong et al., 2022). Several geopolitical tensions between countries have been studied as case studies, including the tension between China and Japan (Antonetti & Manika, 2022), between China and the US (Mainolfi, 2021), between China and Korea (Lee et al., 2021). Future researchers can extend the research by adopting Animosity as a variable and studying its impact in the MOS industry.

Conclusion

The mobile operating system (MOS) industry, dominated by Apple's iOS and Google's Android, has become a critical component of the global smartphone market. However, recent geopolitical tensions, such as the US-China trade war and the banning of Huawei from using Android, have highlighted the vulnerabilities associated with reliance on the American-based duopoly in the MOS market.

This article contributes to the academic discourse by exploring product innovation adoption in the MOS industry and highlighting the need to incorporate geopolitical factors into adoption studies. While previous research has extensively examined the adoption of smartphones and mobile applications, there is a notable academic gap in understanding the adoption of MOS, particularly Chinese MOS. By synthesizing theories such as Diffusion of Innovations (DOI), Technology Acceptance Model (TAM), and Unified Theory of Acceptance and Use of Technology (UTAUT), this article lays the groundwork for future research and explores the possibility to incorporate variables that best reflects the geopolitical risks, for examples, variables related to Country of Origin like Animosity. Figure 3 present the proposed important areas for future research.

The practical implications of this article and future research can extend to stakeholders in the smartphone industry, policymakers, and technology companies. Understanding consumer behaviour in the MOS industry is crucial for smartphone manufacturers aiming to develop and market competitive products. Moreover, policymakers need to recognize the geopolitical risks associated with reliance on foreign MOS providers and consider strategies to promote domestic MOS development. For technology companies, especially those in China facing restrictions from foreign MOS providers, this article underscores the importance of developing alternative MOS solutions that resonate with consumers.

In conclusion, this article highlights the need for further academic research to understand consumer behaviour in the MOS industry and the importance of geopolitical risks. By bridging the gap between theory and practice, stakeholders can navigate the complexities of the MOS market and adapt to changing geopolitical landscapes effectively.

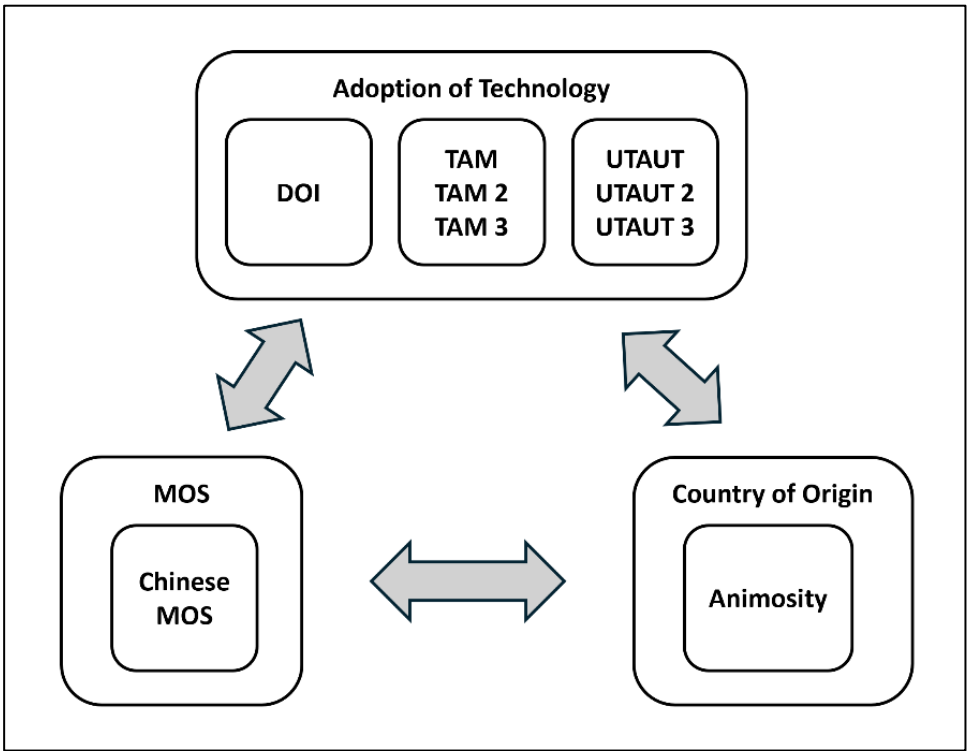

Figure 3. Proposed Important Areas for Future Research

Acknowledgments

I would like to thank Dr. Mazilah Binti Abdullah from Universiti Teknologi Malaysia for the guidance and support of this research.

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