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## Leveraging university research within the context of open innovation: The case of Huawei

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### ABSTRACT

The emergence of 5G and the trade dispute between China and the United States have made Huawei a global hot topic. Owning 37% of the patents, Huawei is undoubtedly one of the key players in the development of 5G. For both governmental policy-makers and business decision-makers, an in-depth understanding of this rapidly growing manufacturer is therefore of significant implications to formulate 5G policy and strategies. Given the lack of systematic studies of how Huawei has grown from a local technology follower to a global technology leader in less than three decades, this paper provides a comprehensive review of Huawei's practice in implementing open innovation. Open innovation is perhaps one of the most powerful key factors behind Huawei's rapid development. The findings shed new lights on the use of open innovation governance models and how to source and work with academic partners. The implications of Huawei's case will also be discussed.

### 1. Introduction

Although Huawei has been the market leader for telecommunications manufacturing as early as 2012, it has attracted global attention only since 2018 when China and the United States began to have intense trade dispute. Huawei's competitiveness in telecommunications equipment manufacturing, 5G system in particular, has raised curiosities, if not concerns, among government policy-makers and business decision-makers.

Comprehensive studies analyzing the competitiveness of Huawei at fact-based evidences are henceforth important. First, it can identify where Huawei's innovations come from; Second, it can alleviate concerns of some governments and companies if Huawei's competitiveness is an outcome of a market-orientated innovation scheme; Third, it can explain different aspects of Huawei's open innovation practice which could be useful for other companies in other countries to learn from. As technology, in addition to market and regulation, is one of the three threads surrounding China's telecommunications reform (Xia, 2017), a clear understanding of Huawei, or China's home-grown manufacturing, is critical to understand China's telecommunications industry.

In the existing literature, what has contributed to Huawei's growth and its subsequent success remains unanswered (Whalley, 2016). Since the outbreak of the US-China trade war, Huawei's fast growth is argued to be the result of the Chinese government's financial assistance (Yap, 2019), and some even argue that Huawei's majority shareholder, the "trade union committee", is owned by the government (Balding & Clarke, 2019). But these were not well-founded, as Huawei did not receive special funding from the Government (Li, 2019a) and the trade union committee is made up of Huawei's employees (Li, 2019b). Moreover, the existing literature does not support that government backing can enable a firm to grow into a global technology leader. Empirical findings on the impacts of government support on a firm's innovativeness are inconclusive (Guo, Guo, & Jiang, 2016). Government support in R&D can boost the innovativeness on the industry level and improve the local economy by facilitating collaboration and providing a favourable growth environment (Li & Wu, 2019). Though a firm may benefit from government support (Joo, Seo, & Min, 2018), the

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benefits vary on the firm level (Szczygielski, Grabowski, Pamukcu, & Tandogan, 2017; Wang, 2018). New companies are more likely to benefit from government support and achieve better innovation performance than well-established companies (Wei & Liu, 2015), and small and medium-sized companies are more likely to improve innovativeness than large companies (Guo et al., 2016). Therefore, the existing literature indicates that government support alone cannot explain Huawei's fast growth.

Instead, the literature indicates that Huawei's long-term commitment to investing in R&D is one of the key success factors of Huawei's technological leadership (Tao & Wu, 2015; Cui and Liu, 2019). In this paper, we argue that Huawei's open innovation strategy is one of the key enablers of Huawei's move from a technology follower to a technology leader.

Following the literature review and research methodology sections, we will briefly introduce Huawei's R&D-orientated development strategy, and then identify the challenges that Huawei faced in cooperating with university scholars when it took open innovation approach. On that basis, the paper will introduce and analyze the systematic scheme that Huawei has developed, namely Huawei Innovation Research Program (HIRP). This will be followed by a discussion of Huawei's experiences on how to facilitate the collaboration between industry and academia, which is of significant implications for governmental policy-makers and business decision-makers in order to build an effective ecosystem that can facilitate open innovation.

## 2. Literature review on open innovation

Open innovation was first introduced by Chesbrough (Chesbrough, 2003) and has become a widespread business practice (Chesbrough & Brunswicker, 2014). It refers to "a distributed innovation process based on purposively managed knowledge flows across organizational boundaries." (Chesbrough et al., 2014) Different from traditional closed innovation where companies invested a large amount of resources to develop their own labs and R&D capabilities, open innovation breaks the organizational boundary to open up a company's internal innovation processes to the inputs and contributions from external parties and to export their unused ideas to other companies to use (Chesbrough, 2003).

Open innovation can be inbound (Bogers, Henry, & Moedas, 2017), outbound (West & Bogers, 2014) or a combination of inbound and outbound (Pillar and West, 2014; Stanko et al., 2017). Most studies focus on inbound open innovation and discuss how a company can open up its innovation process to different kinds of external inputs and contributions (West & Bogers, 2014, 2017; Randhawa et al., 2016). The inbound open innovation has three major steps: The first step is to obtain innovation from external resources, including searching, sourcing, incentivizing and contracting; the second step is to integrate innovations by identifying and handling those enabling and inhibiting factors of integration; and the third step is to commercialize innovations. These steps are not linear which requires an interaction mechanism to include feedback loops, reciprocal interactions with co-creation partners, and integration with external innovation networks and communities (West & Bogers, 2014).

Large firms normally have more inbound than outbound open innovation and are net takers of free knowledge flows, partly because of their concerns of IP protection for outbound knowledge (Brunswicker & Chesbrough, 2018). Modest, not excessive, formal appropriability mechanisms have positive impacts on innovation collaboration, because they can prevent conflicts over ownership of jointly developed knowledge assets and knowledge leakages and avoid the possibly negative effects of overly strict controls by legal departments on innovation collaboration (Miozzo, Desyllas, Lee, & Miles, 2016).

More recently, the contingencies of open innovation processes have received increasing attention (Cassiman & Valentini, 2016). Innovation is no longer seen as a linear process and requires the users to give feedbacks to producers on what kinds of innovation is needed (Bogers, Afuah, & Bastian, 2010). It becomes critical to develop an ecosystem to enable co-creation among people, organizations and sectors (Gawer & Cusumano, 2014), and the most interesting disruptive innovations are often the results of cross-disciplinary and cross-sector researches (Bogers et al., 2017). However, the collaboration is complicated. The university-industry collaboration is such an example. Companies want to gain competitive advantages by protecting their technologies, but academic recognition depends on the publication of the research results. Companies' R&D efforts are more product-oriented and time sensitive, but academic research focuses more on fundamental research to solve long-term challenges which takes time to produce research results. Moreover, companies often pursue the collaborations with universities in an ad hoc, piecemeal manner, based on individual initiatives rather than systematic corporate strategy, leading to duplication of effort, lost opportunities and squabbles over intellectual property (Perkmann & Salter, 2012, pp. 79–88).

Additionally, the human side of open innovation emphasizes the interaction between individual and organizational capabilities and the focal organization's readiness mechanism to welcome and adopt open innovation practices (Salampasis and Mention, 2017). Existing research has found that improving a company's internal absorptive capacity processes to shape the ability to leverage external knowledge sources can enhance its open innovation strategies' effectiveness (Flor et al., 2017). But one of the challenges open innovation faces is the not-invented-here (NIH) syndrome. This refers to "a negative attitude toward knowledge (ideas, technologies) derived from an external source" (Antons & Piller, 2015), which can be caused by organizational inertia and structural rigidity. NIH is related to an individual's irrational devaluation or rejection of external knowledge, independent of organizational culture.

This paper uses Huawei's open innovation platform as an example and contributes to our understanding of open innovation in the following ways.

First, in response to Robert Solow's query that "we see the computer age everywhere except in the productivity statistics" (Solow, 1987, p. 12), a successful business model should include both value creation and value capture. Research on external sources of innovation has emphasized on sourcing innovation while ignoring making a profit from those innovations. Thus, much research is needed on capturing value from external sources, including explaining the difference in value capture between projects and companies (West & Bogers, 2014). Though innovation does not create the same results across organisations and people (Bogers et al., 2017), Huawei is a good example to show that the company's continuing investment in innovation in general has so far paid off. This paper

gives a structured, comprehensive picture of Huawei's open innovation ecosystem, a showcase of how a company can systematically benefit from open innovation projects and research partnerships and successfully develop from a technology follower to a technology leader.

Second, Huawei's case study shows possible solutions to some controversial issues encountered in open innovation. Since valuable external knowledge will not automatically and easily flow into companies (Vanhaverbeke and Cloudt, 2014), searching for partners is a major issue in open innovation (Bogers et al., 2017). Existing literature suggests using keywords in relation to key roles and activities to develop network visualization and semantic algorithms to enable organisations to search for open innovation partners (Meulman, Reymen, Podoyntsyna, & Romme, 2018). Huawei not only shows an effective way to search and work with academic partners, but also gives a possible solution to handle the issues commonly seen in open innovation, such as the university-industry collaboration and the Not-Invented-Here Syndrome.

### 3. Research methodology

The purpose of this study is to explore how and why Huawei has used open innovation to quickly move from a technology follower to a technology leader. This research is a qualitative case study. Qualitative study helps us to seek answers to the "how" and "why" questions (Yin, 2003), and the case study approach allows us to collect rich data from different stakeholders and study different aspects of Huawei's open innovation (Yin, 1994).

The data used in this research were collected from both primary and secondary sources. Primary data were collected through interviews, observations during the company visit and attending company presentations. We conducted in-depth interviews with the senior managers of HIRP, principal investigators and university professors on the HKUST campus, most of which were one-to-one interviews, each lasting at least 1 h. We had two group interviews with Huawei's engineers at Huawei's headquarters in Shenzhen, as well as a number of informal group discussions with the HIRP team. All the interviews were recorded with the permission of the interviewees. The sources of secondary data mainly came from Huawei's company reports and internal documents, industry reports, websites, books, newspaper and journal articles. The data from group interviews were triangulated with the data from the secondary sources and informal discussion in order to make research findings and conclusions more accurate and convincing (Yin, 2003).

While designing this research, we have taken into account three main limitations of using the case study approach, including representativeness, subjectivity and generalization. Stake (1994, p. 236) argues that a case study's potential for learning is a different and sometimes superior criterion to representativeness. We chose Huawei because Huawei's HIRP is a successful case of using open innovation. This case is instrumental in nature, which can deepen our understanding of the challenges facing open innovation management in commercial companies, such as the academic-industry relationship and Not-Invented-Here Syndrome. Huawei's ways of handling of these issues should be useful for other companies. To make our research conclusions more accurate and convincing, we shared our findings with interviewees in Huawei and universities to seek verification and clarification. We refined our findings based on their feedbacks.

### 4. Huawei's R&D-orientated strategy

Founded by Ren Zhengfei in 1987 with an initial investment of US\$2,533, Huawei has grown from a sales agent for telephone switches into the world's leading information and communications technology (ICT) solutions provider. The company owns the largest number of patents in China and ranks among the top worldwide. By the end of 2018, the company owns 87,805 patents, presents in over 360 standards organisations, industry alliances and open source communities with over 300 key positions and 54,000+ proposals submitted (Huawei, 2018; Annual report of Huawei, 2018). In 1992, Huawei launched their C&C08 digital telephone switches, the first major product developed in-house. In 1997, the company made its first move into an international market by providing fixed-line network products to a Hong Kong operator. In 2012, Huawei overtook Ericsson and has been the largest telecommunications equipment manufacturer in the world (The Economist, 2012).

In 2019, Huawei ranked #61 among the Fortune Global 500 companies and became the first Chinese company named amongst the Top 100 Best Global Brands by Interbrand@ in 2014. Today, Huawei has more than 170,000 employees with products serving one-third of the world's population across 170 countries. 75% of Huawei's overseas employees are non-Chinese (Annual Report of Huawei, 2018). LinkedIn identified Huawei as one of the world's 100 Most In-Demand Employers.

Huawei's growth has been driven by customer demand and technology push. R&D has always been the priority to the company. When it was first established, Huawei decided to leverage its own R&D capabilities to make switches and compete with international telecommunication companies. This was very different from other Chinese companies, which normally formed joint ventures with foreign companies to acquire technological know-how and manufacturing competence (Mellor, 2015).

By the end of 2018, more than 80,000 employees, representing 45% of Huawei's total employees, are engaged in R&D. On the operational level, the Productions and Solutions Department was established in 2014 as a centralized, product-oriented R&D platform to respond to market trends. On the strategic level, Huawei has a so-called "2012 Lab" to focus on developing future technologies of strategic significance. The Lab is regarded as the innovation engine of Huawei, leading the company's future product development. Huawei has developed 28 innovation centers worldwide to leverage global resources to better understand local markets and generate innovative ideas. Huawei is highly regarded as an innovative company (Wagner, Taylor, Zablit, & Foo, 2014).

As a key player in the ICT industry, Huawei has made long-term investments in basic research to drive the industry forward. This is our unshakable commitment to the industry. Over the past 26 years, we have invested at least 10% of our annual sales

revenues in R&D every year. Just last year, Huawei spent 14% of its annual sales revenue on R&D. We also allocate 10% of our total R&D investment on future technologies research.

Ryne Ding, President of Products and Solutions, Huawei (Ding, 2015)

Huawei is well aware that it needs to change from a technology follower to a technology leader. To enhance its research capabilities and strengthen its industry leadership in telecommunications and networks, Huawei has emphasized on open innovation and win-win research collaborations as the most efficient and cost-effective way to achieve technology and industry breakthroughs.

Starting as early as 1999, Huawei Science and Technology Fund was established to sponsor industry-related projects in universities. It is Huawei's firm belief that academic research has historically been, and still is, an essential source of high-impact innovation [Table 1].

To further strengthen collaborative research efforts with academia on the development of cutting-edge technological innovations in a more systematic way, the Huawei Science and Technology Fund was reshaped into Huawei Innovation Research Program (HIRP) in 2010. HIRP has developed a sustainable system that allows Huawei engineers to successfully collaborate with academic partners at top universities to solve complex technical problems in a timely and cost-effective way.

## 5. Open innovation at Huawei

As mentioned above, Huawei Science and Technology Fund was established as early as 1999 to sponsor industry-related projects in top universities of mainland China. In 2004, Huawei started looking for university partners outside mainland China and launched the first project with the Hong Kong University of Science and Technology (HKUST).

While running the Huawei Science and Technology Fund, Huawei encountered many challenges common to open innovation:

### 1) What project topics to pursue through open innovation?

Enterprises seek holistic, birds-eye-view solutions, while academics develop expertise in a single discipline (with limited access to alternative angles for development). To be a technology leader, rather than simply providing research funding, Huawei aspires to get more deeply involved in defining research directions that will result in win-win outcomes for both the company and academic partners. Huawei is keen on the latest research findings and the hottest research topics in academia because the company can quickly identify emerging trends and potential collaboration partners.

### 2) Whom to work with? How to identify right experts?

Huawei had limited knowledge of "who knows and does what" in the academia. Huawei had to spend a lot of time and effort to look for suitable research partners. Sometimes projects had to be canceled because no suitable partners were found. There was no established communication channel between research universities and Huawei.

### 3) Once experts are identified, how to get them on board? How to deal with mismatched expectations and motivations?

Even if potential partners were identified, Huawei had to find a way to deal with mismatched expectations and motivations. For instance, academic researchers tend to spend a lot of time pursuing novel research with rigor while companies prefer conducting rapid research with good enough results. This remarkable difference can be a point of conflict. Both parties should have shared objectives and outcomes; otherwise, trust and collaboration will be compromised.

Professors are very good at theories and may not consider the challenges of mass production. They tend to use the most advanced technologies to build the prototype without considering the commercial value. They may not fully understand the importance of meeting tight deadlines during the product development process. All in all, I think we benefit most from their theoretical guidance and broad thinking.

Xiaolong Luo, Senior Engineer, Products and Solutions

**Table 1**

Telecommunications innovations from universities.

Year	Name of Company	Academic Leader, Name of University	Achievement
1965	IBM	John Tukey, Princeton University	Fast Fourier Transform as a breakthrough in signal processing
1987	Apple	Avie Tevanian, Carnegie Mellon University	Mach Microkernel as the operation system (OS) later being developed into Apple's Mac OS.
1999	CISCO	Nick McKeown, Stanford University	12,000 Core Router iSLIP traffic management algorithm to strengthen Cisco's leading position in high-end routers.
2008	Huawei	L. V. Chao, Hong Kong Polytechnic University	100G Optical Network Prototype as the world's first vendor displaying such prototype.

Sources: Information provided by Huawei.

- 4) How to monitor project progress? What should be the right collaboration model? To what extent should the focal company control the process?

There was a need to develop an effective and efficient communication channel to save both Huawei's engineers and academic partners' time and efforts spent on communications and to ensure that the project could proceed as scheduled and produce quality research results on time.

- 5) How to evaluate project outcomes?

We find it difficult to evaluate the intangible assets. How to choose proper key performance indicators? How to use objective criteria to evaluate research outcomes? These are difficult questions. While problem-solving research projects can be assessed using project specifications, we need to be more flexible for those explorative projects in terms of setting targets and exchanging ideas. Like futures, sometimes we are not sure whether the project is necessary and whether real demand exists.

Edward Lin, former Head of Huawei's Technology Cooperation Department (Lin, 2015)

While Huawei knew how to evaluate problem-solving-oriented projects, it did not know how to evaluate exploratory-type projects particularly in the areas unfamiliar or uncharted.

- 6) How to integrate project outcomes with existing processes and knowledge?

It was important for Huawei to absorb, not just benefit from, the research knowhow of academic partners so that it could enhance its research capability. Another issue was to integrate academic research outcomes with existing knowledge bases so as to improve products and services.

## 6. HIRP program: A systematic way to manage open innovation

In response to these challenges, Huawei established Huawei Innovation Research Program (HIRP) in 2010. In 2014, HIRP's open innovation platform became alive at <http://www.huawei.com/hirp>.

HIRP has produced great open innovation results. For example, in 2012, the algorithm model co-developed by Huawei's Internet Protocol Television Team led by Professor Yang at Xi'an Electronic Science and Technology University became the core part of two International Telecommunications Union (ITU) standards.

HIRP is a systematic way to manage collaborative research projects from initiation to evaluation. Each project has its own project management team to ensure that the project is kept on track.

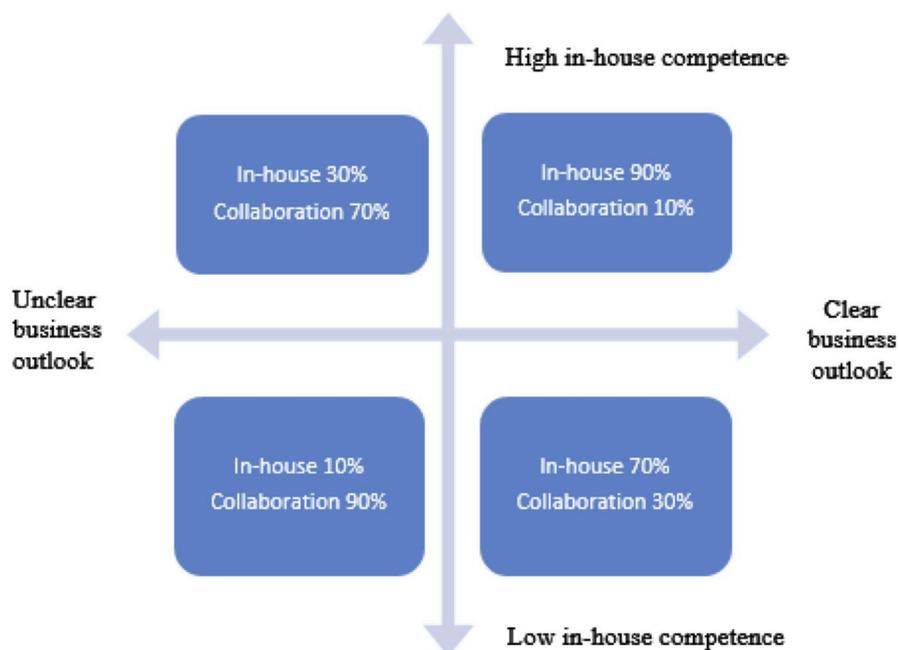


Fig. 1. Research project decision-making.

### 6.1. Project selection

Every year Huawei makes a strategic plan based on its experts' forecast of future technological development trends, customer demands, and existing R&D issues in hand. Accordingly, every department sets its own research objectives and assigns them to individual engineers. Individual engineers then decide whether to fulfill their research objectives through external research collaboration or not.

When we consider whether to look for external research collaboration, we consider these questions: Do we have enough internal resources and facilities? Can the outputs benefit from external help? Who are the experts? Whether the money invested is worthwhile? Also, since the timeline is not easily controlled, we normally will do urgent projects in-house.

Freddy Fu, Senior Engineer, The 2012 Lab, Huawei

Huawei has a model to help make this decision [Fig. 1]. Taking into account the requirements of academic partners, the decision is based on whether Huawei possesses the internal expertise to tackle the research target and whether the collaborative research efforts are new technology exploration which may benefit the ICT industry in the future. Huawei tends to seek collaboration for those research targets with insufficient in-house research capabilities and research targets that cover previously unexplored business opportunities.

Next, if external research collaboration is preferred, individual engineers can propose a research collaboration project to his or her departmental evaluation committee. In evaluating a project proposal, the committee takes into account its departmental research objectives and budget.

If a research project proposal is approved by the departmental evaluation committee, the project will be classified as a HIRP Flagship or HIRP Open project. HIRP Flagship is an invitation-only call for proposals, targeting world-class researchers in top universities and research institutions around the world. HIRP Flagship offers large-scale, multi-year contract-based awards to support research projects that are of significant strategic importance. In 2015, for example, Huawei initiated a two-year Flagship project with the University of Manchester to explore the applications of graphene in the ICT industry.

HIRP Open calls for more forward-looking projects with the aim to exploit new research areas that are unfamiliar but potentially important to Huawei. At least once a year, HIRP issues a call for HIRP Open proposals on the HIRP's website that includes a list of research topics pre-identified by Huawei. HIRP Open also takes in research proposals on non-listed topics just to make sure they do not miss potentially good topics. Upon receiving proposals, Huawei Technical Experts Group consisting of senior researchers conducts a formal review to evaluate the proposals. Former HIRP Open participants with good results are invited to HIRP Flagship for longer-term

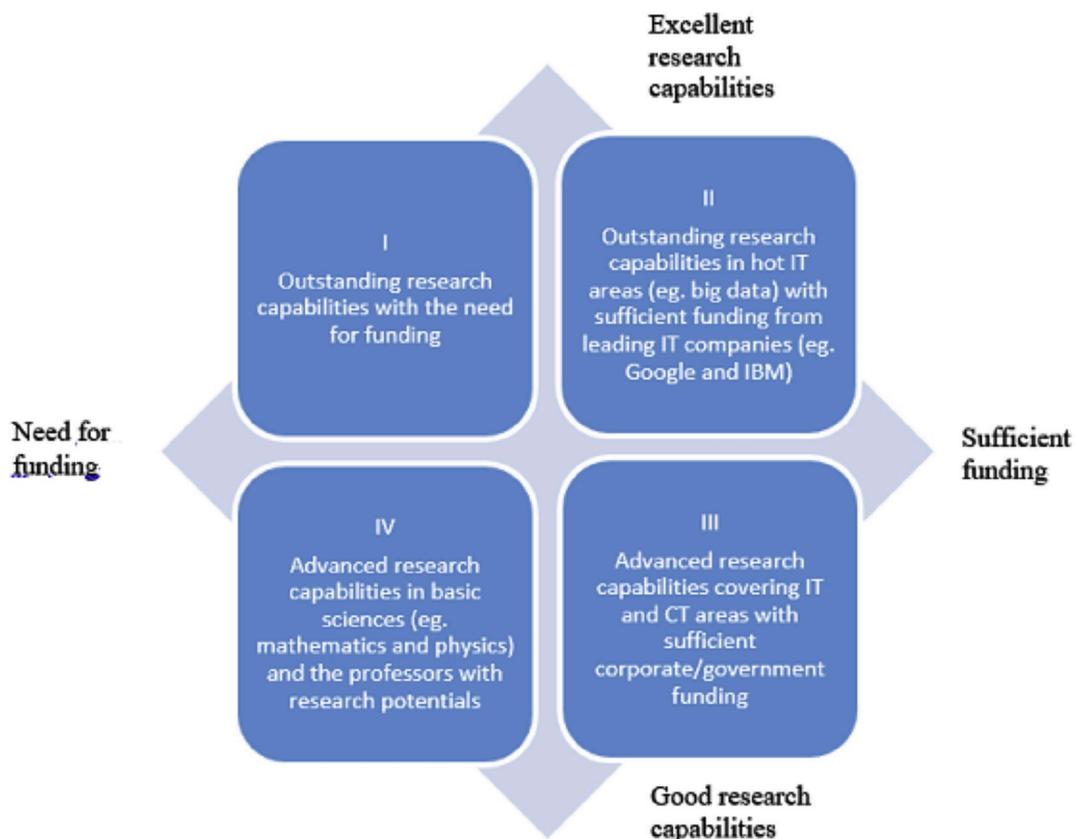


Fig. 2. Searching research partnership.

projects. In 2015, HIRP Open listed 100 research topics and received nearly 400 research proposals, more than half of which were on topics not listed by HIRP Open.

### 6.2. Research partner selection

Academic partners are selected based on the fit between their research expertise and Huawei needs. In the selection process, Huawei engineers play an active role. First, when searching for potential academic partners, Huawei engineers usually browse Huawei's expert database or tap their professional networks including previous and existing research partners for recommendations. To enrich Huawei's expert database, Huawei engineers take every opportunity to establish connections with potential academic partners. They regularly attend leading industry exhibitions and top-level academic conferences to identify key researchers leading the latest research trends. Potential academic partners are evaluated based on their research capabilities and their need for funding [Fig. 2]. Publications and patents are strong indicators of research capabilities.

Once potential academic partners are identified, Huawei engineers contact them in person to discuss the possibility of research collaboration. In addition to funding, knowledge sharing, student training and job satisfaction are common reasons for academic researchers to decide to work with Huawei. Huawei Technical Experts Group makes the final decision in selecting a group of academic partners for funding. The project acceptance rate for HIRP Open is normally less than 20%, while HIRP Flagship has a higher acceptance rate, over 60%.

Huawei has successfully developed long-term research collaborations with a number of top universities. For example, by 2017 Huawei has worked with 24 HKUST faculty members on 53 projects that produced more than 90 technical solutions and a number of high-impact publications.

### 6.3. Research agreement finalization

Huawei and academic partners negotiate the terms and conditions of projects and reach agreement on the deliverables. Projects that are problem solving in nature tend to have more specific requirements than projects that are exploratory and forward looking. In the case of the latter, Huawei often has difficulty in articulating project requirements. Once agreement is reached, a project management team is formed, including a cooperation manager, a project manager, and a local collaboration manager from Huawei.

- > A cooperation project manager oversees the progress of multiple projects.
- > A project manager acts as the end-to-end contact person for the academic partner. In many cases, a project manager is also the ultimate beneficiary (end user) of research outputs. Project manager is responsible for delivering and presenting the research outcomes to the company's evaluation panel.
- > A local collaboration manager is affiliated with HIRP and provides assistance to HIRP projects.

### 6.4. Project management

In managing HIRP projects, Huawei has two approaches, depending on the nature of the project and the level of collaboration. One approach is that Huawei sends engineers, sometimes even equipment, to academic partners to work side-by-side in case the project requires intensive face-to-face collaboration. The other approach is that communication and collaboration occur via regular meetings, whether online or offline. This approach is preferred when the project can be independently done by the academic partner.

Project management teams spend a substantial amount of time and effort to ensure effective communications between Huawei engineers and academic partners. Great emphasis is placed on aligning the project objectives between both parties and ensuring that a project finishes on time while meeting requirements. It is also important that Huawei engineers learn from the research projects. Academic partners also learn from Huawei engineers as the engineers pass on information gained from other relevant projects.

### 6.5. Project evaluation

Huawei has developed a systematic way to evaluate the outputs of individual projects. The first internal project review normally takes place halfway through a project. If the evaluation is not satisfactory, Huawei engineers and the academic partner will jointly find out the reasons and make improvements. Huawei is willing to adjust its expectations if the objectives of the project has turned out to be too ambitious or technically not feasible.

Immediately after a project is completed, an evaluation committee will carefully assess the outputs.

For example, an important evaluation criterion is whether the project has produced high-impact patents that may make into technology standards. Project manager is responsible for presenting research outputs to the internal evaluation committee. The evaluation of the project is factored into the performance assessments of Huawei engineers including the project manager who are involved in the project. This is to ensure that Huawei engineers are motivated to initiate and support HIRP projects and have a sense of ownership of the outputs. By doing so, the HIRP management team has sought to mitigate the Not-invented-here syndrome, which is a common problem encountered in open innovation that employees are resistant to accepting external ideas and deliverables, and to facilitate a sense of shared responsibility and trust among project members.

The [Huawei] team working with me are like partners, because we share the same rewards. Since our deliverables are counted as their deliverables, they can get the credit if I'm successful. In most cases, this is an aligned goal. So, we are not competitors. We have mutual trust.

Vincent Lau, chair professor, Department of Electronic and Computer Engineering, HKUST

For most projects, evaluation results are satisfactory and above. For projects that failed to meet original research objectives, Huawei assesses the reasons behind this failure: Was the research target set too high and unreachable? Were there project management problems? Huawei understands that ground-breaking research projects bear higher levels of risks and uncertainties. The final evaluation is normally conducted three years after the completion of a project. The objective is to see whether research outputs are commercialized and used in products.

## 7. Early Achievements of HIRP

Since 2010, HIRP has gone from projects solely with the top 30 Chinese universities, to almost 270 universities in 32 countries and areas, covering over one hundred Fellows of IEEE/ACM, representing an almost exponential rise in complexity (Fig. 3).

For a China-based company, achieving a network of such diversity from nothing in 7 years has been a significant challenge requiring Huawei to build trusted relationships, overcome language and cultural differences, and the industry – academia mismatches. Without a systematic approach like HIRP, it is highly unlikely that Huawei would have achieved such success.

This increased access to high quality academic partners enables the innovation of many game-changing technologies which, when utilised in products and solutions, have the potential to unlock significant benefits at the societal level. Table 2 is an insight of a small number of technologies, the products that they contribute to, and the benefits that Huawei experience or will experience in the future resulting from HIRP.

## 8. Discussion

Though pursuing open innovation with academic partners can be challenging, Huawei has demonstrated that open innovation can produce great results. The key is to take a systematic approach. Considering the case of Huawei, we highlight the following points in relation to the key issues of open innovation mentioned in the literature review:

First, in regard to choosing the research partners, the right open innovation partners are not necessarily the best academic researchers in their respective fields. Some of them are not so keen on pursuing industry projects. Some are hard to reach because they are on high demands with abundant funding opportunities. Companies should manage an expert database that tracks those who are both excellent in research and keen to work with industry partners. HIRP has enabled Huawei to create an intermediary network (Billington & Davidson, 2013) from which it can identify the right experts given the needs at the moment. Huawei case shows how a company identifies research partners and builds an intermediate network (Lopez-Vega, Tell, & Vanhaverbeke, 2016).

Some criticised Huawei for only establishing research links with the leading universities in China and the prominent research universities in North America and Europe (Jansen, 2019). This is a misunderstanding because Huawei's focus on choosing research partners is not placed on the best-known professors or the most prestigious universities, but on the professors' research interests and capabilities and their willingness to participate in industry projects. HIRP Open welcomes project proposals from researchers of any background. If the collaboration works really well, then they may develop into a long-term research partnership. In 2019, Huawei worked with the research organisations from 100 universities in North America, 123 in Europe, 85 in Asia (including 59 Chinese universities) and 5 universities in Oceania (Huawei, 2019).

Second, Huawei's case shows that there can be many different governance models of open innovation, and a company can reap the benefits from the project proposal to the end results. In Huawei, HIRP Open allows researchers from different backgrounds to contribute and even make new proposals, while HIRP Flagship allows the company to establish long-term collaborations with well-

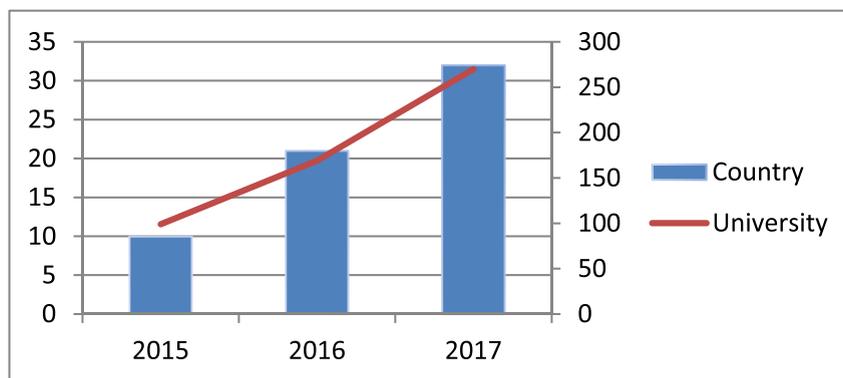


Fig. 3. Number of HIRP's partner universities and related countries.

**Table 2**  
Sample achievements of HIRP.

HIRP Technologies	Products/Solutions contributed by HIRP technologies	Society uses enabled
<p><b>Optical Technologies:</b> A variety of technologies including:</p> <ul style="list-style-type: none"> <li>• Novel space optical structure</li> <li>• LCOS chip technology</li> </ul> <p>Winning 2nd prize in 2015 in the State Scientific &amp; Technical Progress Award – the highest honor in China in science and technology</p> <p><b>5G Wireless Technologies:</b> 5G air interface algorithms:</p> <ul style="list-style-type: none"> <li>• <b>SCMA</b> – Sparse Code Multiple Access technique which can improve spectral efficiency of wireless radio access</li> <li>• <b>Polar code</b> – Polar code has better performance than all the codes currently used in the 4G LTE systems, especially for short code length</li> <li>• <b>F-OFDM</b> – Filtered Orthogonal Frequency Division Multiplexing where the assigned bandwidth is split up into several sub-bands, and different types of services are accommodated in different sub-bands with the most suitable waveform and numerology, leading to an improved spectrum utilization</li> </ul> <p><b>4G Wireless Technologies:</b></p> <ul style="list-style-type: none"> <li>• <b>Key Component Behavior Models</b> – working with European universities over 4 years to research an approach that improves the efficiency of power amplifiers in base stations.</li> </ul>	<p><b>Optical Transmission Networks:</b> Highest performing optical switch for Optical Transmission Networks (OTN) – increasing the bandwidth from 100G to 400G to 1T to provide a faster broadband backbone for clients whilst reducing the power consumption</p> <p><b>5G Wireless Networks:</b> 5G wireless standards that will become key to delivering 5G requirements of:</p> <ul style="list-style-type: none"> <li>• Ultra capacity</li> <li>• Ultra high rate</li> <li>• Ultra low latency</li> <li>• Massive connectivity</li> <li>• Ultra low energy consumption</li> </ul> <p><b>Micro-Based Station Deployment:</b> To address the dense deployment of base stations in the future, Huawei has explored developing a business model for crowdsourcing – based network construction in micro base stations integrated into intelligent street lighting.</p>	<p><b>High-Speed Broadband:</b> Fast broadband for consumers and businesses allowing:</p> <ul style="list-style-type: none"> <li>• Improved access to the digital economy (businesses)</li> <li>• Ability to access 4 K/HD video streaming (business and consumer)</li> </ul> <p><b>Future Mobile Connectivity:</b> For network operators:</p> <ul style="list-style-type: none"> <li>• Easy deployment &amp; maintenance</li> <li>• Differentiated, rapidly adaptable tailored service offerings</li> </ul> <p>For Society:</p> <ul style="list-style-type: none"> <li>• Universal consistent experience in relation to opportunities related to IoT e.g. autonomous vehicles</li> </ul> <p><b>High Speed Mobile Internet:</b> Pervasive high speed internet enabling:</p> <ul style="list-style-type: none"> <li>• Smart cities</li> <li>• Autonomous vehicles</li> </ul>

Sources: Information provided by Huawei.

established university labs. Different companies can maximize the potential value of open innovation when they not only recruit academic partners for internally-identified needs but also let academic partners propose projects for needs gone unrecognized. In so doing, companies can stay away from a path-dependent innovation trap. The dual mode of HIRP Open and HIRP Flagship is a good example of how a company forms a different governance model of open innovation (Felin & Zenger, 2014).

Third, Huawei's open innovation ecosystem focuses on continuous learning from leading academic experts, which is sustainable and allows the company to benefit in the long term. Open innovation is often considered as a cost-effective way to outsource R&D. Companies "conveniently" reap benefits from outsiders who are paid to do their homework. Companies can better realize the benefit of open innovation in the long run when they put emphasis on learning not just on results. Co-located collaboration is highly recommended as it allows the transfer of tacit knowledge (Morgan, 2004), especially when information asymmetry exists (Maietta, 2015).

In the context of the Sino-US Trade War, the legal disputes between the US government and Huawei, as well as Huawei being blacklisted by the US Government, some universities including Oxford, MIT and Stanford announced to cut research ties with Huawei in early 2019. In the meantime, some other universities including Cambridge are going to strengthen their cooperation with Huawei (Leung, 2019). In April 2019, Huawei newly founded the Institute of Strategic Research to strengthen fundamental research and oversee all co-operations with universities and research institutes. An annual total of USD 300 million will be granted to university labs around the world. Huawei hopes that professors around the world can use the funding to carry out fundamental research, which is also named as innovation 2.0 by Huawei, and share their knowledge with the rest of the industry by publishing academic papers (Hao, 2019). Therefore, Huawei's open innovation efforts are not simply results-oriented by focusing on gaining IPs but also learning-oriented by conducting fundamental research.

Fourth, Huawei shows that one way to solve the not-invented-here syndrome, which is common in open innovation, is to introduce a win-win incentive structure. Huawei engineers get credit when their open innovation projects produce good results. Open innovation literature has reported that employee feel threatened when open innovation projects are successful and thus tend to discredit them (West & Bogers, 2014). This is not the case at Huawei. Successful open innovation projects are not threats but rewards for Huawei engineers. HIRP shows how companies can encourage the internal use of external sources of innovation.

## 9. Conclusion

There is no secret for development but intensive spending on R&D for players in such high-tech industries as telecommunications manufacturing. In particular, open innovation is perhaps one of the most effective ways to maximize the efficiency of R&D. By

leveraging university research with a systematic and solid approach, Huawei has strengthened its leadership in technology and market. Huawei's practice in open innovation could be adopted by other companies in other countries. As Huawei case shows, a company may adopt different governance models of open innovation which suit their needs. When choosing a research partner, companies should also look for most suitable academics who are not only experts in their fields but also are willing to work with the industrial partners. Moreover, companies should focus their efforts on learning from the academics, instead of being result-oriented by paying to do the homework. This echoes the research finding on the complementary nature of a company's absorptive capacity and open innovation strategy on radical innovation (Flor, Cooper, & Oltra, 2017). Additionally, Huawei's win-win strategy to solve the NIH syndrome has reconfirmed the importance of stakeholders relationship management in innovation management (Jiang, Wang, Zhou, & Zhang, 2019). For governmental policy-makers, how to create policy environment that is favourable to open innovation is important, while for companies how to formulate a systematical scheme that can effectively leverage external resources is critical.

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