國立臺灣大學管理學院國際企業學系

碩士論文

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Master Thesis

以動態能力、交易成本、平臺理論及治理理論分析鴻海的 MIH 開放式電動車平臺生態系

Analyzing Hon Hai’s MIH Open Platform Electric Vehicle Ecosystem: Perspectives of Dynamic Capabilities View, Transaction Cost Economics, Platform Theory, and Governance Theory

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口試委員會審定書

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本論文係 柯愷莉 君（R10724062）在國立臺灣大學國際企業學研究所完成之碩士學位論文，於民國 112 年 07 月 17 日承下列考試委員審查通過及口試及格，特此證明。

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中文摘要

台灣世界領先的代工製造商鴻海精密工業股份有限公司（Hon Hai Precision Industry Co. Ltd.）大膽進軍電動車（EV）產業。鴻海在 EV 市場策略的前沿是「Mobility in Harmony」（MIH），這是一個國際性的開放平台聯盟，擁有來自 70 個國家和地區，並超過 2,600 家公司。旨在通過合作開發模塊化、全球標準化的 EV 硬體與軟體組件，來解開汽車供應鏈。儘管 MIH 已成為公眾對鴻海在 EV 項目中成功能力的猜測焦點 ，但至今，MIH 的優勢和缺點卻缺乏基於國際商業理論原則的論述。本研究運用動態能力理論、平台理論、交易成本經濟學和多種治理理論的視角進行質化的研究，進一步確定並闡述 MIH 平台架構和治理機制中的缺陷。鑒於 MIH 和 Android 在打開智能手機行業方面存在明確的相似之處，本研究也以前述理論爲基礎，進行了兩個平台生態系統的比較分析。本研究透過對 MIH 辦公室運營與市場總監鄭宇翔（Joe Cheng）的現場訪談，進一步深入了解 MIH 的設計特徵和運作模式。研究結論指出，MIH 及其未來的前景（包含其旗艦項目 X 計劃的結果）將取決於是否能有效解決平台生態系統當前價值主張和治理機制等組織上的弱點。最後，本研究也提出一套相對應的建議，以提高 MIH 的長期可持續性的成功機會。

Keywords: *鴻海*、*MIH*、*電動車*、*平臺生態系統*

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Abstract (English)

Taiwan's world-leading contract manufacturer, Hon Hai Precision Industry Co. Ltd., has taken bold strides to enter the electric vehicle (EV) industry. At the forefront of Hon Hai's EV market strategy is Mobility in Harmony (MIH), an international, open-platform alliance of over 2,600 companies spanning 70 countries and regions, which aims to "open up" the automotive supply chain by collaboratively developing modular, globally standardized solutions for EV hardware components and software. While MIH has become a focal point of public speculation on Hon Hai's ability to succeed in its EV venture, there has been to-date a lack of argument for MIH's strengths and weaknesses founded on the tenets of international business theory. Through a qualitative research study that applies the lenses of dynamic capabilities view, platform theory, transaction cost economics, and assorted governance theories, gaps in MIH's platform architecture and governance regime are identified and addressed. Given the explicit parallels drawn between MIH and Android's success in opening the smartphone industry, a comparative analysis of the two platform ecosystems is conducted as the medium for theory application. An on-site interview with Joe Cheng, the MIH office's Director of Operations and Marketing, provides further, firsthand insight into MIH's overall characterization. This study concludes that the long-term future of MIH, its flagship Project X, and any future endeavors will hinge upon addressing the organizational weaknesses of the platform ecosystem's current value proposition and governance regime. Lastly, a set of corresponding recommendations are given to improve MIH's long-term sustainability and chances of success.

Keywords: *Hon Hai, MIH, Electric Vehicles, Platform Ecosystem*

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CHAPTER 1 RESEARCH CONTEXT

1.1 Research Background

Electric Vehicles, or EVs, have taken the forefront of automotive innovation in recent years as our global society experiences unprecedented digitalization and increased environmental consciousness. The potential for electrified transportation to reduce carbon emissions and contribute to a sustainable, efficient world civilization has been lauded by climate activists, academic organizations, and government institutions alike, fueling a surge of new EV ventures and startups. Nonetheless, with this ambitious vision for modern mobility also comes a complex web of multi-faceted issues and required supply chain reformation. Zulkarnain et. al.'s (2014) exposition on the global EV ecosystem and its key challenges defines three overarching roadblocks to building an effective business model.

The first category, "consumer acceptance", entails demand-side concerns regarding EV driving range, speed, safety specifications, access to maintenance services, and a high price tag outweighing gas savings, with EV batteries alone accounting for 48 percent of vehicle cost. The second category of "technical aspects & infrastructure" concern the supply-side obstacles of standardizing EV components, improving upon existing battery technology, and connecting vehicle and charging port OEMs with public officials in creating a sufficiently robust vehicle-to-grid (V2G) charging network. Third is the "environmental challenges & regulatory issues" associated with deployment of EV networks in different nations, navigating international EV trade, and structuring an EV value chain that does not actively contradict the product's mission of sustainability, particularly in regard to the mining of toxic battery materials and disposal/recycling of used batteries (Zulkernain et. al., 2014). Due to the capital-intensive, time-consuming nature of

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electric vehicle R&D, individual vehicle brands and other members of the EV value chain find it exceedingly difficult to develop solutions for each of these themes on their own.

It is amid this backdrop of high growth potential paired with fierce competition and market uncertainty that Taiwan's world-leading contract manufacturer, Hon Hai Precision Industry Co., Ltd., has taken bold strides to enter the EV industry. As part of this strategic expansion in business scope, Hon Hai founded an independently operated, open industry platform for collaboratively developing globally standardized EV hardware and software solutions, called Mobility in Harmony (MIH). The establishment of MIH has been a focal point of public discussion and speculation on Hon Hai's ability to succeed in the EV space, while Hon Hai executives have continually promoted the platform ecosystem's mission of "opening up" the automotive supply chain as the imminent future of mobility, even declaring that MIH could achieve for EVs what Android did for smartphones (Hon Hai, 2020). Absent in this public discourse, however, is a comprehensive argument of MIH's strengths and weaknesses that is founded on the tenets of international business theory.

1.2 Research Motivation

As an overseas international student with especial interest in cross-border business strategy and collaboration, three key decision factors were at the heart of my research topic selection. First and foremost, I wanted to study an industry phenomenon involving complex business relations at a global scale, particularly involving interactions between my home country, the United States, and Taiwan. Second, this phenomenon should require sophisticated business strategy to operate successfully, and as such can be analyzed under the strategy school of international business theory. Third, I desired for the industry in question to be an emerging, high technology with ample need

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for new research. As a novel and disruptive venture within a highly uncertain but rising technology field, Hon Hai's MIH consortium for EVs fulfilled all three selection criteria.

The subject of software-empowered, electrified vehicles itself is a compelling field of study, not only for their potential environmental benefits, but also as a means to improve road safety and overall quality of life for modern civilization. Thus, selection of MIH as my research topic was also strongly motivated by a desire to contribute towards resolving the strategic challenges of internationally applicable EV business models and standardization, thereby paving the way for cleaner, safer, and smarter transportation.

1.3 Research Objective and Questions

The objective of this thesis is to remedy the above-mentioned gap in academic analysis for MIH by applying a series of international business theory lenses in explicating the origins and driving forces of MIH's formation, then subsequently evaluating the open industry alliance's potential and performance as a platform ecosystem. Dynamic capabilities view (DCV) is first applied in interpreting the rise of MIH from a perspective of the parent Hon Hai's response and transformation skills in a dynamic macroenvironment. Principles of platform theory and transaction cost economics (TCE) are then utilized to concisely delineate MIH's structural efficiencies and costs. Next, governance theory pertaining to organizational control and platform leadership strategies are introduced to investigate MIH's existing toolset for member coordination and control. For each theoretical dimension, an in-depth comparison of MIH to the historical case of Android is made for further insight generation. Finally, to enhance the depth and accuracy of this report's findings with a firsthand internal account, a focused, on-site interview with one of MIH's executive managers is conducted.

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Six core research questions will be explored in conjunction with this objective and research framework. The first research question to be addressed is the underlying reasoning for Hon Hai's establishment of MIH and how its purpose differs from the diverse array of EV related inter-business collaborations Hon Hai has pursued in its parallel:

Research Question 1: Why did Hon Hai choose to establish an open platform ecosystem for electric vehicles (MIH) when the company is already engaging in several electric vehicle joint ventures on its own? What are the strategic goals for this arrangement? How would this arrangement create values? At what benefits and costs?

Questions two through five encompass the research goals behind this paper's comparative analysis of Hon Hai's MIH and Google's Android. Using the four theoretical lenses listed above, Android's platform history, structure, efficiencies, costs, and governance mechanisms are presented as a baseline case study to compare MIH's core characteristics and determine what lessons can be rendered from Android's own precedent as a disruptive, open platform ecosystem:

Research Question 2: What does the formation of MIH reveal about Hon Hai's dynamic capabilities?

Research Question 3: How does MIH's origins, development, and governance compare to the Android open platform ecosystem for mobile computing?

Research Question 4: What kinds of complementarities does the architecture of the MIH platform entail, and how might they impact member behavior?

Research Question 5: What are the transaction costs related issues faced by Hon Hai, MIH as a consortium entity, and its umbrella of members?

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Lastly, following a synthesis of the identified risks and inefficiencies within MIH, the final research question will advise on potential remedies that improve MIH's long term sustainability and chances of success:

Research Question 6: What governance and dynamic capability mechanisms are recommended for MIH to optimize transaction costs and succeed in its objectives?

1.4 Research Method

The following research is of a qualitative and exploratory nature, comprised of an introduction phase, analysis phase, and conclusion (see Figure 1). The introduction phase provides the underlying context and theoretical basis for studying MIH as an international business phenomenon. Next, the analysis phase introduces the rise of MIH under the current EV industry environment, after which a comparative analysis between MIH and Android is made using the four chosen IB theories, followed by a detailed description of insights uncovered from the MIH Office interview. Lastly, the conclusion synthesizes key analysis findings for a discussion of recommended solutions, research limitations, and proposed areas for future research.

Secondary data utilized in conducting the analysis consists of publicly released information from the respective platform ecosystems' websites, such as financial statements, published guidelines, event livestreams, and other documents pertaining to organization activity. For Android, a selection of academic articles compiling the ecosystem's history and evolution are cited. News releases for both ecosystems from reputable media and industry analysts are also referenced.

As a primary data source, an interview with one of the MIH Office's executives constitutes the final section of this paper's analysis phase. The questions prepared in advance of the interview were designed based on the six research questions, with the intention of clarifying the managerial mindset and strategies Hon Hai and MIH executives implement in designing, operating, and

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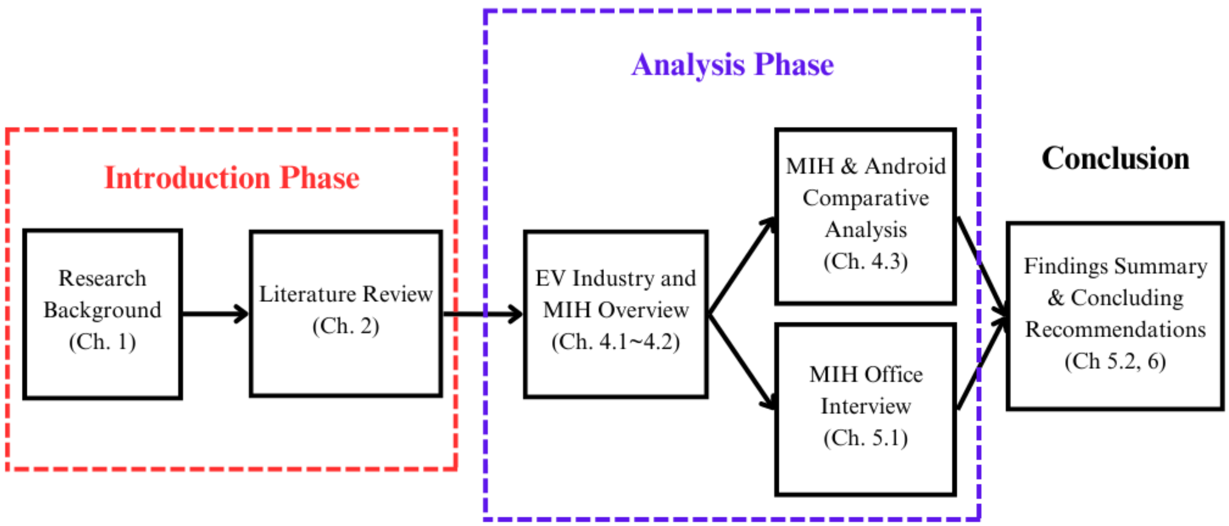
governing the platform ecosystem. Based on the responses, I then evaluate these strategies from an IB theory lens to determine how the above group of dependent variables are impacted. For the detailed question transcript, please refer to Appendix B: MIH Office Interview Questions.

Figure 1: MIH Research Flowchart



Source: Compiled by Researcher

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CHAPTER 2 LITERATURE REVIEW

Prior to entering the analysis phase of this study, the following section will provide a review of the extant literature as it pertains to each of the four theoretical dimensions utilized.

2.1 Dynamic Capabilities View

Dynamic Capabilities View (DCV) is a theoretical framework popularized by Teece et. al. (1997) in the context of extending a Resource Based View (RBV) to frequently changing business contexts for multinational enterprises (MNEs), which holds particular relevance for high technology markets. Though varied definitions have been brought forth from scholars, for the purposes of this study, Teece's definition of "the firm's ability to integrate, build, and reconfigure internal and external competencies to address rapidly changing environments" serves well (Teece et. al., 1997). Teece (2007) further develops DCV into three subcategories that typically function as a continuous cycle, comprised of sensing opportunities and threats, seizing opportunities, and maintaining competitiveness through active management and recombination of firm-specific assets (FSAs) (Teece, 2007). Further elaborating upon DCV's application for MNEs establishing and managing multi-sided platforms in the digital economy, Teece (2017) builds upon James F. Moore's platform lifecycle to clarify the comparative significance of generative sensing during a platform's birth and self-renewal phases, compared to the imperative of seizing opportunities and transforming in tandem with organizational learning during the stages of expansion and leadership (Teece, 2017).

Grøgaard et. al. (2019), on the other hand, frames DCV as a tool for optimizing an MNE's position on the Integration-Responsiveness (IR) scale, based on the transnational strategy described by Bartlett & Goshal (1989) that actively balances global integration and local responsiveness. Based on this objective, they proposed "legitimizing, leveraging, and launching

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capabilities" as key location and non-location bound resource recombination skills for an MNE to possess under DCV (Grøgaard et. al., 2019).

2.2 Platform and Ecosystem Theory

A prerequisite to conducting a thorough analysis of Android and MIH's respective architectures would be providing clear terminology definitions for platforms and platform ecosystems. As explicated by Nambisan et al. (2019) in their analysis of global platforms and ecosystems, the definition of "platforms" is characterized by a prevailing duality of perspectives (Nambisan et. al., 2019). The first perspective originates from product development studies, as is represented by Gawer & Cusumano (2014, 2009, 2002). Gawer & Cusumano divide their definition of platforms into internal (i.e., company or product) and external (i.e., industry-level). Under this categorization, internal platforms are defined as a streamlined configuration of assets made for generating new products, while external platforms refer to "products, services, or technologies that are similar in some ways to [internal platforms] but provide the foundation upon which outside firms (organized as a 'business ecosystem') can develop their own complementary products, technologies, or services" (Gawer & Cusumano, 2014).

The second perspective is an extension of industrial economics, represented by the assertions of Rochet & Tirole (2006, 2003). Rochet & Tirole treat platforms as a "multi-sided market", wherein the platform is a transactional conduit between two distinct sides such as suppliers and consumers (Rochet & Tirole, 2003). Gawer & Cusumano explain that the multi-side market diverges from industry platforms in that a multi-sided market does not necessarily require a community of complementors to innovate on the market's behalf. Online tutor, babysitter, or other job recruitment websites are prime examples of multi-sided markets not generally engaged in multi-party innovation activity (Gawer & Cusumano, 2014).

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Breaking down the dual perspectives of platforms further, each perspective reveals key efficiencies and catalysts for value creation that can be fostered within an ecosystem. From the product development perspective, a platform generates efficiencies in the form of complementarities. A complementarity is derived from combining the resources of different ecosystem members in order to catalyze value creation; in other words, joining platform components together increases overall platform value (Gawer & Cusumano, 2014). As categorized in the extant literature, complementarities come in two types: unique and supermodular.

Unique complementarities are characterized by mutual dependency, in the sense that a platform component and its resources must be joined to another to optimize its functionality and value. (Nambisan et. al., 2019) Teece's (1986) definition, while originally referring to intrafirm resources, emphasizes that unique complementarities should be difficult or costly to replicate for outside competitors, thereby establishing a more sustainable competitive advantage (Teece, 1986). An example of unique complementarities in the platform context would be Gogoro's proprietary software and battery-swapping technology, for which partnering motorcycle manufacturers would require the battery module specifications to properly design their e-bikes and participate in the platform.[1] Jacobides et. al. (2018) describes unique complementarities as having a spectrum of strict, specific, and generic sub-types. Strict and specific subtypes refer to component A strictly requiring component B for proper functionality, or A requiring component B *given certain customization* to be optimal (Jacobides et. al., 2018).

Returning to the Gogoro example, any electric scooter made by a platform member will require the proper hardware to support battery swapping across Gogoro's network of swapping

[1] Interestingly, Gogoro Taiwan Limited is also a member of the MIH consortium and announced a strategic partnership with Foxconn in June 2021 for accelerating the manufacture of smart scooters and electric batteries. (Source: https://www.foxconn.com/en-us/press-center/events/ev-events/637)

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stations. To keep distinction from in-house Gogoro scooters, however, manufacturers may integrate their own exterior design and dashboard features with Gogoro software while keeping the "Powered by Gogoro" label to meet a particular segment of consumer demand. Meanwhile, the generic sub-type of unique complementarities are standard resources that platform members utilize but that do not require special governance or IP protection (Jacobides et. al., 2018). For Gogoro, the electrical wires used to design e-bikes would be considered generic, as while they are essential to the e-bikes, they come from a mature and standardized materials market that does not necessarily need the platform architecture to conduct business.

Supermodular complementarities, on the other hand, describe the phenomenon in which a greater total of complementing firms and/or resources within a platform result in an even greater increase in overall platform value, or "increasing returns to scale" (Jacobides et al., 2018). A collaborative innovation platform such as Topcoder or virtual think-tanks benefit from supermodular complementarities when a larger variety of industry talents and firms agree to share knowledge and resources to achieve a common product objective.

From the industrial economics perspective, efficiencies are primarily achieved through the generation of network effects. Similar to complementarities, the focus of network effects is optimizing the value of the overall platform. Unlike complementarities, however, emphasis is placed on adding value as a function of the number of participants on a given side of the platform rather than the resource synergies which come from joining complementing participants together. [2] Network effects can be same-sided, meaning that an increase in the number of participants on one side acts as a positive feedback loop that increases overall platform value and thus attracts

[2] Jacobides et. al. (2018) ties network effects to supermodular complementarities, but for the sake of this research, I have chosen to separate the quantifying of *resources* and of *participants* into supermodular complementarities and network effects, respectively. It should be noted that the concepts need not be mutually exclusive.

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even more participants on the same side. Social media platforms classically leverage such same-sided network effects to attract more users, as a social application has limited value when those which a user seeks to socialize with are not present. Alternatively, network effects can be cross-sided, referring to when an increase of members on one end of the platform generates additional value for a different side of the platform. Cross-side network effects may be unidirectional, as is the case with advertisers on a news platform (advertisers would seek platforms with a higher user base, while readers do not base their platform choice on number of advertising companies), or bidirectional, in the way that both customers and merchants on an e-commerce site find the platform more valuable when there exists a greater number of their respective counterparts.

Both complementarities and network effects play an essential role in not only justifying a platform's existence, but also endowing the collective platform with competitive advantages that may not have been reachable by more conventional joint ventures or individual member operations. The compounding of these mechanisms can even result in "winner-takes-all" scenarios, where an industry consolidates to the point of only one or a few platforms enjoying tremendous market share (Nambisan et. al., 2019). This powerful phenomenon in action has been evidenced across several industry segments, such as the cannibalistic consolidation of food-delivery apps (Uber Eats acquiring Postmates and Takeaway acquiring Just Eat, to name a few examples) and a recent string of acquisitions in the digital gaming space (i.e., X-box parent Microsoft acquiring Activision Blizzard, PlayStation parent Sony acquiring Bungie, etc.).

The terms platform and platform ecosystem tend to be used synonymously in the literature but can occasionally be distinguished from each other in terms of scope. A platform itself may simply refer to the application or governing structure that connects different stakeholders to one another, such as the Spotify app for music streaming or Facebook for social networking. Platform

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ecosystem, on the other hand, is a more adequate description for both the central platform and all of the associated parties that establish a connection to said platform, regardless of whether their role is direct or indirect. For example, ecosystem participants that are not directly engaged in value creation but nevertheless play a crucial role include third-party payment providers that facilitate intra-ecosystem monetary exchange (ex: credit cards, bank transfer, PayPal) and regulatory agencies that determine relevant legal policies (ex: local departments of transportation authorizing Uber to operate rideshare fleets in a given region).

Further explicating the rise and composition of ecosystems in international business, Ron Adner (2017) compares and contrasts two conceptualizations he terms "ecosystem-as-affiliation" and "ecosystem-as-architecture". Ecosystem-as-affiliation places emphasis on formation of a cross-industry community tied together by platform affiliations and resulting interdependencies. The strategy rooted in this conceptualization is increasing the number of affiliated ecosystem members, thereby giving the central firm(s), or platform leader(s), greater market power. Adner observes that ecosystem-as-affiliation has its limitations in explaining an ecosystem's value creation and governance (Adner, 2017).

In remedy to this shortcoming, Adner asserts that ecosystem-as-structure is a distinct but mutually consistent lens for understanding ecosystems from an activity-centric vantage point. Namely, the ecosystem-as-structure lens appoints the value proposition as the core that defines which actors and activities should be linked together, and in what configuration. In contrast to ecosystem-as-affiliation, which first looks at potential ecosystem members, identifies ways to link them together, then derives value propositions from these links, ecosystem-as-structure begins with establishing the desired value proposition, only after which relevant members and activities are selected and positioned. Ecosystem-as-structure illuminates the importance of alignment

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between ecosystem members, defined by Adner as "the extent to which there is mutual agreement among members regarding [ecosystem] positions and flows" (Adner, 2017). In conjunction, ecosystem-as-structure reveals strategic implications for aligning an ecosystem with value-creating activities, such as the need to address and overcome co-innovation risks (ensuring members have the technical ability to engage in new activities) and adoption chain risks (willingness of each member to engage in required activities) (Adner, 2017).

2.3 Transaction Cost Economics

Transaction cost economics (TCE) is a renowned theory of inter and intra-business interactions first derived from the findings of Ronald Coase (1937) and Oliver Williamson (1975), both of which contended that the reason for non-market forms of organization such as firms and contracts existing is due to transactional externalities, of which without them, all transactions would operate in a pure market setting. These externalities, termed "transaction costs", include bounded rationality and opportunism, each referring to the human tendency of individuals to act on limited information and in consideration of their own self-interests (Coase, 1937; Williamson, 1975). TCE had not been explicitly applied to the MNE context, however, until Hennart's PhD thesis in 1977, "A Theory of Multinational Enterprise." The theory asserts that the configuration of any given business transaction, and indeed the existence of MNEs and other cross-border business arrangements, is founded on achieving optimal transaction cost levels. Depending on transaction factors such as required asset specificity (i.e., transaction-specific investments with low resale or reusability value outside the transaction), level of easily transferrable vs tacit knowledge, behavioral risks such as cheating or shirking, and other cost considerations, a given firm may choose to conduct its transaction activities through internal, external, or hybrid mechanisms. Commonly referred to as the "Make or Buy" paradigm, Hennart argues the

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conventional dichotomy of firm vs market contains a spectrum of hybrid business arrangements that in fact entail the majority, which he refers to as the "swollen middle" (Hennart, 1991, 1993, 2010). One can observe that with the emergence of digital communication and platform ecosystems that this middle only continues to swell.

To understand why businesses so often opt to transact through hybrid entities as opposed to fully internalizing or externalizing them, it is important to first review the advantages and disadvantages of each spectrum pole. On the market side, greater transaction efficiency is achievable when product knowledge is easily transferrable, output is easily measurable, and value can be effectively signaled and governed through pricing. Contract manufacturers such as Hon Hai have historically acquired a robust clientele through its streamlined production and assembly capacity, of which could easily replicate and mass-manufacture custom technology blueprints at a lower cost than the owners of consumer electronics IP could achieve through internal means. Through Hon Hai's dedicated relations to major client Apple, the firm has also demonstrated a deeper business commitment through expensive investments in iPhone assembly equipment and tight confidentiality controls on unreleased product orders. This more integrated and reputation-reliant form of market transaction is what Williamson would categorize as relational contracting, which overcomes the complexity and interdependency challenges normally addressed through vertical integration by incorporating principles of flexibility and trust within the transactional terms (Williamson, 1975).

On the opposite end, the cost advantages of verticalizing transaction activities and enforcing behavior through hierarchy and/or socialization are extensively explored under internalization theory, a branch of TCE. Internalization scholars such as Buckley and Casson (1976, 2007) have shown through their decades of research that internalizing value chain activities can

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reap substantial benefits for firms in knowledge-intensive industries through circumventing the issues of adverse selection and consequent buyer uncertainty that arise from information asymmetry (Buckley and Casson, 2009). In explaining the existence and comparative efficiencies of MNEs in certain international business contexts, Hennart (2010) further identifies three conditions where MNE integration would be preferrable to other transactional relations. These include situations where investments of high asset-specificity are involved, which exposes transacting parties to significant hold-up risk (i.e., the potential for one partner to exploit the other due to sunk investments in transaction-specific assets); where there is difficulty in measuring the output contribution of each value chain participant, opening the possibility of poor-performing business partners to cheat and free ride the network; and where the timeliness of knowledge transfer is paramount but challenging in a market context due to its tacit nature (Hennart, 2010). For these hierchical transactions, use of behavior mechanisms such as measuring performance on following authority and socializing workers through organizational culture norms take the place of pricing as primary enforcement mechanisms (Hennart, 1991).

Especially as it pertains to high-technology industries, however, a given firm or business entity rarely, if ever, depends on solely hierarchical or solely market-based transaction mechanisms for every level and category of its transactional activities. Invoking commercialized space travel as an example, the design of a commercial-ready rocket ship may require easily standardized components such as metal framing and cabin light fixtures, whose production are better outsourced to manufacturers who already possess the proper capabilities and fixed capital. Inarguably, however, several aspects of rocket building and space travel services require astronomical levels of asset specificity and tacit knowledge to succeed, such as unique fuel formulas, associated equipment to handle and load such hazardous materials into the rocket's custom chambers, pilots

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with extensive high-risk flight experience and spontaneous decision-making skills, and a similarly educated crew accustomed to executing specific directives from superiors. It is no wonder, then, that the US-based Commercial Spaceflight Federation (CSF) was founded as early as 2006 to meet the hybrid transaction, co-innovation, and policymaking needs of industry players in developing such a complex value proposition (CSF, 2023).

2.4 Platform Governance Theory

Due to the wide scope and complex nature of platform ecosystems, effective governance mechanisms and processes are viewed as paramount to enabling sustainable, long-term success. According to the observations of Nambisan et. al. (2019), the emergence of platform ecosystems has contributed towards a major strategy shift for MNEs from controlling and owning all resources necessary for value creation, to organizing, synthesizing, and integrating them (Nambisan et. al., 2019). The core themes of governance, besides determining organizational architecture, include rulesets for onboarding complementors; principles of revenue sharing and value appropriation; protocols for conflict resolution among parties; and maintenance of platform's overall vision and integrity (Mukhodpadhyay and Bouwman, 2019). Ouchi (1979) stresses the importance of governance as a conduit for aligning partially congruent motives of complementors and fair rent distribution, warning that poorly managed platforms with inequitable value appropriation amongst members will incentivize individual behavior adjustments that lead to suboptimal outcomes for the group as a whole (Ouchi, 1979).

Mukhodpadhyay and Bouwmans' (2019) own review of the extant platform governance research identifies three categories of governance mechanisms, which are essentially synonymous with TCE's pricing vs behavior vs reputation controls. The first type is market/contract-based, where value creation and appropriation within the platform ecosystem are dictated by legally

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binding agreements such as contracts and IP rights. The power/authority-based type pertains to the ways one organization enforces decisions over others in the ecosystem. The final governance type is trust/clan-based, which depends on socialization tactics such as establishing an agreed code of conduct and fostering a shared vision among parties. Selection and implementation of these governance types in order to align member interests for value creation is explorable under Ouchi's (1979) Organizational Control Theory model, which houses the three governance types into market, bureaucratic, and clan systems. Much like Hennart's (1993) argument of the "swollen middle" for hybrid transaction forms, Ouchi asserts that while each system is distinct, their usage is often overlapping, citing the way procurement managers look to pricing for supplier decisions but are also tasked with the close supervision and qualitative evaluation of their subordinates (Hennart, 1993, Ouchi, 1979).

The resource controlling, or "gatekeeper roles", of platform ecosystem leaders can also be classified into various archetypes (see Figure 1). As argued by Iansiti and Levien (2004, cited Zhang and Liang 2011) in their study of such roles, platforms characterized by high levels of uncertainty and complexity are best governed through the "keystone" archetype, whose key attributes are as follows:

1. Building and sharing high-value common assets: the leader both contributes to value creation as well as shares the resulting assets with complementors;
2. Promoting innovation: the leader actively updates common assets with new technologies as well as encourages innovation among ecosystem members;
3. Managing the value creation process: the leader ensures that the overall value of the ecosystem grows at a faster rate than the costs associated with an increase in members;

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4. Sharing values among the contributors: the leader strikes a proper balance between equitably dividing value generation amongst complementors and retaining a share of value for itself;
5. Shaping the external network: the leader continually influences the platform's architecture by stimulating intra-ecosystem competition in order to identify and leverage complementors with the highest value.

Figure 2: Governance Strategic Roles Archetype Matrix

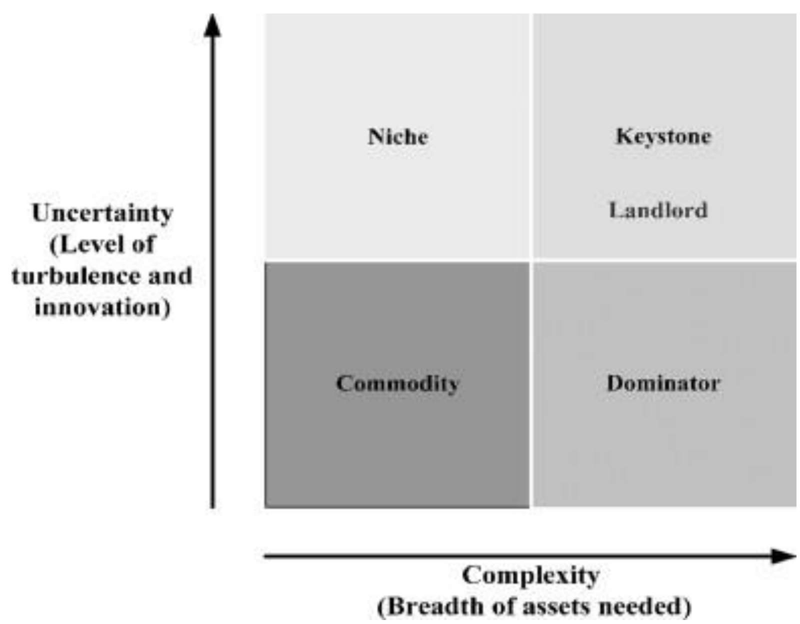

Figure 6 Source: Iansiti, M., & Levien, R. (2004). Cited by Zhang, J. and Liang, X.J. (2011).

Once the market surrounding a platform ecosystem matures and stabilizes, the platform leader may then opt to expand its market power and value capture via horizontal or vertical integration of key ecosystem assets. A platform ecosystem leader can even juggle multiple strategies for different ecosystem segments and objectives, like how Linkedin currently dominates the digital professional networking space but acts as a keystone for skill-sharing and certification through its "Linkedin Learning" service offering. Iansiti and Levien caution against the leader adopting the landlord

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archetype and seeking maximum ecosystem rents prior to industry stabilization, however, as it could result in dissolution or collapse of the entire system (Iansiti and Levien, 2004; Zhang and Liang, 2011).

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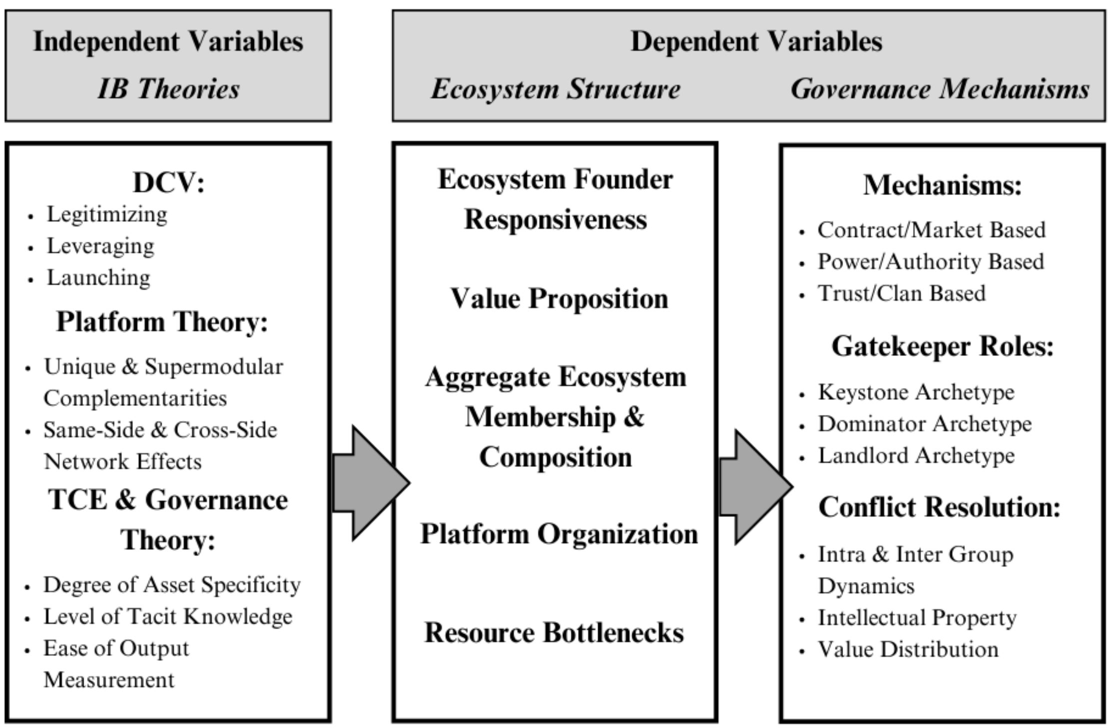
CHAPTER 3 RESEARCH METHODOLOGY

3.1 Research Framework

Utilizing the key concepts derived from each of the four international business (IB) theories explicated in Chapter 2, this research is organized under a cause-effect, sequential framework wherein MIH's ecosystem structure and consequent governance mechanisms can be explored as a function of IB theory factors (see Figure 2):

Figure 3: Research Framework for MIH Analysis



Source: Compiled by Researcher

3.2 Description of Variables

A breakdown of each variable encompassed in this research framework is as follows:

3.2.1 Independent Variables

DCV

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Grøgaard et. al.'s (2019) DCV three-point analysis model of legitimizing, leveraging, and launching is selected as the key factors for measuring the ecosystem founder's ability to quickly respond to industry change, in the form of establishing the platform ecosystem.

- Legitimizing: referring to the signaling and alignment skills, internal or external, formal or informal, utilized by the firm to justify resource recombination in the face of a dynamic business environment.
- Leveraging: referring to the firm's subsequent ability to draw upon existing resources and competencies for recombination into a new strategy.
- Launching: referring to the firm's ability to execute new strategies as a result of resource recombination (in this context, launching the platform ecosystem).

Platform Theory

Four key variables are chosen to analyze platform architecture between the two competing schools of product development (i.e., unique & supermodular complementarities) and industrial economics (i.e., same-side & cross-side network effects).

- Unique & Supermodular Complementarities: derived from the product development school of platform theory, used to measure the platform ecosystem's value proposition effectivity and consequent attraction of complementing members.
- Same-side & Cross-side Network Effects: derived from the industrial economics school of platform theory, used to measure the platform ecosystem's value proposition effectivity and consequent attraction of complementing members.

TCE & Governance Theory

As demonstrated by Chapter 2.3 through 2.4, TCE and Ouchi's (1979) organizational control theory are both impacted by the same three variables, each which influence the platform

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ecosystem's value proposition, organization, resource bottlenecks, as well as all aspects of the ecosystem's governance mechanisms.

- Degree of Asset Specificity: referring to how specific to the value creation activity (and therefore how difficult to extract value from in an alternative activity) each member of the ecosystem's resource contribution is.
- Level of Tacit Knowledge: referring to the level of difficulty in transferring critical value creation information from one party or organization to another.
- Ease of Output Measurement: referring to the level of difficulty in determining the exact value (or damage, in the case of cheating/shirking) each complementing member contributes to the platform ecosystem.

3.2.2 Dependent Variables

Ecosystem Structure

- Ecosystem Founder Responsiveness: referring to the origins of the platform ecosystem as a result of the founding firm's dynamic capabilities, determined by the above mentioned DCV variables.
- Value Proposition: based on the information acquired and resources recombined through the founder's dynamic response, referring to the advantages and potential returns which the platform ecosystem is based on, and which are communicated to prospective members.
- Aggregate Ecosystem Membership and Composition: referring to the number and nature of complementing members attracted by the platform ecosystem's value proposition.
- Platform Organization: referring to the way in which newly recruited ecosystem members are configured into the platform and assigned appropriate value creation roles.

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- Resource Bottlenecks: referring to the points of resource scarcity that arise as a result of the structure and membership of the platform ecosystem, the control of which can give platform leaders greater governing power.

Governance Mechanisms

- Mechanisms: referring to the different categories of governance approaches used for different value activities and operational needs of the platform ecosystem.
- Gatekeeper Roles: referring to the archetype options as outlined by Iansiti and Levien (2004) that the platform leader can adopt in its governance of ecosystem members and resource bottlenecks. Note that the assumption of product complexity is already made, ruling out the possibility of niche or commodity archetype adoption.
- Conflict Resolution: referring specifically to the formal and informal protocols in place for resolving platform ecosystem conflicts as it pertains to assigned complementor roles/groups, value appropriation, and management of IP.

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CHAPTER 4 ECOSYSTEM ANALYSIS

4.1 EV Industry Overview

A report compiled by Fortune Business Insights states that the global EV market was valued at approximately 385 billion USD in 2022 and is projected to grow at a Compound Annual Growth Rate (CAGR) of 17.8% to over 1,579 billion USD by 2030. Daimler AG, Ford Motor Company, BYD, and Renault Group are named among the key automotive incumbents that are investing in vehicle electrification and EV manufacturing. According to their analysis, driving factors for this industry growth include an increase in favorable government subsidies, policies, and carbon emission regulations, while the high costs of EV battery and charging infrastructure manufacturing is noted as a key restraining factor (Fortune Business Insights, 2023). The above market observations are consistent with Zulkernain et. al.'s (2014) own description of the EV industry and its three roadblock categories previously described in the research background. That is to say, despite the high growth potential and governmental support for EVs, a variety of demand-side, supply-side, and environmental issues must be addressed for any EV venture to be truly sustainable and profitable. Pointing to the difficulties of building a global EV supply chain capable of overtaking the traditional automotive market, Zulkernain et. al. summarizes:

> "The grand challenge of the EV ecosystem in this competition [of fuel-powered vehicles] is to change [the] status quo by creating compelling customer value propositions, which, by itself, facilitate the emergence and growth of [a] thriving global business ecosystem." (Zulkernain et.al., 2014)

It can thus be seen that the birth of MIH is in direct answer to the juxtaposition of a high-growth, high technology business opportunity and a dire need for ecosystem-level collaboration to overcome the complex obstacles of establishing a globally standardized EV business model.

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4.2 MIH Subject Overview

Hon Hai Precision Industry Co. Ltd., or "Foxconn", has been renowned in the Information & Communication Technologies (ICT) industry for decades as the Original Equipment Manufacturer (OEM) of a wide range of consumer electronics such as smart phones, tablets, and gaming consoles. According to Fortune Magazine's 2022 Global 500 list, Hon Hai's revenue ranks 20th in the world at nearly 215 billion USD, championing as Taiwan's largest company by revenue (Fortune, 2022). Nevertheless, in light of the growing maturity and saturation of traditional ICT markets, Hon Hai now seeks to leverage its OEM legacy in penetrating and transforming the rising global EV market. Taking center stage of Hon Hai's EV market strategy is Mobility in Harmony, an international, open-platform alliance of over 2,600 companies from 70 countries and regions, operating as an independent consortium as of July 6th, 2021. The following subject overview will contextualize the rise of MIH, provide a preliminary examination of its key characteristics, and summarize the key activities and organization mechanisms between MIH and its industry members.

4.2.1 Hon Hai Tech Day and the Unveiling of Mobility in Harmony

Hon Hai's initial strides into the EV sector can be traced back to June 2019, after Young Liu took the helm from founder Terry Gou and became the company chairman. (Wu, 2019) Shortly following Chairman Liu's appointment, Hon Hai unveiled its new corporate strategy known as the "3+3 Model for Transformation", a framework that pinpoints three key industries—electric vehicles, digital health, and industrial robotics—to be combined with Hon Hai's three core competencies in AI, semiconductors, and next generational communications (referring to 5G and beyond). As described by their official website, Hon Hai's aims for EV industry participation include creating global standards and best practices that local markets can adopt via a "Build-Operate-Localize" co-investment solution for EV production plants (Hon Hai, 2023). With

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building an EV supply chain as a leading goal for the "3+3" strategy, Hon Hai intends to increase its net profits from 5 to 10 percent (Huang, 2021). To fortify this vision and with EV as the first expansion priority, Hon Hai made three major strategic moves in the following year. First, Hon Hai signed a joint venture agreement with Taiwanese vehicle developer Yulon Group in March 2020, later established under the name "Foxtron" (Foxtron, 2023). Second, the Hon Hai Research Institute and its five research centers were founded in Q2 2020, each employing an average of 40 R&D professionals spanning the topics of AI, semiconductors, next-generation communications, information security, and quantum computing (Focus Taiwan, 2020; Hon Hai, 2023). Third, in parallel to their vision of an open EV platform architecture, Hon Hai conceptualized an EV Software & Hardware Open Platform named the Mobility in Harmony alliance.

To formally introduce MIH's pivotal role in Hon Hai's new EV strategy while commemorating founder Terry Gou's birthday, the company's very first Hon Hai Tech Day (HHTD) was held October 16th, 2020. [3] During this public showcase, Chairman Liu formally introduced MIH as a way for Hon Hai to "share [their] results with everyone, as a common good and for mutual improvements". He expounds further on the mission of MIH, stating:

> "We hope opening up the software and hardware platform will empower Taiwan's EV industry by preventing redundant investments, reducing EV product development cycles, enabling faster time to market, stronger competitiveness and prosperous development." (Hon Hai, 2020)

4.2.2 Merging Hardware with a "Software-Defined" Future: MIH Platform Explained

[3] HHTD was originally planned as a multi-day showcase that would present each of Hon Hai's plans for all three target industries; due to COVID, it was shortened to one day focusing on Hon Hai's EV sector development.

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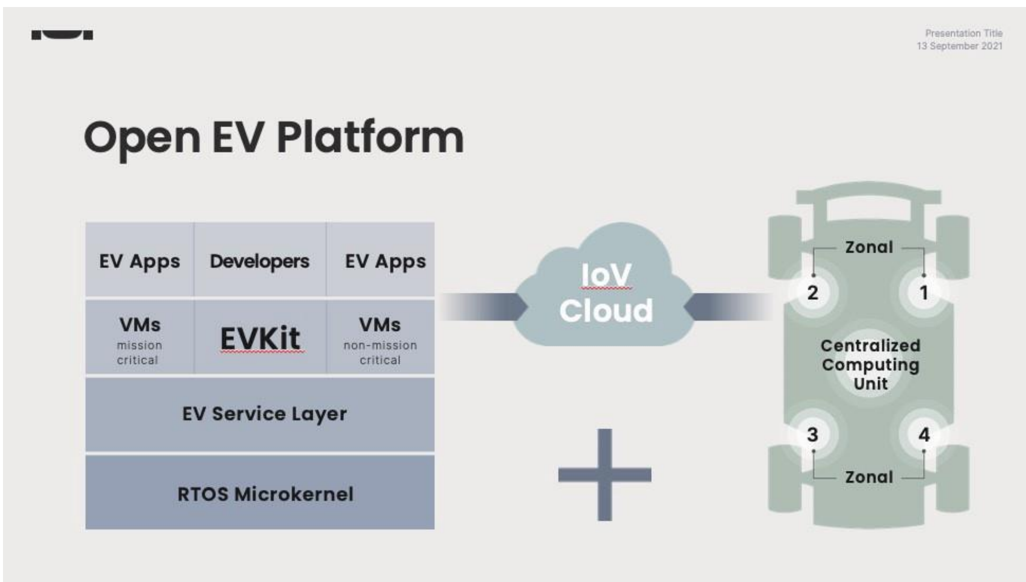
MIH is characterized by independent development of an EV chassis platform and a software development stack, with these layers integrated through an IoV cloud (see Figure 4). Hon Hai's proposed software stack begins with a Microkernel Real-Time Operating System (RTOS) as the base, followed by an EV service layer that enables abilities such as telematics and Controller Area Network (CAN) bus:

Figure 4: MIH EV Platform Stack and Chassis Diagram



Source: "6/25 MIH Consortium Opening Event Slide Deck" (2021). MIH Consortium.

Next, the EV Kit acts as the software stack cornerstone by providing a standard platform for developers to build and customize EV applications for mission-critical and non-mission-critical Virtual Machines (VMs). [4] As for the hardware layer, Hon Hai has designed a lightweight chassis platform model with adjustable dimensions and battery pack configurations for A to E class vehicles, described by Foxtron Vice Chairman Zi-Sheng Zuo as an "underlying vehicle platform" with integrated essential controls such as steering and power output. These layers, combined with

[4] "Mission-critical" is defined by Hon Hai as real-time requirements pertaining to security and safety, such as end-to-end encryption, RTOS edge devices, 5G/6G, etc. Features such as In-Vehicle Infotainment (IVI) would qualify as "non-mission-critical" VMs.

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Hon Hai's R&D efforts in key components including unibody e-powertrains, heat dissipation technology, and solid-state battery development are what constitute MIH's proposition for enterprises across the EV supply chain (Hon Hai, 2020).

During HHTD 2020, Hon Hai CTO Wei-Guo Zhang explained that the separation of hardware and software in future EVs would prevent redundant and lengthy R&D cycles while allowing each layer to be efficiently upgraded and adjusted based on consumer need. In effect, Hon Hai anticipates that the continual upgrading characteristic of software-centric products will disrupt the traditional automotive industry by allowing vehicles to grow in value over time rather than depreciate. By ushering in this era of EV categorized by "the power of open" and "the power of software", Zhang concludes that Hon Hai may do for EVs what Android achieved for smartphones, thus extending beyond its reputation for hardware manufacturing capability and revealing "the softer side of Hon Hai" in anticipation of a "software-defined future world" for automobiles (Hon Hai, 2020).

4.2.3 Project X and Current Status of Hon Hai EV Industry Efforts

On November of 2022 during MIH's first "Demo Day" conference, MIH's current CEO Jack Cheng officially unveiled the alliance's first major EV production mission, called Project X. Cheng describes the modular, Build-Your-Own-Vehicle vision of Project X as EVs built "like a Lego", wherein a standardized chassis acts as a foundation for custom wheel, battery, smart cockpit, and other configured modules to be easily installed or removed according to procurer preference and consumer need (Cheng, 2022; Hon Hai, 2022). As of a press release from the *Taipei Times* covering Hon Hai and MIH's participation at the Taiwan International Automobile Electronics Show, Cheng revealed that completion of Project X's 3-seater model could be completed in

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October, with mass production starting in 2025. The alliance also plans to publish 6-seater and 9-seater model concepts of the vehicle around the same period (*Taipei Times*, 2023).

In Hon Hai's most recent iteration of HHTD, the company itself unveiled two new EV prototypes for its Foxtron JV, a Model V pickup and Model B hatchback, to join their existing portfolio of the Model C recreational vehicle, Model E sedan co-designed with Pininfarina, and Model T electric bus (Hon Hai, 2022). During MIH Demo Day, Hon Hai's Electrical/Electronic Architecture (E/EA) Senior Assistant Vice President Zeke Wu further announced that Hon Hai's newly created software OS for EVs, HHEV.OS, is under review by MIH to become a recommended industry standard (MIH, 2022). As of June 1st, 2023, Hon Hai's online press center boasts a series of international BOL model projects, JVs, and related partnerships across Thailand (HORIZON PLUS), Indonesia (PT Foxconn Indika Motor), Mainland China (Geely Holding Group), Germany (Infineon), Saudi Arabia (Ceer) and the United States (Stellantis, Lordstown Motors, and Monarch Tractor). Notably, with the exception of Infineon, none of these partners or JV entities are registered in MIH's member directory.

4.2.4 Working Groups and Patent Agreements: MIH Key Organizational Mechanisms

4.2.4.1 Office Organization, Membership Tiers, and Working Groups

Since being officially established as an independent consortium on July 6th, 2021[5], the MIH Consortium is organized into four primary layers: a board of directors, the MIH executive office, the Technical and Advisory Committees, and the industry members (see Figure 5):

[5] NOTE: Though the initial interim Directors were all appointed by Hon Hai, the Board of Directors were subsequently diversified over a six-month period and completed December 31st, 2021.

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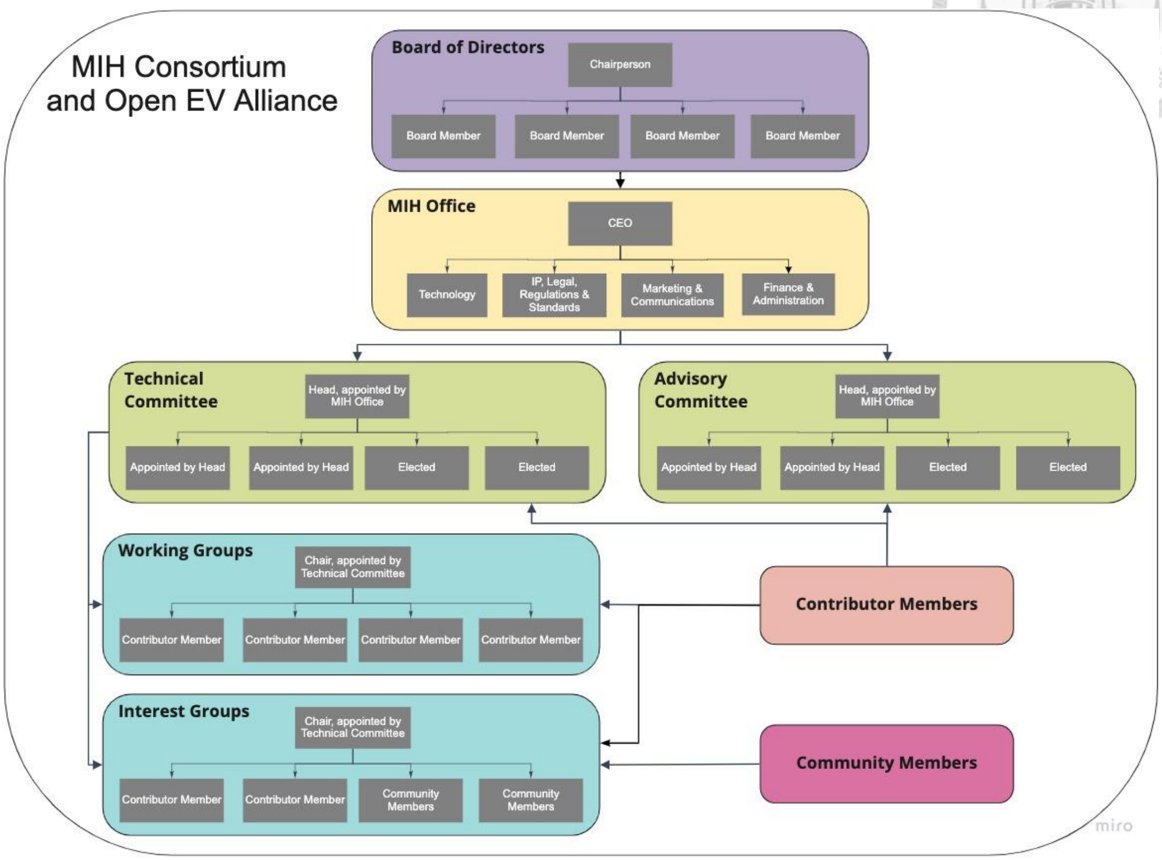
Figure 5: MIH Organizational Structure Chart



Source: "About MIH Consortium" (2023). MIH Consortium.

Companies that apply to join MIH are subject to privileges according to three separate membership tiers. The free membership package subscribes companies to MIH's monthly newsletter, allows for participation in interest groups (to be described in more detail below), and grants access to MIH exclusive events and services for an additional fee between 100 and 600 USD. For an annual membership fee of 1000 USD, the M+ service subscription tier enjoys free access to these events and services for 1-2 colleagues, including public MIH events and meetings, certification training courses (3-6 per subscription year), exclusive market insight seminars, and IP consultation services (one 30-minute session per month). For a separate fee between 300 and

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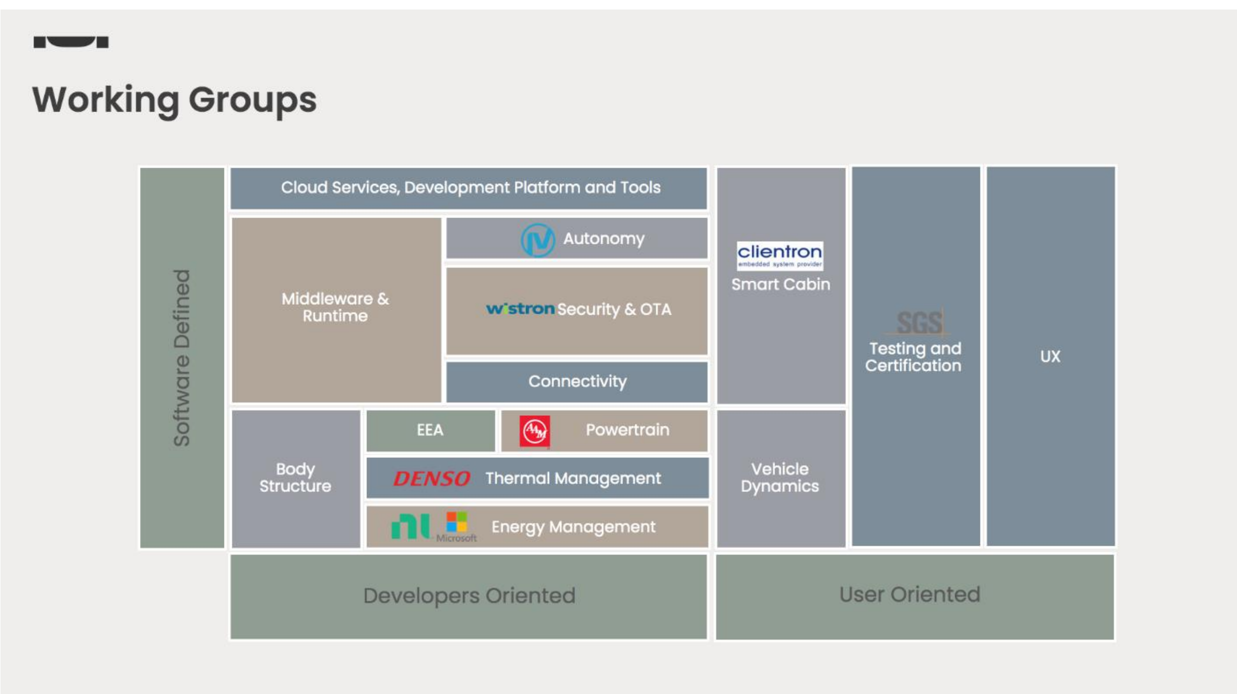
600 USD, member companies can be featured in MIH's monthly newsletter for a maximum of two times a year at minimum three-month advertising intervals (MIH, 2023).

"Contributing Members" that contribute donations of 10,000 USD or more per year comprise MIH's final membership tier. Contributing members can be elected to seats in the consortium's technical or advisory committee and are able to join the consortium's network of fourteen "working groups" (see Figure 6). The function of MIH's working groups is the most critical, as they are tasked with developing the "recommended standards" and "reference designs" that act as the foundation of MIH's Open EV ecosystem. Each of the fourteen working groups are categorized by a key EV function, including programming solutions such as "Autonomy", "Middleware & Runtime", structural modules such as "Body Structure" and "Powertrain", as well as user-oriented subsectors such as "Smart Cabin" and "Testing and Certification":

Figure 6: MIH Working Groups Cluster Chart



Source: "Working Groups" (2023). MIH Consortium.

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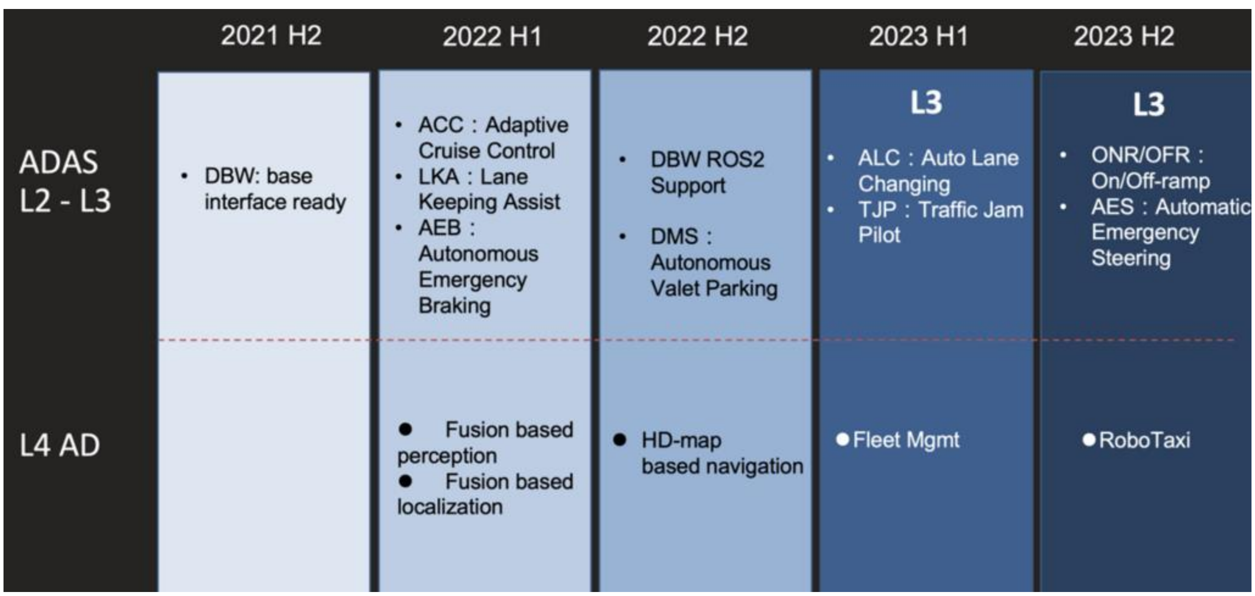
Working groups with more than three interested contributing members must hold a meeting with MIH's Technical Committee, after which a group chair is nominated, then a group charter is drafted and approved by this committee. An MIH working group charter specifies the mission, regular meeting schedule, scope, and projected project timeline of the group. Using the Autonomy working group as an example, the charter states their mission as "develop[ing] autonomous driving (AD) and Advanced Driver Assistance Systems (ADAS) requirements and specifications for the MIH Open EV Platform" and projects the release of a number of AD and ADAS "deliverables" on a half-year basis between 2021 H2 and 2023 H2 (see Figure 7):

Figure 7: MIH Autonomy Working Group Charter, Projects Timeline



Source: "Autonomy Working Group Charter" (2023). MIH Consortium.

4.2.4.2 Standards Process and IP Management

The specifications and designs developed by each working group are subject to a strict, multi-stage standards proposal process (see Figures 8 & 9). Additionally, the standards process is governed by MIH's Intellectual Property & Patent Policy to "reduce patent risk for Members applying MIH reference designs and standards, so that investment in the preparation, adoption and

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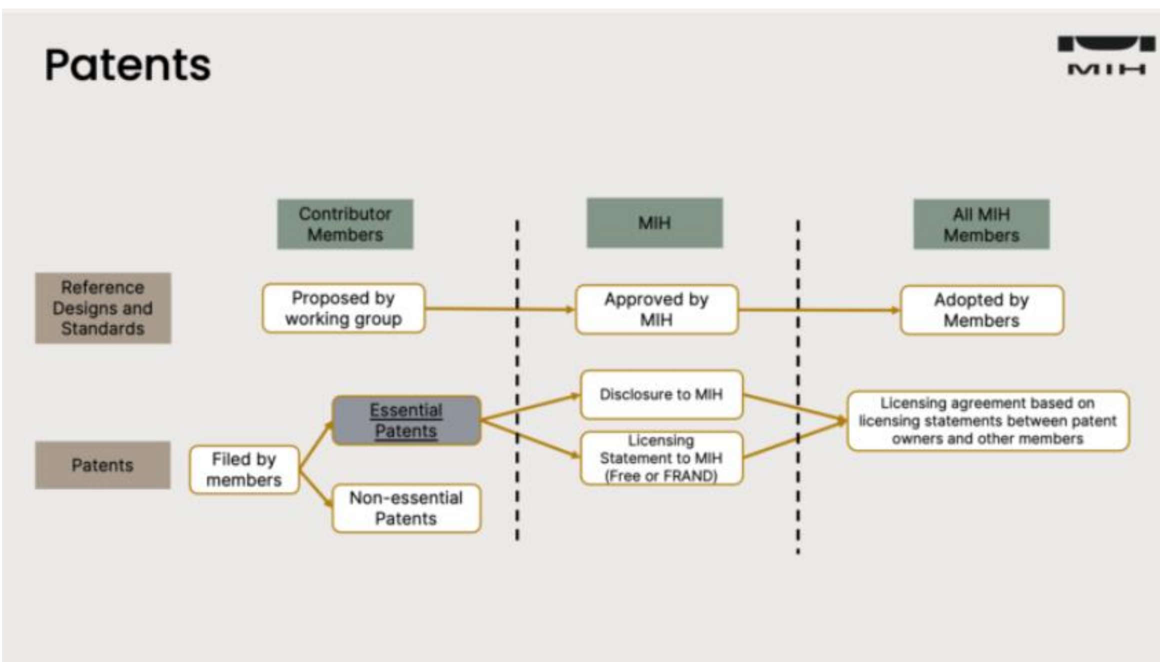
application of MIH standards would not be wasted as a result of an essential patent for a reference design or standard being unavailable" (MIH, 2023). Namely, this policy requires contributing members in working groups to disclose patents that may potentially be considered "essential" to the technical standards and designs developed under MIH. If evaluated to be essential, the corresponding patent owner then must make an irrevocable statement that they are willing to grant licenses for its use on royalty-free or fair, reasonable and non-discriminatory (FRAND) terms. In the instance a patent owner refuses to license such a patent, the MIH technical committee will intervene to either adjust the reference design/standard, work among MIH members to resolve the problem, and/or request the MIH member in question reconsider their role in the consortium (MIH, 2023).

Figure 8: Patent Disclosure Process for MIH Contributor Members



Source: "About MIH Consortium" (2023). MIH Consortium.

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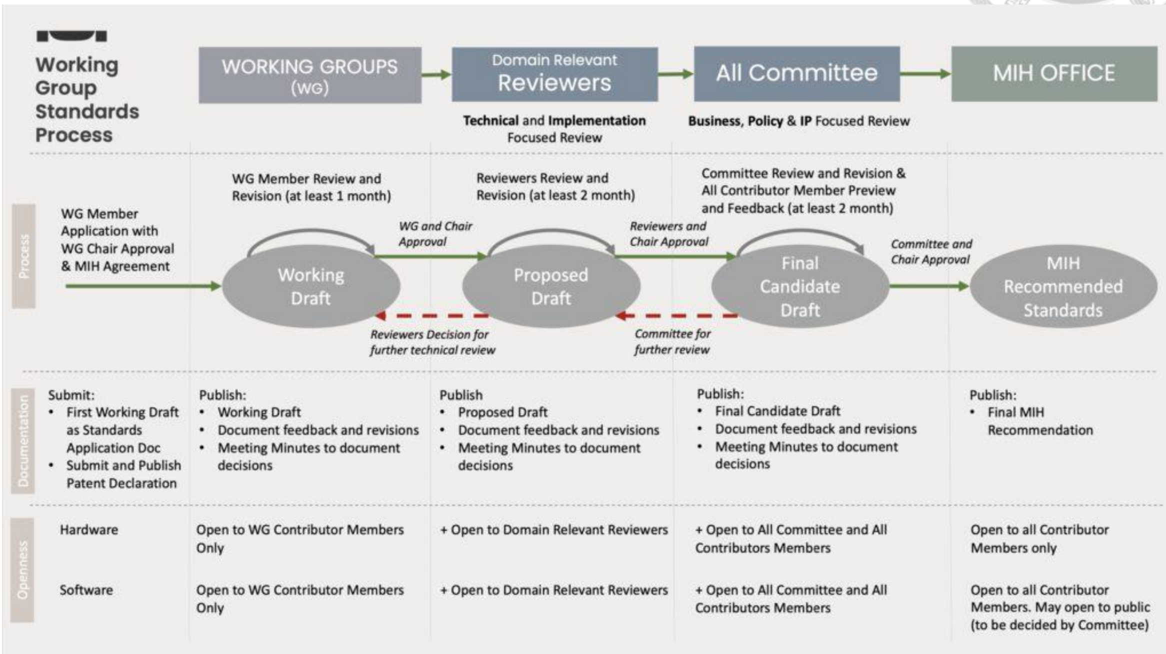
Figure 9: MIH Standards Proposal Process Flowchart



Source: "MIH Standards Proposal Process" (2023). MIH Consortium

The first stage of the standards process consists of the working group submitting a "working draft" application and a patents declaration. After approval by the MIH office and the working group chair, this draft undergoes at least one month of review and revision amongst the group members. The working draft then transitions into the second, "proposed draft" stage, during which relevant industry experts provide a thorough technical and implementation-based review over an additional two-month review/revision period. Assuming the draft passes, it then moves to the third phase and becomes a "final candidate draft". At this stage, the entire MIH committee will review the draft for at least two months from the lenses of business, government policy, and intellectual property rights. The draft will also be shown to all MIH contributor members. If the draft passes this final review, it finally becomes published as an MIH recommended standard, with

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both hardware and software specifications accessible to contributor members. Should the MIH committee deem it appropriate, some software standards may also be published for public use (MIH, 2023).

4.3 Android vs. MIH: A Comparison of Open Ecosystems

During Hon Hai's first Tech Day exhibition in 2020, Hon Hai CTO Wei-guo Zhang drew an explicit parallel between Google's Android open-source coding platform for smartphone devices and MIH's efforts in opening the electric vehicle ecosystem (Hon Hai, 2020). Indeed, becoming the "Android system of the EV industry" is an ambition highlighted in Hon Hai's official press release statement, and a comparison which numerous industry analysts have drawn upon to describe MIH and its implications for EV production and adoption worldwide (Hon Hai, 2020). Given MIH's relative newness and vast scale at 2,600+ members in less than three years, what commonalities and lessons can be gleaned on MIH's behalf from applying business theory to Android's ecosystem origins and evolution? The following comparative analysis will first analyze the rise of MIH and Android from the dynamic capabilities of their respective parent firms Hon Hai and Google, after which both ecosystems will be analyzed based on its architecture, transaction costs, and governance mechanisms.

4.3.1 Ecosystem Origins from a Dynamic Capabilities Lens

Recognizing the firm as the unit of analysis for DCV, this section will employ Grøgaard et. al.'s overarching concepts to investigate parent firms Google and Hon Hai as they navigate pressures for FSA recombination, overcome organizational impediments, and leverage recombination capabilities to establish their respective open platform ecosystems.

4.3.1.1 Android

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Andrew Rubin founded Android Inc. in 2003, wherein he and his company developed the first Android OS built atop a Linux kernel. His prior industry experience with developing smartphone predecessors at General Magic and Danger Inc. informed his ambitions to create an open-source, software-based smartphone model where revenue was generated through receiving a percentage of carrier service fees as opposed to hardware sales. [6] Sensing the opportunity for mobile computing to transform the market while acknowledging the current bargaining power of phone carriers and high innovation barriers for app development, Rubin devised his open-source ecosystem strategy as a means of shortening the innovation cycle while catalyzing adoption among key industry players. Leading up to Android's founding, Rubin's late 2002 partnership with T-Mobile for releasing the "T-Mobile Sidekick" caught the attention of Google's Co-Founder Larry Page when he discovered Google was set as the Sidekick's default search engine. Having yet to surpass AOL and Yahoo in market share, the Sidekick highlighted an opportunity to extend Google's advertising revenue model from desktop search engine to mobile computing services, as well as a threat of being locked out from the smartphone market through carriers reaching exclusive agreements with competitors. Namely, Microsoft had begun selling proprietary operating system licenses to handset OEMs and related developers, whose own search engine competed directly with Google (Pon et. al., 2014; Business Casual, 2018).

When Google attended Android's investor pitch meeting in March 2005, Android's team contrasted the previous year's global shipments of PCs (178 million units) and mobile phones (675 million), stressing the near quadruple market penetration potential available through handsets which already possess computing power comparable to a 1998 desktop. Addressing the integration

[6] As will be explained in the later sections, the revenue model ultimately implemented by acquirer firm Google was not receiving a percentage of service carrier fees as Rubin originally envisioned, but rather the collection of targeted advertising revenue, and more recently a percentage share of in-app purchases from the Google Play store.

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work required, Android proposed their open software business model, complete with a comprehensive developers' toolkit, as a means to lower the steep cost and time thresholds for OS development that individual carriers found difficult to bear alone (Haase, 2021). Recognizing these collective and compelling pressures for FSA recombination, Google acquired Android for 50 million USD, thereby enabling the company's non-location bound FSAs to penetrate the mobile space and catalyzing the search engine's global exposure.

Google's second wave of dynamic capability transformation arose with the January 2007 announcement of Apple's first iPhone, whose fully integrated touchscreen controls and exclusive carrier contract with AT&T shook the telecommunications sector at its foundations. The news had a powerful legitimizing effect not only for Google's Android team, but also for incumbent carriers that had stubbornly adhered to the industry convention of incentivizing consumers to keep the same phone model as long as possible, i.e., focusing on long-term service revenue and minimal carrier switching while neglecting product innovation. In response, Google quickly leveraged its advantages in technological expertise and brand equity through three key steps. First, it mobilized the Android team to revise their existing OS model for accommodating touchscreen capabilities. In parallel, Google successfully contracted with T-Mobile and HTC to launch this upgraded OS through the "HTC Dream" smartphone, which was ultimately released in September 2008 (Business Casual, 2018). Second, as carriers perceived a greater need for intra-industry cooperation in the face of disruptive innovation, Google utilized its ubiquitous household name and influence in the technology sector to launch a consortium of phone service carriers, original equipment manufacturers (OEMs), and software developers, named the Open Handset Alliance. Established in 2007, the 84 members of this alliance include prominent industry names such as

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Sprint [7], LG, Acer, Asus, Dell, Fujitsu, Garmin, Sony, eBay, Nvidia, Intel, and Qualcomm (Open Handset Alliance, 2011). Third, Google formally launched the Android Open-Source Project (AOSP) the same year to the public, allowing for coders and enterprises around the world to download and build upon Android's basic source code (Pon et. al., 2014).

The results of these actions propelled Google's transnational trajectory similarly to the way Grøgaard et. al. (2019) argues in their "legitimizing, leveraging, and launching" model. Google's effective sensing of an opportunity in mobile computing and subsequent seizing via acquisition of Android was importantly paired with legitimization at both an internal and industry level before its FSAs could be effectively recombined and leveraged. Indeed, Android's case demonstrates that in a high technology sector characterized by supply chain interdependencies and product complexity, signaling legitimacy may necessarily go beyond the boundaries of the MNE and extend to the greater supply chain network. Although Google's management had observed and legitimized their purchase of Android early on, a deal for pairing their OS with a mobile handset could not be struck until carriers and OEMs saw themselves the legitimacy of this novel business model. Thus, while Grøgaard et. al. (2019) originally framed legitimization as a means of alignment between headquarters and subsidiaries in their longitudinal study of telecommunications firm Telco, it can be argued that this same logic is applicable to recruiting complementing firms for the MNE's own transformative projects—in this case an open platform ecosystem—especially when transaction cost economics dictate it is more efficient to outsource complementary activities rather than absorb them.

Further, legitimacy alone is insufficient for forging successful business relations. Just as Google leveraged its software expertise and brand, an MNE must bring leverageable FSAs to the

[7] Merged with T-Mobile as of 2020.

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table for both parties to realize synergies and embark on value co-creation. Lastly, in spite of an uncertain industry environment, the MNE's leadership must be willing to take calculated risks in breaking convention by launching new projects and initiatives in conjunction with its newly configured resources, similar to how Google founded the Open Handset Alliance and AOSP.

Table 1: Key Dynamic Capabilities Summary

Dynamic Capability Type	Android	MIH
Legitimizing	Justified acquisition of Android through the sensing of mobile computing's market potential and threat of competing search engines expanding in the space	Following inauguration of new chairman, published "Foxconn 3.0" evolution framework and "3+3 Model for Transformation" strategy to calibrate corporate mission
Leveraging	Leveraged Google's brand equity and software FSAs to quickly respond to iPhone release as well as attract and align key industry players with Android	Leveraged Hon Hai's contract manufacturing and cost control FSAs in seeking EV market entry, strategic alliances, and joint ventures
Launching	Launched Open Handset Alliance and AOSP to accelerate Android's value proposition	Launched series of JVs, annual Hon Hai Tech Day, and established MIH as catalyst for Hon Hai's desired EV industry transformation

Source: Compiled by Researcher

4.3.1.2 MIH

In contrast to Google's extensive software-based administrative heritage, Hon Hai's business model is founded on contract manufacturing for electrical components and devices.

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Founder Terry Gou led the firm from its humble beginnings of molding television knobs in 1974, to manufacturing a wide portfolio of industrial and consumer electronics while also offering in-house design and integration services for clients across the globe. Hon Hai's management legacy of operational cost-cutting and taking strategic risks for high-value clients has driven the MNE's ability to produce increasingly complex devices at vast quantities while under tight time and expense pressures. At the turn of the century, for example, Hon Hai agreed to manufacture metal chassis for desktops in the United States per their client Dell's request, even though it meant acquiring a factory in Kansas City that operated at a loss. Hon Hai's famous supplier relationship with Apple has also been characterized by risky investments in exchange for long-term payout; to meet Apple's quality standards for the iPhone 4's metal frame, Hon Hai had purchased over 1,000 specialized machines at 20,000 USD a unit (Balfour and Culpan, 2019). Nevertheless, as Hon Hai faced the repercussions of deteriorating Sino-US trade relations and destabilized cyclical demand for Apple's iPhones, an imperative for deviance from the firm's existing revenue streams emerged. The smartphone industry, for which the majority of Hon Hai's total revenue depended on (Apple accounting for over 50% alone), was showing signs of saturation and decreased product turnover. According to the Wall Street Journal's reports at the time, Hon Hai's profit fell 18% in the first quarter of 2019 during the same period that Apple reported a 17% decrease in iPhone sales (Kubota, 2019). Moreover, Hon Hai's margin for assembling consumer electronics is razor thin, making its primarily Mainland-China based manufacturing especially vulnerable to tariffs levied amid the growing Chinese-US tensions. OEMs producing higher margin products such as semiconductors, while not immune to cyclical demand nor geopolitical tensions, have the advantage of a more robust net income. Comparing the financial statements of Taiwan Semiconductor Manufacturing Company (TSMC) and Hon Hai's 2018 FY annual reports, Hon

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Hai's consolidated revenue (5.29 trillion NTD) was over five times that of TSMC (1.03 trillion NTD); Hon Hai's total comprehensive income, however, was at a loss (-29 billion NTD) while TSMC's achieved a net positive (361 billion NTD) that underlines a significant operating margin difference between Taiwan's tech giants (2.6% vs 37%) (TSMC, 2018; Hon Hai, 2018).

Though Hon Hai's leadership had doubtless sensed these threats to the company's market position, it took an internal legitimizing process led by newly inaugurated chairman, Young Liu, to formally initiate Hon Hai's entry into the EV market. Shortly following the 2019 shareholders' meeting that appointed Liu and eight other executive managers as members of a company-wide director committee, Hon Hai announced a series of strategic objectives meant to steer the organization towards a unified purpose (Lu, 2019). On Hon Hai's official website, this "shared leadership vision" is divided into three evolutionary segments: Foxconn 1.0, 2.0, and 3.0. Foxconn 1.0 refers to optimizing the organization's existing business model through fortifying the governance structure, intraorganizational sharing, lean management practices, and procurement protocols, thereby maximizing margins. Foxconn 2.0 signifies Hon Hai's efforts in digital transformation, wherein the company utilizes technology, big data, and statistical analytics to increase information transparency across the supply chain and with shareholders. Lastly, Foxconn 3.0 stands for Hon Hai's entry into three new industry verticals of high technology, otherwise promoted as the aforementioned "3+3 Model for Transformation" (Hon Hai, 2023). Contextualized by the dynamic capabilities perspective, Liu's announcement of the 3+3 model acted as a sanctioned blueprint for leveraging Hon Hai's existing FSAs into three new business contexts, with electric vehicles leading the charge. The new strategy signaled a clear direction for Liu's leadership and the nine-director committee that allowed for rapid FSA leveraging and initiative launching to take place. Interestingly, the 3+3 model also reflects the IR scale

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considerations so emphasized by Grøgaard et. al. (2019), not only as it seeks to build a verticalized supply chain with globally recognized production standards for electric vehicle contract manufacturing, but also through the modular partnerships Hon Hai has struck in numerous countries based on a "Build, Operate, Localize" (BOL) model. Leading up to the creation of MIH, Hon Hai launched a number of joint ventures tackling various segments of EV supply chain. The first of these initiatives began as early as January 2020, where Hon Hai initiated a collaboration dialogue with the Fiat Chrysler Group for manufacturing EVs (Reuters, 2020). Shortly following was the creation of Foxtron in March 2020, a joint venture signed with Taiwanese automaker Yulon Motors, notorious for producing Nissan and Luxgen vehicles for the region (Tan, 2010). The necessity of launching joint ventures as a predecessor to launching MIH was twofold. First, Hon Hai had set its sights on participating in the entirety of the EV supply chain. As Chairman Liu acknowledges in his interview with *The Commonwealth Magazine*, the complexity of smart vehicle production is severalfold that of smartphones and other consumer electronics, the former requiring five to six thousand parts compared to the five to six hundred of the latter (Huang, 2021). In order to successfully capture such an expansive range of value chain activities and remain competitive while doing so, lending the field expertise of others through vehicle industry collaboration was essential. Hon Hai was able to successfully justify these partnerships to their counterparts by leveraging their existing competencies in coordinating the supplier network, labor division, and integration of various components during assembly (Huang, 2021). Second, Hon Hai needed to overcome the industry-wide skepticism surrounding its EV market entry through definitive actions that signal their legitimacy and commitment. Now having a basis for declaring itself an industry leader and attracting complementary members, MIH's official launch received sufficient recognition to collect hundreds of members in its first few months.

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How does Hon Hai's creation of MIH compare to the rise of Android from a dynamic capabilities perspective? One key commonality between the two cases is the usage of legitimization signaling that extended past internal organizational boundaries for attracting industry level cooperation. Tied into this legitimacy signaling is also the importance of speed in each case's underlying dynamic capabilities cycle, underlining the rapid pace of high technology sectors which gives platform ecosystems and their lowered innovation time cycle prospects such strong appeal.

Nevertheless, there also remains a key difference between the rise of each platform ecosystem. Importantly, Android and MIH are built upon different path dependencies, defined by Teece et. al. (1997) as "the cumulative effect of past strategic and tactical decisions, which influences the range of feasible current and future options" (Teece et. al., 1997). While Android was founded by a prominent software developer and acquired by a software-centric search engine company, MIH's convergence of hardware and software is not in full congruence with Hon Hai's primarily hardware-centric manufacturing legacy. The implication of Hon Hai's fully integrated EV strategy is an imperative to dedicate finite resources for each aspect of EV production, including those lacking internal precedent or FSAs such as software. In attempts to remedy Hon Hai's software competency gap, the company did announce during Hon Hai Tech Day 2021 (HHTD21) its intentions to build a 1,500-employee software research center and recruit 1,000 more software engineers over a three-year period (Hon Hai, 2021). The following year's Hon Hai Tech Day and MIH Demo Day additionally unveiled Hon Hai's freshly designed vehicle OS, named HHEV.OS, which claims ability to support cross-domain fusion (i.e., incorporation of other EV operating systems) and at the time of announcement was awaiting review by the MIH committee for becoming an official MIH software standard (MIH, 2022).

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By contrast, Android purposefully delegated the hardware requirements of their ecosystem to complementing manufacturers for several years, with ecosystem parent Google only verticalizing into the hardware segment via acquisition of HTC and releasing the first Google Pixel in 2016. This late-stage entry allowed for gradual acquisition of competitive hardware FSAs, and arguably balances the platform leader's pursuit of value capture with complementor relationship management by giving complementing OEMs ample time to establish their own market share. Consequently, as of Q3 2022, the share of Google Pixel phones in the global smartphone market reached 0.8% —a promising but by no means dominating market presence (Michaels, 2022). [8]

The question therefore remains as to whether hardware path dependencies will ultimately act as a roadblock to Hon Hai's ability to compete in the EV market, especially as it pertains to autonomous driving software. Moreover, as will be discussed in the governance mechanisms analysis, insisting on software verticalization poses the risk of damaging MIH's relations with software complementors, potentially resulting in ecosystem abandonment.

4.3.2 Platform Ecosystem Architecture Analysis

Given that both Android and MIH were first formed through conception of industry-disruptive value propositions, utilizing ecosystem-as-structure to aid breaking down the architecture of these respective platform ecosystems and identifying the efficiencies attached to their configuration should lend particular insight into why they were created over other forms of business alliance and what advantages they possess.

4.3.2.1 Android

[8] For the North American market, the share percentage rises to 5%, still well behind other competing Android devices such as Samsung (25%).

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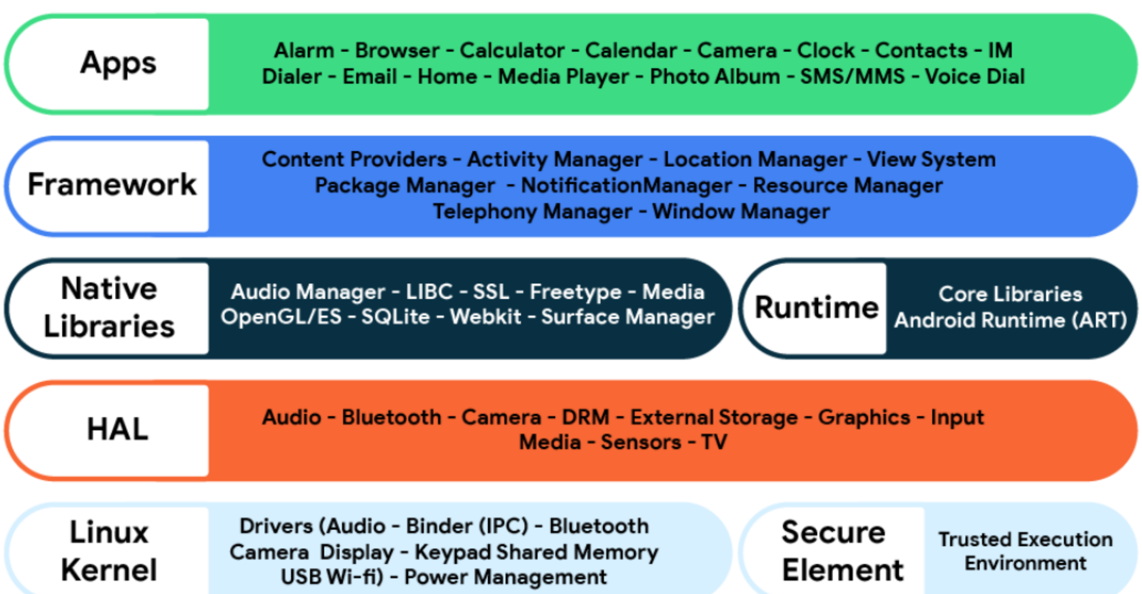
The Android platform ecosystem consists of three concentric layers. At the center lies Google and its internal Android team, who act as platform leader and determine the rules of the ecosystem, such as which application codes are open to the public and which are proprietary, which smartphone OEMs are authorized to install the proprietary Android app suite on their devices, as well as how rents are appropriated from the various platform activities to the Android headquarters. Surrounding this internal core is a global constellation of OEMs, telecom carriers, and other complementors under the Open Handset Alliance, which has since been extended to include several additional participants under an overarching Android Compatibility Program (Android, 2023). Encapsulating both of these layers is the AOSP, the base Android software platform that acts as the open foundation for app developers, smartphone makers, and any other industry players to freely use and build upon. This Operating System (OS), in turn, can be dissected into five stacked segments (see Figure 10):

Figure 10: Official Android Stack Diagram



Source: "Set up for Android Development." (2023). Android.

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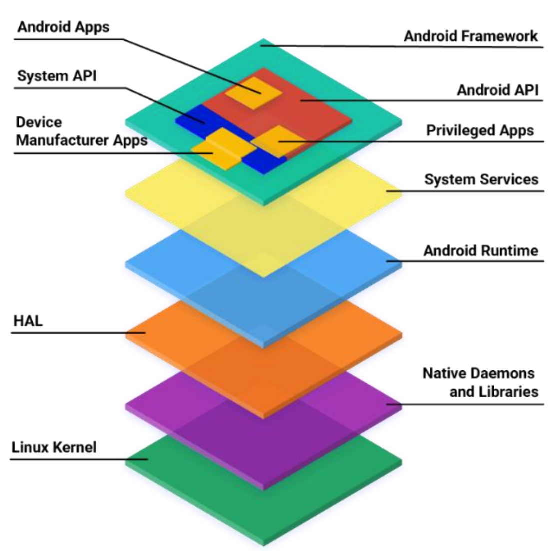
At the top is the applications suite, including fundamental smartphone apps such as the browser, camera, phone, contacts, and media player. Supporting these features is the applications framework, a family of middleware that manages the interface and efficiency of applications in the background. Beneath this segment are the libraries and Android runtime module, which maintains the applications framework and houses the virtual machine (Android, 2023; Haris, 2017). In order for hardware vendors to ensure OS compatibility, the Hardware Abstraction Layer (HAL) is an interface for integrating phone hardware drivers to the latest Android software (Android, 2023). Lastly, the Linux-based kernel resides at the bottom segment, housing the fundamental drivers and security protocols that keep the OS running at a macro level (Haris, 2017; Android, 2023). In parallel to the OS, an external Integrated Development Environment (IDE) called "Android Studio" that includes the OS's software development kit (SDK) functions as a publicly available and comprehensive toolkit for developers to program, design, and optimize android apps (Android, 2023). Figure 11 provides an alternative view of the AOSP's architecture:

Figure 11: Official AOSP Software Stack Diagram



Source: "Architecture Overview" (2023). Android.

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Table 2: Android Platform Architecture Efficiencies

Product Development Lens	
Unique Complementarities	• Complementor dependence on API for optimal OS functionality • OEM/telecom carrier dependence on OS for smartphone functionality • Dependence of application developers on Android Studio and SDK • Co-specialization between hardware/application developers and Android through compatibility standards
Supermodular Complementarities	• Between end-users and number of available Android apps • Between end-users and number of Android-compatible smartphone brands
Industrial Economics Lens	
Same-side Network Effects	• Between OEMs and application developers
Cross-side Network Effects	• Between OEMs and Android end-users • Between mobile accessory suppliers and end-users • Between application developers and end-users

Source: Compiled by Researcher

A summary of Android's platform architecture efficiencies is shown in the above table. Initially investigating the Android platform ecosystem from a product development lens, one can observe clear complementarities of both types. Unique complementarities are present between Android and the upstream Android Compatibility Program members in that OEMs and telecom carriers require ability to install Android's OS *and* proprietary Application Programming Interface

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(API) onto their products to be considered fully functional, and therefore must comply with Android's compatibility standards to join the ecosystem. (Android, 2023) Adjusting products for conformity to Android reinforces a level of specialization between the supplier and the platform leader, which in turn evolves into co-specialization as Android continues expanding its OS functionality into new forms of interconnectivity (smart home devices and other IoT equipment, for example). App developers also possess unique complementarities with the platform ecosystem, as access to Android Studio is essential for creating apps compatible with the latest API. Of course, Android also requires the participation of these app developers for their platform to stay relevant, incentivizing the company to continuously generate resources that simplify and incentivize app development. [9] End users experience supermodular complementarities as the number of apps on the Android platform increases, making the value of Android devices a competitive alternative to Apple's closed iOS ecosystem. The number of mobile device brands and carriers that join Android generate additional supermodular complementarities for end users by providing a level of customization that Apple does not, empowering consumers to choose a device brand from a wider range of price points, aesthetics, and features.

At an industrial economics level, Android clearly exhibits both cross side and same side network effects. The bidirectional dynamic between app developers and end users fuels a continuous growth of Android product consumers that consequently attracts more app creation and capitalization on Android's key app marketplace, the Google Play Store. Other front-end supply chain members, such as suppliers of Bluetooth-enabled audio peripherals and other mobile accessories, are also drawn to this cross-side growth despite not playing an active role in the

[9] To give another example besides Android Studio, Android hosts an annual Dev Summit that keeps developers up to date on the platform's latest trends and innovations. https://developer.android.com/events/dev-summit

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platform's core product development activities. This, in turn, creates a same-side network effect between manufacturers and app developers, as both types of complementor will view the other's participation in an ecosystem as a signal that there is cross-sided value available for capture. The rapid compounding network effects of each actor as they join in response to one another can explain the current oligarchical industry structure of smartphone OS providers, with Apple in one corner dominating the closed ecosystem model, and Android in the other enjoying the "winner-takes-all" effects of its open platform ecosystem. Indeed, as reported by research firm Gartner, Android's overall share of the global smartphone market surpassed Apple by the fourth quarter of 2010 (Gartner, 2011).

Now let us place these collective complementarities under the lens of ecosystem-as-structure. As touched upon in the dynamic capabilities section, Android was founded on the value proposition of a comprehensive, open software ecosystem as a means to leverage lower the cost and time requirements for OS innovation. To achieve this aim, one can observe that Android first configured its own FSAs through creating the OS foundation and SDK to justify its position as platform leader. After all, as Adner succinctly notes, "Successful leadership is contingent on willing followership" (Adner, 2017). Recognizing the disruptive nature of its proposition, which would naturally create adoption resistance and risk for its would-be complementors, Android made their AOSP free to use and build off of, securing its own revenues instead from advertising traffic on its apps (similar to Google's own business model) and eventually from proprietary app suite licensing and in-app purchase commissions. App developers and device OEMs agreed to such an ecosystem structure for its co-innovation complementarities backed by zero usage costs in the beginning, after which cross-side and same-side network effects took hold, making access to a large pool of platform users the primary incentive. Additionally, Android's AOSP was built to be

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flexible, such that newcoming developers or manufacturers could "plug and play" to a common set of software standards compatible with a wide range of devices (Nambisan et. al., 2019). Further, as explained in their official website's "governance philosophy" statement, Android is "designed so there's no central point of failure, where one industry player restricts or controls the innovations of another" (Android, 2023). Over the course of Android's evolution as both an OS and platform leader, however, a pattern of increased internalization (or what complementors would view as "scope creep") and stricter structural controls has emerged in reflection of Android's increased bargaining power. As will be discussed in the following transaction cost and governance analyses, these changes arise in answer to various ecosystem challenges, notably at the expense of a growing imbalance of power between Android and its key complementors.

4.3.2.2 MIH

Compared to Android, MIH's platform ecosystem is more modular and implements a tier membership system to segment its thousands of participating complementors. At the center of MIH's architecture is the consortium office, supervised by a board of directors and comprising of an executive team headed by the CEO. Directly beneath this executive office are the technical and advisory team branches, who supervise the co-innovation and engagement activities of MIH members. MIH's highest membership tier, contributor members, are in closest association with the core consortium office through their minimum 10,000 USD annual donations and leadership in one of fourteen working groups, the heart of MIH's EV technology and standards production. Outside the working groups are three interest groups that focus on EV technology and policy evaluation as opposed to deliverables, and in which community members can participate, but only contributor members can chair. The two lower tiers of complementor membership, M+ subscribed members and community members, are able to enjoy certain intra-industry engagement and paid

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services, but have little say in the consortium's innovation process and limited access to the entire range of ecosystem resources. That is to say, lower-tiered members can attend consortium events and promote their own business but are not given access to MIH's "Recommended Standards" specifications for EV manufacturing and design[10]; they may log into the platform's membership directory for business matching purposes but are unable to view contributor-exclusive details such as direct points of contact or intra-consortium activity history. While the MIH's organization and membership tiers configure the position of each actor, MIH's EV hardware chassis and software stack is the blueprint for where the developments and activities of each working group lie.

Table 3: MIH Architectural Efficiencies

Product Development Lens	
Unique Complementarities	• None identified
Supermodular Complementarities	• An increase in innovation resources attracts more complementors to MIH's cause, configured into working groups
Industrial Economics Lens	
Same-side Network Effects	• Between different MIH members (B2B)
Cross-side Network Effects	• *Theoretically* between MIH office and automotive retailers/end-users (B2B2C)

Source: Compiled by Researcher

Now let us turn to analyzing MIH's architectural efficiencies, summarized in the above table. Being a newly formed ecosystem at the crux of digitally empowered EV innovation, MIH's ecosystem structure naturally places strong emphasis on complementarity generation, especially of the supermodular kind. In particular, the fourteen working group modules aim to foster rapid

[10] An exception is select published MIH software standards, which may be announced to the public following the corresponding working group committee's approval.

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innovation activities such that one group's development does not depend on the progress of another, all the while ensuring a comprehensive and cohesive package for customizable EV manufacturing. Nambisan et. al (2019) describes this configuration advantage as "reducing interdependencies" between different innovation segments by simplifying the rules of interconnectivity, thus allowing a more heterogenous array of complementary industry players to innovate in relative harmony. (Nambisan et. al, 2019) The aggregation of industry specialists that supermodular complementarity prescribes doubles as a reinforcement to MIH's value proposition: lowering innovation barriers to entry and reducing time-to-market for smart EV production. As a consequence, the attractiveness of the working groups and participating in MIH's open platform ecosystem, as well as their probability of generating a successful modular EV product, is inextricably linked to an increase in complementary members and associated assets.

A similar logic applies to MIH's efficiencies under the industrial economics school of thought. Though still in its pre-production phase, MIH's potential as a multi-sided market is currently evidenced by MIH's appeal as a forum for meeting and matching with firms rather than consumers. While complementary members may share a common objective of selling their technologies to consumers on the platform in the long run, same-sided value creation opportunities such as B2B supply chain partnerships take clear precedence while MIH's innovation activities are still in its early development stages.

Interestingly, MIH's framework appears to place stronger emphasis on generating same-side network effects and supermodular complementarities as opposed to generating unique complementarities or cross-side network effects. The available evidence suggests a few reasons for this distinction from the Android platform ecosystem. Firstly, MIH's Project X is still under development and is consequently unproven compared to existing electric vehicle business models.

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As at least a temporary consequence of MIH's relative newness, the consumer side of MIH's platform ecosystem is undetermined, rendering cross-side network effects unavailable. Moreover, this current lack of customers and track record makes the bargaining power MIH has for committing complementary members to a platform in which there are unique complementarities that could lock players in relatively low. Still, Android was also an unproven co-innovation model in its beginnings yet managed to establish unique complementarities through gatekeeping its most advanced software API and app store behind the Android Compatibility Program and its comprehensive software development kit. Why has MIH not achieved the same? This question leads us to MIH's second distinction from Android: administrative heritage. One cannot ignore the impact MIH founder Hon Hai's contract manufacturing legacy has on the architecture of MIH. Per the previous section's parent organization analysis, MIH was designed by an MNE which had adapted to making custom products for competing electronic companies, accomplishing the delicate feat of simultaneously managing supply chain relations between rival firms. MIH thus places strong emphasis on being an *agnostic* open ecosystem, described by MIH's CEO Jack Cheng as an ability for any consortium member to enter or exit the ecosystem at any given time (MIH, 2022). MIH possesses the same flexibility and neutrality of its conventional contract manufacturing roots, seeking to attract complementors regardless of extant intra-industry rivalries, and making its production standards as customizable to differing EV styles as possible. While Android has also been neutral in its cooperation with competing OEMs, carriers, and even app compatibility with Apple's iOS, these relations are bound by longer-term contracts and a dialogue of product co-specialization under the Android Compatibility Program. By contrast, MIH's subscription-based membership model is more reflective of the seasonal irregularity of contract manufacturing, where clients renew relations based on short-term demand and benefits such as

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competitive pricing. Such hyperextended flexibility could come at the detriment of MIH's ultimate standards and IP creation, both in terms of development speed and quality. Third, the MIH ecosystem is founded upon a B2B2C value model, in which the most crucial relations are those between complementary firms, effectively connecting MIH's standards and designs to the branding and retailing capabilities of incumbent automotive firms. Phrased differently, MIH's connection to end users is currently dependent on the FSAs of its complementing members as opposed to the other way around. In this way, MIH is at risk of losing what Teece (2017) refers to in his exposition of dynamic capabilities and platform lifecycles as a "complementor bottleneck", a component of the Profiting from Innovation (PFI) model where control of key complementary assets allows platform leaders to appropriate a larger share of industry value for its innovation (Teece, 2017). Without sufficient long-term incentives for complementors to remain in the consortium, such assets may quickly dissipate from the ecosystem as soon as a dominant design for smart EVs emerges.

It shall become increasingly clear in the following transaction cost and governance analyses that establishing a business ecosystem free of unique complementarities, and therefore lacking in long-term competitive advantage, poses a variety of challenges in ensuring MIH's sustainable future and appropriability regime governance. A major aim of the next sections is to identify what could motivate or deter complementing innovators from remaining in the consortium long-term, as well as what governance mechanisms are or should be in place to prevent exiting complementors from misappropriating MIH's intellectual property.

4.3.3 Transaction Cost Analysis

Having dissected the architectures of MIH and Android's platform ecosystems, the next step in evaluating and comparing their ecosystem-driven efficiencies to identify their implications

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from a transaction costs lens. Both the Android and MIH platform ecosystems seek to lower intra-industry communication costs and information asymmetry while also leveraging membership scale to decrease the necessary transaction-specific investments of each contributor. Nevertheless, as is demonstrated by the "make or buy" paradigm's tendency to exchange one cost type for another, a concerted effort in linking individual firm FSAs to lower an overall group's asset specificity should be paired with an awareness of the corresponding rise in opportunism, in the challenge of controlling transactional outcome, and in the complexity of coordinating and monitoring the transactional framework as a whole. The following table provides a comparative summary of the three major costs for both ecosystems:

Table 4: Android and MIH Core Transaction Cost Comparison

Transaction Cost Category	Android	MIH
Coordination Costs	OS updates are fragmented among global network of OEMs and telecom carriers	One office in charge of 2600+ members dispersed across 70 markets
Opportunism Costs	AOSP incentivizes smart device providers to engage in code "forking" and design competing OS atop Android source code	Agnostic membership framework incentivizes IP theft and value misappropriation from co-innovation efforts
Switching Costs	**High:** No open, mainstream OS alternatives, designing OS from ground up prohibitively costly	**Low:** Members can exit at any time for an alternative alliance or venture

Source: Compiled by Researcher

4.3.3.1 Android

Debuting the smartphone market as a completely open-source programming effort has not been without consequences for Android over the course of its history. To begin with, Android faces the conundrum of coordination costs each time it develops and subsequently releases a new

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iteration of its API, denoted by either a dessert nickname in progressing alphabetical order (i.e., from “Cupcake” to “Donut”) or an uptick in number sequence (i.e., 9.1 to 9.2 for smaller API updates, 9.x to 10.0 to signify a more drastic API generation jump). That is to say, as Android rolls out updated versions of its proprietary OS, its collection of complementing OEMs and smartphone carriers exhibit different gaps in adopting these updates and applying them to their product lines. Kamran et. al. (2017) indicates in their study that according to *Open Signal's* 2014 data, only 12.4% of smartphones in Android's global market were operating under the latest Android generation (“Lollipop”, 5.0 and 5.1 at the time), with the remainder of devices spread amongst “Kit Kat” (39.2%), “Jelly Bean” (37.4%), “Ice Cream Sandwich” (5.1%), all the way down to Android versions released in 2010, “Gingerbread” (5.6%) and “Froyo” (0.3%) (Kamran et. al., 2017). This struggle with fragmented OS implementation heightens the costs of quality control for Android products across the globe, and its resulting product dissonance is damaging to Android's brand reputation, particularly when users compare their outdated Android phones to the frequently updated, closed-loop evolution regime of Apple iPhones.[11]

Next, as Android has grown to overtake former major OS such as Nokia's Symbian and Blackberry's BlackBerry OS, the AOSP has become a prime target for the opportunism of competing smart device providers that wish to capture their own share of the OS market. Android challengers achieve this by developing coding “forks”, or OS deviations which branch from the original Android source code, thereby creating a differentiated software which could compete and even overtake their predecessor. Pon et. al. (2014) points to Amazon's Kindle Fire OS and Xiaomi's MIUI OS as major examples of Android code forking that rose to challenge the

[11] With that said, it should also be acknowledged that since the device brand of a given smartphone is the more front-facing brand to a consumer, these reputational effects may be shared by or even fully placed on the device brand instead. This marketing tactic is known as co-branding, much like how Intel advertises its CPUs with various laptop brands, and can sometimes result in one brand free-riding on the reputation of the other.

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incumbent's market power. In Android's US home territory, Amazon sought to customize its own Android-based OS as early as 2011 to complement its line of eBook readers and tablets. On the other side of the world, Chinese smartphone and electronics brand Xiaomi built its own domestic empire of smart devices from 2010 onward with its Android fork OS and custom app marketplace, where Google products are largely restricted by the national government (Pon et. al., 2014). This second fork-coding incident presents additional monitoring and even legal cost implications for managing an OS platform's usage in foreign markets and under differing digital governance laws.

Lastly, reframing Android's ecosystem from the complementors' perspective, OEMs and app developers alike may feel compelled to remain in the Android platform due to relatively high switching costs, meaning building an OS independently for OEMs or seeking marketplace approval from Apple's comparatively strict app store regulations for developers. Nevertheless, the risks of hold-up from adhering to Android's compatibility standards could foreseeably push extant or would-be complementors to reject the platform ecosystem and usher in a new wave of technological disruption, much like how ChatGPT is currently challenging the supremacy of Android parent Google's search engine today.

4.3.3.2 MIH

To a demonstrably larger extent than even Android, MIH's sheer membership scale and activity scope presents tremendous challenge, and therefore expenditure, in managing the ecosystem at every tier. As previously highlighted from *The Commonwealth* magazine's interview with Chairman Liu, the jump from managing a smartphone's hundreds of components to the thousands of a smart electric vehicle is no small leap for Hon Hai and its fledgling MIH consortium to make (Huang, 2021). When there are thousands more considerations for a project to succeed, there are also substantially more ways for activity coordination and monitoring to fail. Not to

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mention, compared to Android's platform architecture, in which tighter control is exerted over smartphone suppliers through the Android Compatibility Program, MIH remains true to its "agnostic" principle of membership at each tier, granting even those contributors involved in working group patent creation the right to exit at any time. The risk of MIH's patent creation process being disrupted by a key contributor exiting is somewhat mitigated through the modularization of the fourteen working groups, which allows distinct but linked EV technologies to develop with relative independence from the progress of its counterparts; nevertheless, an unanticipated disagreement between a contributing complementor and the MIH office could still create innovation setbacks. For example, if a complementor disputes the use of a critical technology that belongs to its IP, this could potentially force an MIH standard or patent to undergo revision, ultimately delaying the time-to-market for MIH's current Project X. In a more severe circumstance, an opportunistic complementor may misappropriate the proprietary or confidential knowledge it obtained from MIH following its exit to benefit its own brand and even compete against the consortium. The more tacit such misappropriated knowledge is, the harder it would be theoretically for MIH to prove this kind of information breach in a court of law.

To further complicate matters, MIH is an international consortium of currently 70 countries/regions, while electric vehicles themselves are subject to highly localized safety-related and trade-related regulations. Although Project X's build-your-own vehicle value proposition attempts to overcome this coordination cost challenge by enabling highly modular customization, it may still prove exceedingly difficult to design a cost-effective vehicle framework that can adapt to the laws, norms, and even aesthetic preferences of all 70 markets. Project X's current prototype concept art, after all, differs significantly from the structure of several popular vehicle brands in

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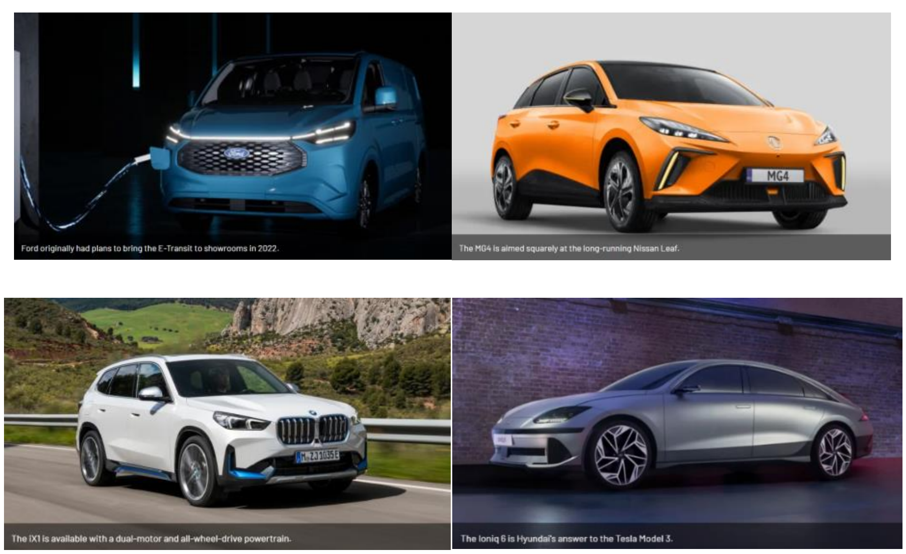
the United States, Europe, and Australia that operate outside of MIH, which could translate to difficulties securing consumer adoption in these markets down the road (see Figures 12 & 13).

Figure 12: MIH Project X Concept Art

Source: "MIH unveils Project X" (2022). Hon Hai Precision Industry Co., Ltd.

Figure 13: A Sampler of 2023 EV Models Outside MIH Ecosystem



Source: "Best electric cars arriving in 2023" (2023). Carsguide.

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Creating a harmonious MIH culture is also at odds with the geographic and technical diversity of its thousands of complementing members, increasing the difficulty of socializing complementors as a behavioral enforcement mechanism.

Returning to the perspective of complementary members, capital-constrained small to medium enterprises (SMEs) and EV/AV-relevant startups arguably benefit the most from MIH's information sharing and co-innovation prospects, while larger firms would not necessarily attain as high of gains due to its existing scale, funds, and FSAs in R&D. On the one hand, a larger complementing firm joining MIH could enjoy the same benefits as an SME, including lower searching costs for B2B opportunities in the industry, information costs regarding EV/AV trends, and overall innovation costs—albeit to a lesser extent depending on its already available capabilities and relations. On the other hand, a larger firm sharing its expertise and technologies with SMEs comparatively lacking in contributions may be viewed as inequitable, perhaps even to the extent that more value is surrendered to the ecosystem from their IP than is appropriated. This discrepancy could explain why a number of recognized automotive MNEs involved in the EV space have not joined MIH to date. Regardless of size or category of complementor, MIH has intentionally designed ecosystem entry to be as effortless as possible, implementing a simplistic online application form with clear payment instructions for the corresponding tier. But on the flip side of attracting complementary members through a low commitment, "agnostic" membership framework that allows firms to come and go with little restriction, is the reality of low switching costs in the instance of complementors deciding better partnerships could be found outside the MIH ecosystem. Consequently, unless the consortium sustains key cost and value motivations to remain in the ecosystem over the long-term and particularly post-Project X implementation, MIH's membership could deflate as easily as it has ballooned over a short time. This is quite unlike

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Android's ecosystem, where strong market power resultant of network effects and unique complementarities make the prospects of switching far less easy or attractive.

At its core, MIH recognizes the overwhelming asset specificity and integration costs of verticalizing every aspect of smart electric vehicles, which it seeks to address and optimize through its open platform ecosystem format. MIH's working groups and intra-ecosystem events are essentially Hon Hai's and the overall industry's compromise between participating in all aspects of smart electric vehicles and securing relatively open knowledge transfer while not incurring the steep costs of verticalization. The question that now must be addressed is what governance strategy is or should be in place for the managing and minimizing of monitoring costs, coordination costs, and opportunism or membership exodus risks.

4.3.4 Governance Mechanisms Analysis

This final section of the MIH-Android comparative analysis will identify which core governance mechanisms are in place for the respective ecosystems, how these mechanisms shape MIH and Android's gatekeeping roles, and what gaps may be present in their existing governance framework.

4.3.4.1 Android

Table 5: Android's Governance Mechanisms

Market/Contract-based	Power/Authority-based	Trust/Clan-based
• Google Play Store app pricing and in-app purchase commissions • Google Services Suite licenses	• Android Compatibility Compliance Program • Open Handset Alliance	• Common vision of open programming innovation and cross-brand Android functionality

Source: Compiled by Researcher

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Table 5 provides a categorized summary of Android's current government mechanisms. By the early 2010s, Android launched a calculated response to the OS fragmentation and code-forking issues that challenged their gatekeeper role in the platform ecosystem. This started with rebranding Android's app market into the Google Play store in 2012, wherein certain core Android APIs were converted into Google-branded apps and transferred to Google Play Services. This new structure served the dual purpose of proprietizing strategic portions of Android, which prevented AOSP forks from achieving competitive quality, while also alleviating global OS fragmentation through automating API updates in the background with Google Play. An article by analyst Amadeo (2018) refers to this move as a "closed source creep" that turns segments of the AOSP into "abandonware" while the rebranded API is continually optimized and updated. Now able to leverage their proprietary API in manufacturer relations, Android proceeded to build upon its Android Compatibility Compliance Program and began offering paid "Google suite licenses", including popular apps such as Gmail, YouTube, and the Play Store, contingent on compliance rules. Manufacturers that formally entered Android's Open Handset Alliance, and thus were contractually prohibited from producing devices unapproved by Google, enjoyed the benefits of expedited approval for this suite license (Amadeo, 2018). The compliance program, Open Handset Alliance, and Google suite licensing each served to lock-in OEMs from using competing open-source code "forks", allowing Android to exert tighter ecosystem control and generate the greatest value capture for itself. By 2018, Google had closed its 1.1 billion USD acquisition deal for HTC's smartphone design & manufacturing assets, officially expanding Android's resource scope into the hardware space through the Google Pixel smartphone series (Whitwam, 2018).

From this evolution of Android's governance mechanisms, an observable shift from a keystone to dominator strategy is clearly visible at the ecosystem's upstream layer of smartphone

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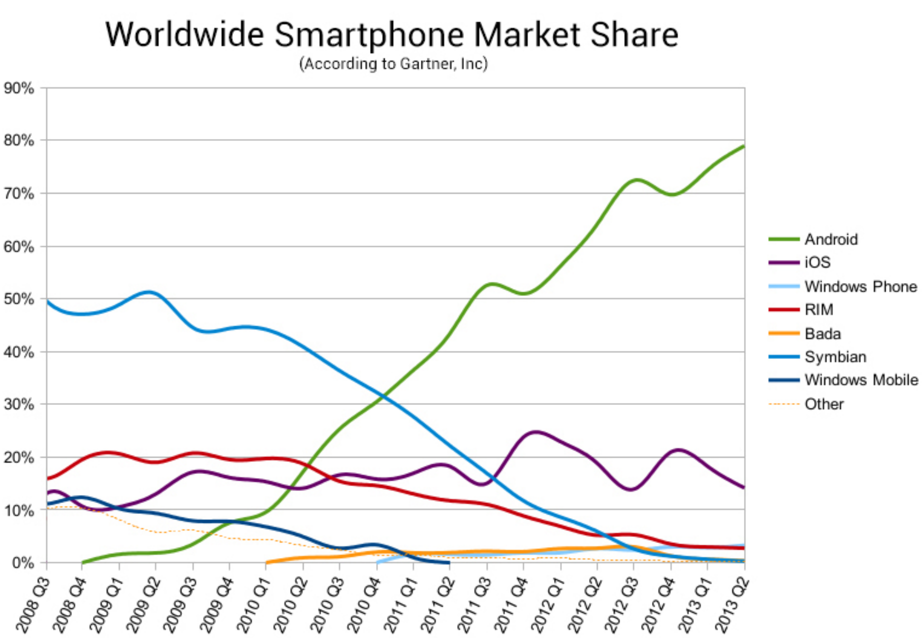
manufacturing. Android methodically expanded its scope as its share of the OS market increased, giving it sufficient bargaining power to bar major device OEMs from producing fork products, thereby also discouraging smartphone brands and carriers from designing devices outside Android approved specifications for fear of 1) not finding an OEM willing to manufacture them; and 2) being unable to install proprietary applications widely demanded by smartphone users, which would likely result in mass product rejection by the market. By waiting for Android's position in the OS market to mature and stabilize, Android was able to effectively transition from a keystone to dominator role; had it moved too quickly and sought to lock-in OEMs before surpassing iOS and Symbian in 2010 (see Figure 14), this attempted scope creep could have generated the opposite outcome, inciting industry-wide rejection of Android due to its inequitable, "landlord"-like tactics and creating a new opening for would-be successors such as Amazon.

Figure 14: Trend Timeline of leading Smartphone OS Market Shares, Q3 2008-Q2 2013



Source: Gartner, Inc (2013). Cited by Amadeo, R (2018).

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In parallel to the leader's gradual resource integration, however, Android maintains its keystone role for downstream app developers. While a growing official suite of core OS applications like SMS messaging and calendar have been moved under a proprietary umbrella, Android has kept the AOSP open and actively encourages app developers to create their own complementary software for the ecosystem. Per the aforementioned five criteria of a keystone leader, Android:

- Continually contributes to shared asset creation and encourages innovation by maintaining a portfolio of developer resources, including its Android Studio and SDK (criteria 1 & 2);
- Provides an app store with strong network effects (and therefore cost economies) wherein app developers can monetize their content and Android receives a percentage commission from in-app purchases (criteria 3 & 4);
- Rewards top grossing/quality apps through prominent featuring on the Google Play Store interface and holds app competition events such as the Android Developer Challenge (criteria 5) (Android, 2023).

Pon et. al's (2014) discussion of gatekeeper roles with Android further illuminates that the "hub", or the resource bottleneck of a platform ecosystem that leaders aim to control, can evolve over time, consequently calling for dynamism in a leader's governance strategies to prevent threat of succession. That is to say, when Android's OS itself was no longer the bottleneck that compelled complementors to align with the ecosystem and competitors attempted to break out of the incumbent framework with coding forks, Google responded by identifying key APIs as Android's new ecosystem hub. Pon et. al. additionally points out that proprietizing data-intensive APIs such as maps and speech-to-text internet searching was conducive to Google's core business model of data capture for the purposes of targeted advertising, making the shift as much reflective of

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Google's path dependencies as of the overall smartphone industry's evolving dynamics (Pon et. al., 2014).

The main foreseeable future risk that lies in Android's current governance regime is maintaining ecosystem equitability and managing conflict due to differing stakeholder perceptions of this equity. As Android increasingly exerts dominance over a greater expanse of both horizontal and vertical value chain activities, expanding even into IoT, smart cars, and generative AI, the incentive to shirk, cheat, or abandon the ecosystem for complementors whose value appropriation channels are adversely affected inevitably grows. Since Open Handset Alliance and other related intra-ecosystem contracts are not available to the public, it is unclear what mechanisms, if any, Android has in place to resolve complementor disputes before escalation to court. It is also difficult to measure the level of bargaining power device brands and OEMs have in their negotiations with Android, nor how satisfied each of Android's partners are with their current transactional arrangements. Nevertheless, the implications of organizational control theory and gatekeeper roles suggest two safeguards to ecosystem collapse.

First, an appropriate implementation of intra-ecosystem socialization at both a regional and global level can be used to align stakeholders with Android's core values. Bringing Open Handset Alliance members together for industry roundtables and co-specialization workshops may encourage a mutually beneficial culture of transparency and cooperative growth. Regular, on-site meetings between Android and major complementing partner executives could help maintain a sense of trust and equality between parties, while providing a streamlined system for various categories of Android ecosystem members to communicate their concerns could also prevent the rise of an "us vs them" mentality between platform leader and complementors. Second, regardless of how broadly Android extends its resource scope, it must ensure that participation in the

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ecosystem remains comparatively profitable to alternative ventures for its key complementing members, such as prominent smartphone brands, major device OEMs, and innovative app developers under the Google Play Store. If Android raises its Google suite licensing fees or in-app purchase commissions beyond accepted market levels, this could incite damaging ecosystem disputes, defections, and even the rise of a disruptive competitor, such as a new OS platform.

4.3.4.2 MIH

Table 6: MIH Governance Mechanisms

Market/Contract-based	Power/Authority-based	Trust/Clan-based
• Fixed fees for membership tiers and MIH services/events • Membership application agreements • MIH standards submission and application form • Patent statement and license declaration forms	• Technical, business, and legal reviews under MIH patent and standards protocol • Budgetary planning of MIH office	• Working group socialization and charters • Shared vision of future mobility

Source: Compiled by Researcher

Table 6 provides a categorized summary of MIH's governance mechanisms. A prospective firm intending to join MIH under any of the three membership tiers must first submit a membership application agreement, which functions as a preliminary contract for ecosystem rules and behavior as well as a profile record organizer for the different categories and specialties of firms that register (see Figure 15). Namely, applicants agree to the alliance's code of conduct, including not disclosing any confidential information from the consortium and its members, respecting the IP rights acquired by the alliance or its members at any time, and permit the usage of the member's

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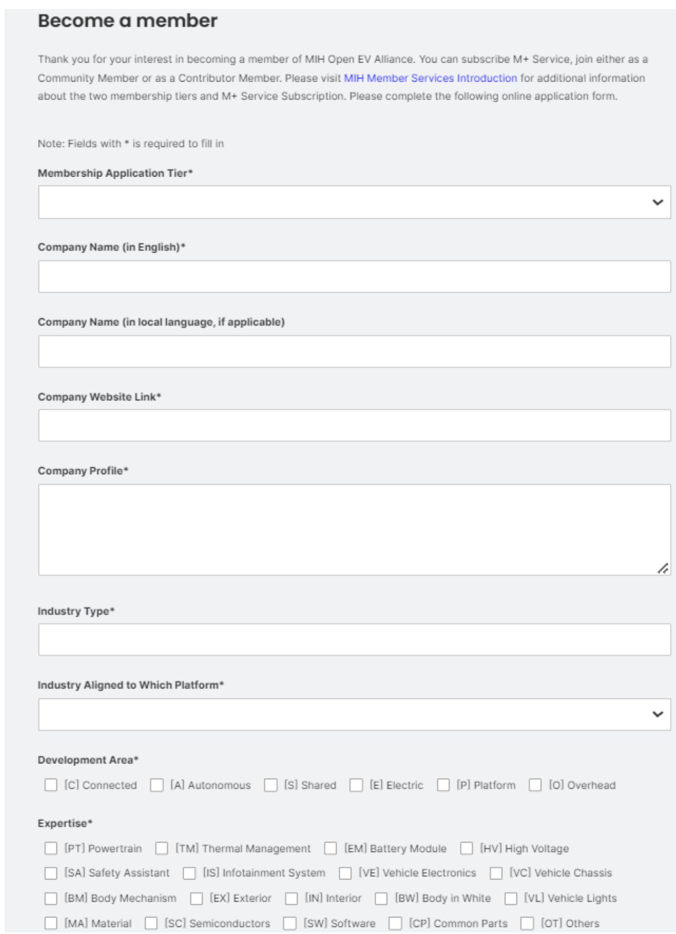
name and logo in MIH cooperative marketing materials. The laws of the Republic of China (Taiwan) and the Taiwan New Taipei district court are appointed as the enforcing bodies of this contractual agreement (MIH, 2023). The M+ and contributor subscription tiers utilize its pricing as a way to segment members by commitment level and establish a market-based value signal for the co-innovation activities offered. Prospective contributor members that pay the annual 10,000 USD fee implicitly validate the price point MIH enforces for working group participation while making an upfront investment that incentivizes the new entrant to actively participate and generate returns.

Figure 15: Partial Screenshot of MIH's Online Membership Application Form



Become a member

Thank you for your interest in becoming a member of MIH Open EV Alliance. You can subscribe M+ Service, join either as a Community Member or as a Contributor Member. Please visit MIH Member Services Introduction for additional information about the two membership tiers and M+ Service Subscription. Please complete the following online application form.

Note: Fields with * is required to fill in

Membership Application Tier*

Company Name (in English)*

Company Name (in local language, if applicable)

Company Website Link*

Company Profile*

Industry Type*

Industry Aligned to Which Platform*

Development Area*

☐ [C] Connected ☐ [A] Autonomous ☐ [S] Shared ☐ [E] Electric ☐ [P] Platform ☐ [O] Overhead

Expertise*

☐ [PT] Powertrain ☐ [TM] Thermal Management ☐ [EM] Battery Module ☐ [HV] High Voltage
☐ [SA] Safety Assistant ☐ [IS] Infotainment System ☐ [VE] Vehicle Electronics ☐ [VC] Vehicle Chassis
☐ [BM] Body Mechanism ☐ [EX] Exterior ☐ [IN] Interior ☐ [BW] Body in White ☐ [VL] Vehicle Lights
☐ [MA] Material ☐ [SC] Semiconductors ☐ [SW] Software ☐ [CP] Common Parts ☐ [OT] Others

Source: "Become a member" (2023). MIH Consortium.

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The funds allocated by member subscriptions and Hon Hai's own donations are governed by the authority of the MIH office, which are annually published for the public. From MIH's 2023 budgetary statement, one can observe the following list of key consortium activities to which funding is applied:

1. Co-innovation activities of working groups for the purposes of establishing modularized and streamlined MIH reference designs and standards;
2. Inviting industry, government, and academia experts to hold seminars, provide advisory directions, and communicate opinions;
3. Compiling MIH-branded written works and integrating with an editorial & publishing team for recording platform history;
4. Holding regular forums for discussing each working group's progress on industry standards production;
5. Managing related conference affairs for MIH alliance members;
6. Office rental and administrative expenses;
7. Participating in both domestic and foreign exhibitions, including the Consumer Electronics Show (CES), India's Auto Expo Components show, the Tokyo Motor Show, and Taiwan's E-Mobility 2035 Trade Exhibition;
8. Coordinating with international and Taiwan-based start-up groups for the incubation of new EV-related firms and technologies;
9. Jointly holding special forum lectures;
10. Hosting MIH activities, including the MIH Partner Gathering, MIH Startup Program and Competition, MIH Demo Day, and Partner VIP Night (MIH, 2023).

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Next, assignment of contributor members to working groups is in itself a socialization process. MIH advisors work directly with the contributor members to match them with a working group corresponding to their field expertise. Members within the working group appoint leadership, adhere to their own designed charter, and agree to a set of aligning goals for team cooperation, thereby fostering a unified compliance culture in each respective group. MIH's next and arguably most important set of governance mechanisms surround the co-innovation process of MIH standard and reference design creation. As part of MIH's four-stage standard proposal process described earlier in the MIH subject overview, each contributor whose technologies are necessary for implementing MIH standards must fill out a Patent Statement and Licensing Declaration Form. Under this form, contributor members notify MIH of the patented technologies in question and declare 1) willingness to grant Royalty Free (RF) licenses to MIH members (including on the condition of reciprocity); 2) willingness to grant Fair, Reasonable and Non-Discriminatory (FRAND) licenses to MIH members (including on the condition of reciprocity), with the option to also grant RF licenses to a specific working group or all contributor tier members; or 3) unwillingness to grant licenses according to the previous two options, which must be paired with a description of the patents and the member's reasons for rejection. Assuming no IP disputes delay the standards approval process, a set of authority mechanisms are embedded in the second and third stages of MIH's standards proposal process, in the form of expert reviews spanning the subjects of technical implementation, business feasibility, and legal policy. Standards and reference designs that pass these reviews are then published through the authoritative approval of MIH's committee and the working group's chair.

Having reviewed all publicly available documents and statements pertaining to MIH governance, some notable gaps which have linkage in the ecosystem's coordination costs and

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opportunism risks persist. It remains to be seen, for example, what specific governance protocol is in place to resolve potential IP disputes or recover working groups from the exit of major contributor members. The system through which MIH and the working groups select the first market or markets to produce Project X vehicles is also unclear, especially considering the diverse international makeup of MIH's member pool. In conjunction with market selection, MIH's governance of Project X production should also foreseeably require a system for communicating and managing discrepancies of automotive law and localized preference across nations, a nuanced issue for which MIH's fourteen working groups would not likely be able to comprehensively anticipate in their design of technical standards.

Another unaddressed question is how MIH decided on 10,000 USD as a membership subscription price point, whether this valuation is "subsidized" to attract members, and whether it would remain feasible once MIH's Project X becomes a reality and a consumer side for the platform builds. A study of 43 ongoing and 219 failed business platforms published by the Harvard Business Review stresses the importance of correctly pricing each platform side, as mispricing or incorrectly sided subsidization was shown to be a common reason for platform failure (Yoffie et. al., 2019). Given that MIH's CEO has declared plans for Project X's initial three-seater models to be priced under 20,000 USD, a critical question of future business model feasibility arises (Taipei Times, 2023). Automotive production's strong dependence on scale economies to turn a profit, if combined with a platform configuration where both business partner membership fees and consumer-end retail prices are kept artificially low, could spell disaster for MIH's long-term sustainability.

As for how MIH measures under Iansiti and Levien's five Keystone leader traits, the MIH office as platform leader demonstrates strengths in the first two criteria of building and sharing

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high-value, common assets while promoting innovation among complementing members. Meanwhile, managing the value creation process in tandem with dynamic membership influx, equitably allocating future proceeds among the contributor members, and continually shaping the ecosystem framework to reward victors of cross-border, intra-ecosystem competition will be MIH's greatest challenge. Formulating clear resolution guidelines pertaining to major changes in working group membership, division of working group patent and Project X proceeds, and incentivizing members to outperform others in their field are all necessary for MIH to be resilient amid the tumultuous waves of EV industry innovation and reform.

Finally comparing MIH's case to the historical evolution of Android's governance tactics, an inference could be erroneously drawn that scope expansion is the single proper method to safeguard from opportunistic member behavior and optimize platform leader value capture. MIH and its parent Hon Hai should not rashly conclude their gaps in governance are best addressed through a dominator approach, however. As it currently stands, MIH lacks leverage, both in market share and unique assets, to attempt extensive resource integration and control on Hon Hai's behalf. Prior to the consortium achieving a degree of stability and lowered uncertainty in the EV market, such an approach would pose a high risk of alienating complementing members by way of brazen scope creep. Rather, reference of Android's governance regime can serve as a cautionary tale for MIH that showcases the potential consequences of open platform ecosystems allowing unchecked access and exploitation of assets, particularly those integral to the platform leader's own value capture.

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CHAPTER 5 INTERVIEW AND FINDINGS DISCUSSION

5.1 MIH Office Interview

Due to inherent limitations in the publicly available information on MIH, research of the platform ecosystem at the internal level was deemed paramount to performing a comprehensive evaluation. In order to gain additional, firsthand insight as to the innerworkings of MIH, an on-site interview was arranged with Joe Cheng, Head of Marketing and Operations at Taipei's MIH Consortium office headquarters. Five key themes arose through this discussion, which shall each be discussed in detail below.

5.1.1 Discussing MIH's Origins and Purpose

The opening subject of Cheng's interview centers on his personal insight of how MIH came to be via the founding company Hon Hai's internal strategizing. The aim of this question was to better understand the parent company's dynamic capabilities process in sensing the electric vehicle opportunity, followed with their designing and implementing MIH in response.

Cheng first addresses the caveat of his joining the MIH team towards the end of 2020, while Hon Hai had already conceptualized MIH around mid-2020; thus, he had not been involved in initial discussions, but rather made aware of their history through an active dialogue with upper-management, Hon Hai's chairman, and MIH's CEO. He then explains that Hon Hai has achieved its contract manufacturing success through its co-evolution through the eras of desktop computers, laptops, and smartphones. According to Hon Hai's vision, the next big digital transformation is found electrification of vehicles, which is why electric vehicles are at the forefront of the 3+3 strategy Hon Hai announced from the beginning. Greater than this shift between electric product segments, however, is a macro shift in high-technology supply chain dynamics. Cheng explains that in the beginning decades of the information era, the markets for computers and mobile phones

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used to be dominated by a small number of tech giants, such as Compaq and Dell in the desktop space. This economic oligarchy was a highly verticalized one, wherein these brands had to take responsibility for the end-to-end value chain, from design and input procurement to final assembly and distribution.

Today, by contrast, major technology enterprises need not have their own factories and often outsource value chain activities that are not attached to the firm's core competencies. This is where Foxconn has emerged and leveraged its economies of scale to serve several of the world's largest consumer electronics brands. Cheng further illustrates his point by postulating that if an entrepreneur has the idea to establish a new smartphone brand, they would no longer need to acquire their own manufacturing capacity, and could easily delegate all production activities to one of several cost-effective OEMs in China. No longer are technology startups and SMEs constrained by the prohibitive capital barriers to entry that characterized the 80s, 90s, and early 2000s.

Now turning to the automotive industry, Hon Hai observes a similar pattern of domination by a handful of large-scale incumbents over the past century, which they now anticipate will undergo the same lowering of entry barriers and opening of flexible value chain opportunities in parallel to vehicle electrification and autonomous driving, just as had occurred for computers and smartphones. Tying this trend together with Hon Hai's inception of "open alliance organization" MIH, Cheng states:

> "We've seen the change from a very closed industry where it was dominated by a few players only, to a very open and vibrant industry where there are standards being introduced, there are open systems being introduced…now no one needs to do the whole thing end-to-end all by themselves. They can focus on the technology, with the parts that they are really good at, and everyone can collaborate together in building things on top of each other."

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The next core question asked, in direct relation to Research Question 2, is why Hon Hai would choose to create MIH given its existing portfolio of EV joint ventures and strategic alliances across the world—Foxtron in Taiwan, PTT in Thailand, Geely Holding Group in China, and Lordstown Motors in the US, etc.—all of which are not listed as members of the MIH consortium? In response, Cheng firstly reiterates that while Hon Hai aims to usher in the opening of the EV industry through MIH, this new and disruptive business model will take time for conventional automotive enterprises and supply chain members to embrace. Keeping in mind that traditional automakers will be slower to adopt open industry principles than Hon Hai may wish, the company has continued to engage in more familiar forms of business collaboration, such as strategic joint ventures and factory acquisitions.

Second, Cheng points out that the localization factors for vehicles are significantly stronger than consumer electronics. Besides the inherent logistic challenges of shipping vehicles worldwide, as opposed to smartphone or computers small enough to build in one location with low-cost factors of production and then ship everywhere, the manufacture and sale of vehicles also involve a growing number of geopolitical concerns. The laws associated with electric vehicles vary from country to country, and for several of these nations, the automotive sector is a protected industry with complex trade tariffs. Cheng cites the Inflation Reduction Act of the United States as a primary example of governmental regulation which incentivizes local production for vehicles and their components. In elaborating on these industry-specific considerations, Cheng also demonstrates that Hon Hai's "Build Operate Localize" model for its ventures parallel to MIH has largely been influenced by EV localization factors, which necessitate the company to invest in a closer-to-market network of manufacturing capacity that also leverages local talents with market know-how.

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5.1.2 Dynamics of MIH and Hon Hai

Another important element to pinpointing the strategic advantages and shortcomings of MIH, is clarifying the working relationship MIH has with its founding company Hon Hai, especially considering that the consortium diversified its board of directors and became an independent entity in 2021. The following set of questions explored this post-independence dynamic as well as how Hon Hai captures value in the EV space through MIH.

Cheng describes that as the consortium's founder, Hon Hai is naturally the largest supporter of MIH and heavily invested in the platform ecosystem's success. This is evidenced by the fact that over half of the funds attained annually for MIH to operate come through substantial donations on Hon Hai's part, such as the 1 million USD granted in this year's budget statement. At the same time, Hon Hai was cognizant of the reality that a consortium explicitly led under the Hon Hai/Foxconn name could invoke hesitance and rejection by industry players who lack trust in the company or its motives. Transforming MIH into a "neutral party", Cheng explains, helps to not only give MIH CEO Jack Cheng autonomy to govern the consortium, but also diversifies the number of players MIH can ultimately access and collaborate with.

Digging deeper into the implications of Hon Hai's involvement in MIH, the subject was then turned towards MIH's latest and largest endeavor, Project X. Given that based on public knowledge, a physical prototype of MIH's "Build-Your-Own Vehicle" project has not been made, but CEO Cheng recently announced the three-seater may be ready as early as October 2023 with mass production beginning in 2025 (Taipei Times, 2023), an elephant in the room had yet to be addressed; who would manufacture the Project X vehicles? To this inquiry, Cheng clarifies that due to the company's significant involvement and strengths in streamlined manufacturing, Hon Hai would indeed be a priority candidate for production and assembly of Project X vehicles.

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Nevertheless, the consortium would still consider the prospects of other manufacturers in the ecosystem, especially those with local advantages in a given target market which Hon Hai itself may not possess:

> "There will be a lot of advantages to manufacture vehicles within the target market… Foxconn already has a lot of footprints across the globe, but if there are places where some of our other members have an advantage in a specific market, we're not ruling those out. So we could potentially leverage some of our other partners who also have some manufacturing capabilities in specific markets…whatever makes sense for the final product and that will make the final product more competitive."

5.1.3 Competition and Competitive Advantages of MIH

The next theme of interview questions centered on identifying what Cheng believes to be MIH's top three greatest accomplishments, how he has personally observed MIH positively impacting the international EV community, and how competition shapes the strategy of MIH leadership. These questions were designed to more deeply examine what competitive advantages the platform ecosystem possesses, as well as what type of challengers may be under their radar.

Cheng reflects that a lot has been accomplished in two short years. For starts, MIH has been effective in mobilizing cross-industry players, acquiring members not only in the automotive space, but also in high technology and software. Next, with the rise of MIH, Cheng and his team have observed an increasing number of other open collaborations occurring in more specific fields of vehicle electrification, such as The Autoware Foundation, a group focused specifically on open-source autonomous driving.

Lastly, returning to the consortium's core values, Cheng emphasizes that MIH is catalyzing a change in the way the automotive industry works together. Traditionally, big-brand automakers

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operate through a hierarchically tiered supply chain approach. As Cheng describes, these brands generally work directly with tier 1 suppliers, who then pass down their requirements to tier 2s, with this chain of command repeating for tier 3s and beyond. He argues that a result of this opaquely layered supply chain structure is communication difficulties and resultant supply chain shortages, as brand OEMs often unable to anticipate fluctuations in key supplies from secondary and tertiary tiers in the chain. What MIH proposes is an open and transparent setting for all supply chain members that would shorten the communication routes and ultimately contribute to higher quality products through consequent cost efficiencies. Interestingly, Cheng invokes the supply chain practices of Tesla, the metaphorical "Apple" of electric vehicles, as an example of what MIH strives to achieve. He describes that Tesla breaks the conventional automotive chain archetype by having a direct communication line with all tiers of suppliers, thereby levelling the playing field. Continuing on this theme of equal supplier treatment, Cheng states:

> "That's what we're promoting as well through the working of these members, having an open and even playing field for each of the members so that then they can work directly with the brands or potential customers that would require their technologies. So there is a shorter line of communication and their working together with different players can be more seamless and more integrated, which we believe will lead to better products, and going forward, lower costs as well."

When asked about who MIH would view as their competition, Cheng predicates his answer with the fact that as an open ecosystem, MIH favorably views and even encourages competition within the EV/AV industries, noting that a healthy amount of competition assists the consortium's goals in decreasing time-to-market, lowering prices, and providing a better product for end consumers. Referring to incumbent automakers outside MIH's network, Cheng comments:

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> "Looking at the current automakers, they are making their platforms available only to themselves. And most, they would be sharing it with a different company or two that can share the platform so they can reduce the costs. So, that's great, but what we're doing is we are trying to offer a platform that can be shared by even more players."

In other words, the alternative EV platforms or brand alliances which exist are more protective of their developed technologies and unwilling to share them in the same open way MIH wishes to achieve. Cheng adds, MIH's platform model enables more new entrants, such as capital-constrained startups, to "build on top of what [MIH] offers". Once again referencing Tesla, Cheng points out that the EV industry used to require brands to create everything from scratch via several years of gradual development and capital investment: "It took [Tesla] a long time to get to where they are today." Whereas now, through the open and co-innovative principles of MIH as well as Hon Hai's EV contract manufacturing offer, startups and SMEs are more empowered to step foot into the industry without the same capital and supply chain networking concerns. Just as smartphone and computer brands do today, automotive brands can thus turn their focus towards user experience and product design instead of the "foundation work" pertaining to vehicle manufacture and assembly. In this regard, MIH's approach to competition is not simply sizing up larger incumbent players, but actually fostering the creation of several new ones and diversifying the EV/AV community.

5.1.4 Intellectual Property and the Transparency Imperative

As previously analyzed in the comparison of Android and MIH's governance mechanisms, protection of intellectual property is at the heart of MIH's long-term sustainability. Questions pertaining to MIH's IP protection protocol, intra-ecosystem communication, and Chang's own

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managerial growth were selected with the goal of shedding greater light on the consortium's current governance practices.

Cheng opens his discussion of IP protection by clarifying that MIH views the issue with a less fatalistic lens. "Instead of saying 'protect', we would like to say we would like to respect each of our members' intellectual properties." Cheng continues, the consortium is aware that every contributor member enters an MIH working group with existing IP, which MIH honors as separately developed and thus fully owned by the entering member. With this said, there is an understanding that once a member decides to contribute such IP into a working group project and it undergoes the process to become an MIH recommendation, the member should be willing to license this IP under Fair, Reasonable and Non-Discriminatory (FRAND) principles. Cheng adds that the ideal scenario which MIH pushes for would be members licensing such IP for free. As for IP that is newly developed within MIH's working groups, these will be co-owned between the consortium office and the contributing members, with any future profits generated by the IPs divided amongst these parties.

These rules may sound watertight on paper, but what if a member with significant contribution value to a given recommendation exits unexpectedly, then refuses to share their owned IP under these terms, or in a more severe case, misappropriates IP knowledge attained from their time as a member to develop their own products which would compete against MIH's Project X? What safeguards would MIH have in place for such a scenario? To this harder hitting play at devil's advocate, Cheng clarifies that the MIH office does undergo a due diligence process for each of its working groups and contributor members, wherein the members contractually agree that MIH is authorized to use any relevant IP that becomes published as recommendations and licensable to MIH members, whether they themselves are active members of the ecosystem or not. If during

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this due diligence process, Cheng's team finds that a member is unwilling to agree to these terms, they would need to find an alternative partner who would. No additional comments were made regarding the risk of exiting members misappropriating MIH-owned IP.

As for what Cheng views to be MIH's greatest governance challenge, given the vast scale and geographic diversity of its membership, he stresses the crucial role that transparency plays in MIH's intra-ecosystem dynamics:

> "Since [MIH] is an open alliance and ecosystem, there's definitely a lot of transparency that needs to be shared with a lot of members, for instance. So I think this is no different from running a lot of open-source groups or a lot of standard-setting organizations."

He elaborates that MIH has thoroughly observed and tried to model itself after those previous, very successful standard-setting organizations, from the way they structure their membership and processes to how they encourage discussion within these organizational boundaries. They have found that the key which underlies each of these elements is keeping transparency among the members and actively seeking their feedback. Cheng notes, this method of collaboration is easily embraced by members in the high technology sector, but it tends to push those players embedded in the relatively quiet and opaque realm of traditional automaking out of their comfort zone. MIH currently works to address this discomfort among their automotive members by having them first observe the dynamics of various working groups, choosing one or two that suits them best, gradually opening their level of participation as trust builds, and holding one-on-one meetings to go over any concerns. All the while, Cheng says his team tries to show MIH members that there are clear benefits to openness, such as receival of prompt industry feedback and the ability to influence industry-wide trends for the strategic benefit of one's company. While converting traditional automakers to the open principles of MIH can be time-

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intensive, Cheng and his team believe that it is a worthwhile investment in certain key partners whose knowledge and technologies can benefit the ecosystem.

Finally changing the subject to what Cheng has learned through MIH from a managerial standpoint, he asserts that working for MIH has little difference from working most any other managerial position, just with somewhat different KPI from a more profit-oriented corporation. Returning to the theme of transparency, Cheng notes that one major takeaway managers can learn from MIH is that being transparent within the internal office is just as crucial to consortium performance as between MIH and its members:

> "The consortium is an elite team of 23-ish people managing over 2600 members, so for a lot of information, we need to make sure that we're in sync. So, transparency to the members and transparency within, internally, I think that is a key thing, and really having trust in each other to do the best for the consortium."

5.1.5 Internationalization and Future Growth

At the ending portion of the interview, focus was turned to encapsulating MIH's ambitions for the future, and how Cheng envisions the platform ecosystem will evolve.

Cheng describes that MIH's project scope not only covers the entire vehicle, but also subjects outside the vehicle, such as building better smart cities through starting with the city's vehicles. The variety of vehicle types and vehicular services MIH hopes to contribute standards to is also wide-ranging. For example, MIH aims to create new standards for "movement of people" (ex: ridesharing, public transportation), "movement of goods", and then the underlying infrastructure to support these fleets, such as EV charging stations. Cheng declares that these are the ways in which MIH is targeting the B2B/B2G market and enabling them to adopt greener, smarter transportation technologies.

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Lastly, on the subject of MIH's current level of internationalization and plans for the future, Cheng estimates that as it currently stands, approximately 70% of MIH's consortium members are Taiwanese, while the remaining 30% comprise of international stakeholders. He adds that as of this year, MIH is placing an especial emphasis on growing the international side of the ecosystem. As an example of recent international engagement, Cheng notes that earlier this year, MIH attended the Consumer Electronics Show (CES) in Las Vegas, United States. During that trip, MIH announced its intentions to build a US-based innovation hub in close proximity to Hon Hai's own Ohio EV manufacturing center, with the objective of supporting members in exploring US market opportunities. In fact, MIH has intentions to build multiple other innovation hubs in Southeast Asia, where the consortium can continue to leverage Hon Hai's global footprint and manufacturing capabilities. There is no questioning that per Cheng's description of MIH's roadmap, the platform ecosystem has a multitude of long-term ambitions that depend on healthily governed member dynamics and sustainable performance.

5.2 Summary of Ecosystem Analysis and MIH Interview Key Findings

Synthesizing the collective insights garnered from each analysis segment, a more complete picture of Hon Hai's intentions in the EV industry through founding MIH, the value proposition this platform ecosystem brings to the table, and the diverse challenges the ecosystem must overcome emerges, as shown by the following table:

Table 7: Key Analysis Findings

Dynamic Capabilities Analysis	• For disruptive platform ecosystems like MIH to initiate effectively, due to the target industry's supply chain interdependencies and product complexity, legitimacy signaling is needed at both the internal MNE and external supply chain level.

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	• MIH's attempt to encompass EV software as well as hardware is at odds with Hon Hai's path dependencies, posing a competitive risk due to lack of software FSAs.
Platform Architecture Analysis	• MIH's core platform efficiencies are in supermodular complementarities for product innovation and same-side network effects for B2B relationship building. • The current MIH architecture lacks unique complementarities, which could prove fatal to the consortium once past its product development phase.
Transaction Cost Analysis	• Coordination and opportunism are the primary transaction costs threatening MIH's performance. • MIH's agnostic membership framework results in low switching costs for complementors, making effective hedging against IP opportunism essential to MIH's long-term sustainability.
Governance Mechanisms Analysis	• As evidenced by Android's evolution, governance mechanisms and platform leader archetypes adopted by MIH may require dynamism to reflect changes in resource bottlenecks. • MIH's current governance regime lacks clear guidelines for managing IP/value appropriation conflict resolution and cross-border market discrepancies in law and consumer preferences. • A "dominator" leader approach akin to Android's resource integration must be preceded by a firm market position and lowered industry uncertainty to succeed, both of which MIH does not currently possess.
MIH Office Interview	• MIH seeks to open up the traditional automotive industry through levelling the multi-tiered supply chain, increasing information transparency among all chain members, and enabling SMEs to participate in the market despite resource constraints. • Besides its role as ecosystem founder, Hon Hai serves as MIH's largest donor and a primary candidate for Project X vehicle manufacturing and assembly. • MIH's approach to co-innovation governance includes an internal IP due diligence process and informal socialization mechanisms such as 1-on-1 advising with contributors from the traditional automotive sector. • MIH's long term goals involve expansion in terms of both geography and scope, with an emphasis on attracting foreign-headquartered complementors and participating in smart city development in the coming years.

Source: Compiled by Researcher

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According to the statements made by Hon Hai executives during HHTD events as well as Joe Cheng during this study's MIH office interview, MIH serves as a catalyst for disrupting the traditional, hierarchical, and opaque automotive supply chain in favor of a non-tiered, globally standardized EV value chain, a role which Hon Hai's personal set of collaborative EV ventures cannot achieve alone. MIH provides a modularized think tank for EV innovation that aims to lower innovation costs, time-to-market, and barriers of entry for related firms of any size and technical capability, while also working to achieve the economies of scale necessary for returns on capital-intensive EV production. Complementing firms pay annual membership fees to contribute to MIH standards and patent creation, for which both the office and working group involved can receive proceeds once implemented in EV manufacturing. As founder and main donor to MIH's operations, Hon Hai serves as the primary candidate for large-scale production deals like Project X, thereby also enjoying returns from MIH's co-innovation activities. Arguably, other strategic goals not explicitly expressed by MIH or Hon Hai leadership is also served through the formation of this platform ecosystem. For example, in parallel to the alliance's goal of promoting white label, mass production for EVs, MIH also functions as an exposure mechanism for Hon Hai to secure production contracts from rising EV stars with strong brand equity and design FSAs, such as Apple and their long-rumored Apple Car, or even Tesla, whose components are already primarily procured from Taiwan (MacRumors, 2023; Lu, 2020). Analyst Chang Tai-Tsieh from Taiwan's *CommonWealth Magazine* echoes this possibility in his analysis of Hon Hai's EV efforts, stating that the company's vision mimics TSMC's semiconductor model in that it seeks to provide EV "fab" services to "fabless" EV brands (Chang, 2023). Since Apple and Tesla both represent closed-loop ecosystems in their own right, however, the effectivity of leveraging an open-source EV alliance to attract these brands to Hon Hai's EV manufacturing services is up for debate.

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Hon Hai's decision to establish MIH as an extension of its "3+3 Model for Transformation" not only demonstrates the firm's prompt sensing of market saturation and stagnating profits in handheld consumer electronics, but also their ability to seize new sector opportunities via leveraging of the firm's FSAs in rapidly launching a series of JVs, cross-border MoUs, and Hon Hai Research Institutes, with MIH's founding as the culmination of it all. The dynamic capabilities comparison of Android and MIH further shows that for high technology sectors characterized by complexity and interdependency of stakeholders, the legitimizing process requires external signaling as much as internal signaling. Hon Hai achieved this dual signaling through first aligning its management under the 3+3 model, investing in EV ventures with partners of relevant field expertise, then publicly instituting an annual "Hon Hai Tech Day" to showcase the progress of their initiatives.

According to this study's comparative analysis, the factors which make MIH's origins, value proposition, and governance structure contrast to Android are essentially threefold. First, MIH's attempt to encompass EV software as well as hardware is at odds with Hon Hai's hardware-centric path dependencies. Where Google adopted Android as an enhancer to their existing software FSAs, MIH must pioneer the challenges of EV software standardization without prior experience or precedent from its founder, posing a competitive risk for the consortium. Second, the complementarities embedded in MIH's platform architecture are supermodular, with no unique complementarities to heighten platform switching costs or sustain consortium membership once past the product R&D phase. While Android was able to attract complementors with a uniquely supported OS development kit and then sustain its ecosystem through co-specialization, MIH's value proposition is largely dependent on the effects of aggregated complementor expertise and resources to make Project X a reality, itself only providing auxiliary consulting services and B2B

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networking opportunities for its collective membership. Combined with MIH's agnostic approach to member entry and exit, this foreseeably increases the risk of frequent complementor exits, including those essential to working group progress, and even mass member exodus. Third, while Android and MIH both face coordination and opportunism risks as their primary transaction costs, the heavily localized nature of EV value chains, legal policy, and consumer preferences requires a more intricate governance regime than Android's primarily globally integrated OS. Moreover, MIH is not in a strategic position to horizontally or vertically integrate resources as Android has done and must consider the stance of complementing members against scope creep. Especially if MIH is to realize the smart city and international expansion goals Joe Cheng expressed as the consortium's future plans, a clear set of guidelines for market selection, managing these target markets' discrepancies, and resolving IP and value appropriation conflicts among a multinational set of contributor members will be essential to long-term success.

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CHAPTER 6 CONCLUSION

6.1 Concluding Recommendations

This study contends that the long-term future of MIH, Project X, and any future endeavors will hinge upon addressing the organizational weaknesses of the platform ecosystem's current value proposition and governance regime. The following is a series of recommendations that could strengthen MIH's performance and stabilize Hon Hai's EV market entry while also protecting the interests of complementing firms in the MIH ecosystem.

6.1.1 Forging an Interdependent Value Proposition Through EV Bottleneck Capture

In addressing MIH's current lack of unique complementarities, it is recommended that founder Hon Hai identify a narrow but focused list of which EV manufacturing components have the most synergies with the MNE's existing FSAs and capabilities, and rate each based on their technical feasibility, cost structure (i.e., achievable margin after production costs), and level of importance to the EV's composition. With such a scorecard in hand, Hon Hai can then prioritize their R&D efforts on capturing a specific EV resource bottleneck that would compel industry players to establish an interdependent relationship with them, either through MIH's Project X or directly with Hon Hai's contract manufacturing services. Components which rank lower in technical feasibility through Hon Hai's own FSAs can alternatively be delegated to the appropriate MIH working group for collaborative experimentation.

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Table 8: Balanced Scorecard Example for Hon Hai EV Resource Bottleneck Prioritization

Percentage weight: *	Technical Feasibility	Cost Structure	Importance to EV production	Score Total:
	30%	30%	40%	
Unibody E-Powertrain				
Heat Dissipation technology				
Solid State Battery				

*Weights adjustable depending on Hon Hai's chosen scoring strategy

Source: Compiled by Researcher

Given the highly dynamic nature of the global EV industry and its development, close market monitoring of each targeted component is advised, including a quarterly analysis of both Hon Hai and MIH's R&D progress and an updated scorecard to reflect both internal and exogenous market changes.

6.1.2 Selective Regionalization of MIH Office Staff and Consortium-Wide Activities

While MIH seeks to unify EV markets across the globe through universal standards and components for EVs, the alliance's governance system should nevertheless recognize the localization factors still required in effectively deploying new standards in different markets. Along these lines, a more streamlined, formalized process of Project X market selection that involves both the MIH Office and working groups should be established. The selected market or markets should subsequently be supported by an appointed advisory team dedicated to that region, which will be tasked with directing working groups on technical specification addendums needed atop established component standards as well as facilitating dialogue with government stakeholders in the target market. These market advisory teams need not necessarily function as

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another reviewing body in the existing standard proposal process, but rather as an intermediary between target market stakeholders and MIH working groups for finalizing manufacturing deals, mitigating coordination costs for regionalized Project X delivery.

Additionally, to fortify MIH's values and EV vision across the platform ecosystem's vast and geographically diverse membership, socialization activities at a regional/market level would be a strong addition to the consortium's primarily technical field-based activities. In parallel to MIH's gradual addition of regional branch offices or research hubs, less capital-intensive programs such as forums centered on localized EV issues could be arranged according to MIH's current target markets, geographic member distribution, and expressed member interest as acquired through surveys and other forms of feedback. Recognizing that MIH's administration and membership currently remains predominantly Taiwanese, a concerted effort to offer regional perspectives an equal share of dialogue would increase cross-border trust and affinity, thereby lowering the risk of member opportunism while simultaneously drawing additional international members into the alliance.

6.1.3 Formalized IP Conflict Resolution for Dynamic Resilience

The last but certainly not least of MIH's governance concerns is the risk of working group disruption and IP or value appropriation conflict arising from complementing members *prior* to the publishing of a licensable MIH patent or standard. While the due diligence process described by Joe Cheng may serve as a preliminary filtration system of contributors who agree to permanently license IP for MIH standards once published, the option to reject IP license granting in MIH's publicly viewable patent declaration form indicates that such due diligence cannot remove the possibility of licensing conflict for standards in progress. Should MIH's due diligence protocol not already include it, it is strongly recommended that MIH prepare an out-of-court, third-

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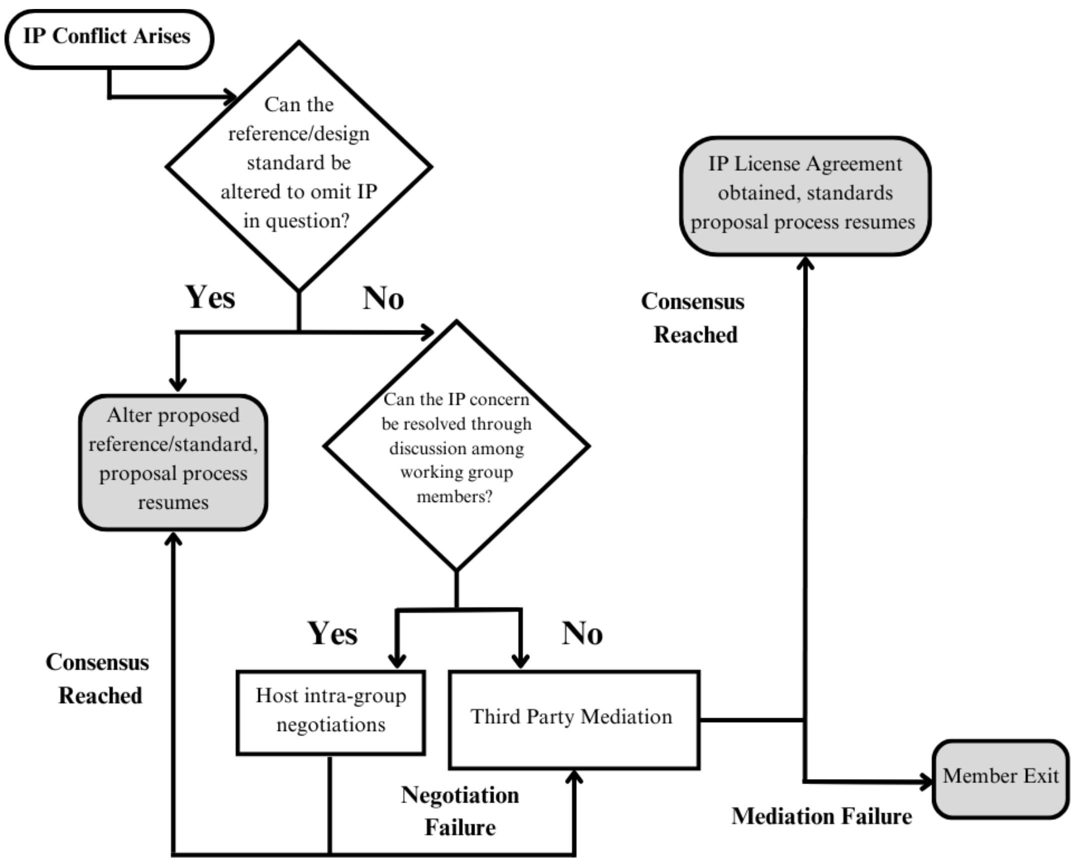
party mediation option to prevent contributor exit by seeking equitable resolutions to pre-published standard licensing conflicts.

To provide a more specific example of what a formalized conflict resolution protocol could look like, the following is a recommended flowchart for IP conflict management based on the methods briefly listed under MIH's "About MIH Consortium" page, this time incorporating third party mediation as a final safeguard:

Figure 16: Recommended Flowchart for MIH IP Conflict Resolution



Source: Compiled by Researcher

6.2 Research Limitations

The above study and analysis of MIH and Android was limited to a combination of one MIH office interview and publicly available information. As such, this research report did not have

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access to the exact composition of MIH's fourteen working groups, including the number of contributors in each group and the composition of Taiwanese versus internationally headquartered firms. Quantifiable data on the geographic, size, and scope distribution of MIH's 2,600+ members could provide additional evidence as to what profile of firms MIH appeals to, in what fields of EV MIH currently possesses the most resources, and what regional or field-based gaps exist in MIH's network and should be investigated as part of MIH's future recruitment efforts. For the governance mechanisms analysis, there is a possibility of undisclosed decision-making protocols and history within MIH pertaining to conflict resolution and market analysis that could have better elucidated the MIH office's full spectrum of governance strategies. A reliable source detailing Android's internal trust-based governance mechanisms, such as Android office working culture and employee socialization, also could not be found.

Due to the rapid dynamics of the global EV industry and MIH's own co-innovation progress, new information is frequently made available to the public. As a natural consequence, readers should not regard this research as a comprehensive and unchanging analysis of MIH and are encouraged to seek supplementary updates and insight from reputable industry sources.

6.3 Proposed Areas for Future Research

As the fields of vehicle electrification, automation, and digitization continue to thrive, there are several areas where further research would prove especially useful in contextualizing global EV development and the success factors of high technology co-innovation entities such as platform ecosystems. A comparative study of different nations' legal policies towards EV safety and production could help illuminate a pathway for establishing globally accepted component specifications as well as what obstacles may be present for standardizing EV manufacturing. Extending a dynamic capabilities and transaction cost analysis towards the EV transition efforts of

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traditional automakers may also provide deeper understanding as to the advantages and shortcomings of navigating vehicle electrification as an incumbent rather than a new entrant. The past decade's surge of startups pertaining to electric and autonomous driving provides ample case examples to investigate causes of EV/AV business model failure from the lens of international business theory. A final proposed subject for continued research is the analysis and comparison of other conventional sectors that, in the context of digital transformation, have turned to platforms or intra-industry alliances as a means of accelerating business development. Pinpointing the commonalities and differences platform ecosystems of varied sectors exhibit, both in terms of strengths and weaknesses, would help scholars and managers alike better understand which benefits/risks are inherent in the platform ecosystem structure, and which derive from industry-level characteristics.

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Appendix A: Timeline of Hon Hai's EV Industry Actions

- 2016
    - July 2016: founded Future Mobility with Tencent and Harmony New Energy Auto (renamed Byton in 2017 and filed for bankruptcy in 2021)
- 2019
    - June 2019: Young Liu named as Hon Hai's new chairman effective July 1st
    - H2 2019: Hon Hai announced "3+3=∞ Model for Transformation"
- 2020
    - January 2020: initiated talks with Fiat Chrysler Group to collaborate on EV production
    - March 2020: signed strategic cooperation agreement with Yulon Motors, JV named "Foxtron"
    - June 2020: established Hon Hai Research Institute
    - October 2020: held Hon Hai Tech Day, introduced MIH alliance
    - November 2020: published "Invitation for Open EV Partnership"
- 2021
    - January 13th, 2021: entered strategic cooperative agreement with Geely Holding Group to establish JV for EV OEM and customized consulting services
    - January 15th, 2021: MIH executive leadership appointments announced
    - February 2021: announced agreement with Fisker Inc to jointly produce over 250,000 vehicles a year
    - March 2021: Foxtron announced strategic cooperation with Nidec in electric vehicle key component development
    - May 18th, 2021: formed JV with Stellantis (merger of Fiat Chrysler Group and Groupe PSA) for developing digital cockpits and personal connected services
    - May 31st, 2021: PTT and Foxconn form JV for electric vehicle production
    - June 23rd, 2021: partnered with Gogoro to accelerate expansion of Gogoro's battery swapping system and smart scooters
    - June 25th, 2021: MIH held Consortium Opening Event, announced next level operating model
    - June 2021: invested approximately 36 million USD in Gigasolar Materials Corporation to develop EV battery materials
    - July 2021: Foxconn partners with CTBC Financial Holding Co to create new fund targeting EV investments
    - September 2021: PTT and Hon Hai celebrate JV milestone with plans to establish fully integrated vehicle production in Thailand
    - October 2021: agreed to purchase former GM auto plant from Lordstown Motors and 50 million USD of Lordstown common stock, with the aims to repurpose plant for manufacturing Endurance pickup trucks and Fisker vehicles

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- October 18th, 2021: 3 Foxtron EV prototypes (Model C recreational vehicle, Model E sedan co-designed with Pininfarina, Model T electric bus) unveiled during HHTD 2021
- November 11th, 2021: strategic partnership with Lordstown Motors announced
- December 2021: signed MoU with Stellantis to design and sell semiconductor chips for automotive industry

- 2022
  - January 2022: signed MoU with Indonesian Ministry of Investment, IBC, Indika, and Gogoro to jointly develop new energy ecosystem in Indonesia
  - January 21st, 2022: MIH announced EV Kit technical specifications
  - May 2022: completion of Lordstown purchase,
  - July 2022: partnered with NXP to develop next-generation vehicle platforms
  - August 9th, 2022: partnered with Monarch Tractor to build next-generation Agri-tech equipment
  - August 19th, 2022: showcased Monarch MK-V Tractor prototype at Ohio facility
  - September 2022: Indika and Hon Hai form JV named "PT Foxconn Indika Motor" (FIM) for Indonesia EV ecosystem development
  - October 6th, 2022: signed MoU with INDIEV to produce INDI One EV prototype
  - October 18th,2022: HHTD 2022 unveils two new EV prototypes and a self-developed EV Operating System
  - November 3rd, 2022: Ceer, a JV between Hon Hai and Saudi Arabia's Public Investment Fund (PIF), established to create first Saudi Electric Vehicle brand
  - November 8th, 2022: CEO Jack Cheng unveils Project X at MIH Demo Day
  - November 12th, 2022: HORIZON PLUS, the JV between Hon Hai and PTT, holds groundbreaking ceremony for EV manufacturing facility in Thailand
  - November 15th, 2022: FIM agreed to donate 5 electric buses to support G20 and B20 events in Indonesia
- 2023
  - January 2023: Hon Hai names Mr. Jun Seki as Chief Strategy Officer for EVs
  - April 4th, 2023: Hon Hai completes production of first five Monarch MK-V tractors in Ohio
  - April 14th, 2023: MIH CEO Jack Cheng states Project X 3-seater completion anticipated as early as October, mass production to potentially begin in 2025
  - May 2023: Hon Hai signs MoU with German semiconductor firm Infineon to partner on silicon carbide (SiC) development for automotive solutions

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Appendix B: MIH Office Interview Questions

1. Please describe from your own experience how Mobility in Harmony came to be. What internal discussions occurred leading up to the announcement of MIH on Hon Hai Tech Day 2020? What are the major concerns? How did Hon Hai legitimize the idea within its management teams, and how were personnel such as yourself selected for MIH leadership?
2. Why did Hon Hai choose to create MIH when it is already engaging in several electric vehicle joint ventures, including international projects based on the "Build, Operate, Localize" (BOL) model? [note: I don't see any JV partners, such as Stellantis, PTT, Geely Holding Group, or Lordstown Motors on the MIH membership directory]
3. Who will be manufacturing MIH's Project X vehicles? A news article suggested PTT, but they are not MIH members, does this tie into MIH's relationship with Hon Hai?
4. Please describe the relationship Hon Hai currently has with the MIH consortium. Since becoming independent in the summer of 2021, how does Hon Hai interact with MIH, and vice versa? Does Hon Hai still hold an equity stake in the consortium?
5. Since MIH's inception, what have been the top three greatest accomplishments of the ecosystem? How have you witnessed MIH positively impacting the global EV/AV industry?
6. Who, if anyone, does MIH perceive to be its competitors? For example, Tesla is often invoked as the closed-loop platform counterpart to MIH. Are there other outside industry players that may potentially be at odds with MIH's objective?
7. How does MIH protect its ecosystem from an intellectual property standpoint? How does MIH protect the IP of its individual members?
8. From your perspective, what is the greatest governance challenge MIH faces, given its vast membership of 2600+ firms spanning 70 countries/regions to date?
9. What is a managerial lesson you have learned being part of the MIH office?
10. Please describe how you envision MIH's future. What do you see the consortium achieving five years from now? What challenges do you foresee MIH will need to overcome?

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