



AN ANALYSIS OF THE IMPACT OF INNOVATION ON THE COMPETITIVENESS OF SMARTPHONE MANUFACTURERS

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ABSTRACT

Purpose: This paper examines different product innovations and the competitive strategies of three smartphone manufacturers: Samsung, Apple and Huawei.

Design/methodology/approach: The data was collected from annual publications from these companies, including reports of research-development expenses, market shares, shipment volumes, and net incomes, and were used to estimate innovation and competition in the smartphone industry.

Findings: These results show that the stronger smartphone manufacturers' for innovation, the more they were competitive in terms of numbers of customers, net income, and market share.

Practical implications: Expenditure on marketing and research development aimed at inventing and developing innovative concepts builds companies' competitiveness and therefore is imperative for increasing their net profit and market share.

Originality/value: This article benchmarks practical measures of competitiveness and product innovation which can be used to evaluate future business strategies. It also describes smartphone evolution in the context of the innovative culture and competitive strategies implemented by key manufacturers.

Keywords: Competitive strategies, Innovation, Benchmarking, Research and development, Industry

1. INTRODUCTION

Smartphones combine the practicalities of mobile phones and personal computers (Nanda, 2008) and have now become part of users' everyday lives (Castells, 2006). Moreover, their technology is being continuously and rapidly improved as manufacturers innovate in order to maintain their competitive edge (Park et al., 2007). From an industry perspective, manufacturers innovate in order to improve the quality of their products, thus contributing to customer satisfaction and increased sales. Innovation and competitiveness are intertwined and so many industries focus on developing an innovation strategy to maintain a competitive advantage because a strong innovation culture culminates in numerous new ideas, services, or products being released to the marketplace (Moser et al., 2016). Therefore, the cultivation of such a culture can be thought of as vital in any organization aiming to create an advantage against their competitors (Abdmajid, 2007) and furthermore, is a route to increasing

creativity, establishing values, and improving overall performance (Szczepanska et al., 2014). Competitiveness gained through strong innovation helps to meet customers' changing demands thus generating profitability and market share. However, true innovation is challenging, and is affected by many factors, including the corporate environment or cultural beliefs that exist within an industry and which guide companies' values, knowledge, imagination, and creativeness. To help understand the potential obstacles manufacturers may face in this context, this article presents and analyzes research focused on innovation in the smartphones industry, illustrating its importance in gaining a competitive advantage in the marketplace.

1.1 Overview of smartphones industry

A smartphone is a mobile phone with an advanced mobile operating system (OS) that combines the features of a personal computer OS with telephonic capacity, in addition to providing a platform for many other useful features. In 1999, the Japanese company NTT DoCoMo created the first smartphone which quickly became very popular across the country (Budmar, 2012); by the late 2000s, smartphones had already become a global phenomenon. By the end of 2012, an estimated billion smartphones were in use globally, and by early 2013, global smartphones sales exceeded that of regular mobile phones (Peter, 2013). The mobile phone industry is an extremely innovative segment of the information technology sector (Cecere et al., 2015): for example, the majority of smartphones released since 2012 already had 4G connectivity, motion sensors (e.g. 3-axis accelerometers), and near-field communication (NFC) capabilities (Don, 2012). However, this smartphone industry has also been bolstered by new manufacturers entering the field.

1.2 Innovation in smartphones industry

Smartphone manufacturers develop technology in order to satisfy customer demands. Thus, innovation in smartphone technology is a key driver of business growth for mobile technology manufacturers and enables them to remain competitive. The two main types of innovation strategy are horizontal and vertical, with both being implemented by the most progressive smartphone manufacturers. In general, the former involves advancement of novel product features and the OS system capacity, whilst the latter tends to involve the application pre-existing technology or knowledge. Examples, horizontal innovations include screen size, the number of ringtones, or storage capacity, while vertical innovations might concern network or data connectivity, or processing power.

This innovation has driven continuous technological advancements in mobile phone consumer goods, which include the transitions from 1G to 4G connectivity, analog-based to tactile screens, a reduction in the size and weight of handsets, and longer-lasting batteries (Fuentelsaz et al., 2008). This latter innovation, as a response to customer demands for features, led to parallel technological advancements (e.g. the invention of Li-Ion batteries) with horizontal cross-sector applications. Successive iterations of the innovation processes have also helped the primary competitors to produce novel vertical innovations such as sophisticated games, fingerprint recognition technologies, and the advancement of mobile OSs, the latter being directly linked to the evolution of 4G protocols (West et al., 2010).

Therefore, investing in innovation, the creation of novel products, aesthetic appearance, and product differentiation are central characteristics of smartphone design (Koski et al., 2007).

1.3 Competitiveness in the smartphone industry

Maintaining a competitive edge is a key driver of innovation in most successful businesses (Urbancova, 2013). Most mobile phone manufacturers implement continuous cycles of innovation drives as a tactic to retain and grow their market share, increase profitability, maintain a technological edge over competitors, and to reinforce brand identity. To illustrate how smartphone competition has significantly increased in recent years, the number of new smartphones using the open source Android OS increased from 6,798.4 units to 259,306.4 units between 2009 and 2014 (Cecere et al., 2015). Google purchased the Android OS in 2005 and since then have become a global influence on the smartphone market and a strong competitor to their main rival, the Apple iOS. They achieved this with a strategy of obtaining approval of their OS by a wide range of smartphone device manufacturers (including Samsung, Huawei, and Xiaomi) coupled to improvements in their Google Chrome browser and Play Store.

Interestingly, there is more competition the area of smartphone OSs than for device hardware. For example, the total number of apps available on Android and iOS increased from 396,920 in 2015 to 429,709 in 2016 (IDC, 2017). The success of the iOS operating environment, first introduced on the iPhone in 2007, is exemplified by its rapid extension first across the United States and then worldwide. The evolution of the Android OS and subsequent introduction of the Windows smartphone, increased competition between hardware manufacturers in the smartphone industry. This widened the range of components available to smartphone manufacturers, allowing them to focus on developing products aimed towards various different global market segments. According to the 2016 Apple annual report, the company assigns its ability to compete with other smartphone manufacturers to its capacity to launch innovative new products and technologies into this market (Daniel Eran Dilger, 2016). Thus, Apple relies on its uniqueness in terms of design and end-to-end product solutions which contain hardware, software, and content services, to maintain its competitiveness. As such, Apple significantly invests in continued research and development (R&D) in order to have innovative products and hold segment market share in worldwide (Steve, 2015).

1.4 Relationship between innovation and competitiveness in the smartphone industry

Innovation and competitiveness are two intrinsically linked concepts that drive each other, companies' overall performance, and the lifespan of their products. The market is driven by the presence of inventive goods which establish a hierarchy among competing companies; this helps to sustain progress and to expand the domain of internal and external cross-sectoral inventions during the product evolution process (Eslami et al., 2016). Hence, the durability of a given product can be thought of as being characterized by competition, itself driven by competitiveness because this allows companies to attract consumers through innovative strategies and ideas. Pekovic et al., (2016) argue that the life cycle of a new product i.e. its introduction, growth, maturity, and eventual decline, can be influenced by competitors that focus their efforts on improving their market share rather than on innovation itself. However, in general, for a company to boost its global market share and net profits, they must become

more competitive by substantially investing in R&D and marketing in order to improve the profitability of their products (Farrimond & F.Jr, 1989)

2. MATERIALS AND METHODS

2.1 Research questions and hypotheses

To explore how companies' capacity for innovation influences competitiveness and success the proxy indicators of net income and market share were used to assess whether there a positive correlation between the innovation capacity and net income of smartphone manufacturers, and whether this in turn, positively correlates with their market share. In addition, the article aims to analyze how the competitiveness of smartphone manufacturers relates to their net income, and if this is related to their market share. These questions are expressed in the following hypotheses:

1. The capacity of a smartphone-manufacturing company for innovation positively correlates with its net income.
2. Smartphone manufacturers which are highly innovative have larger market shares than those that are more weakly innovative.

2.2 Data collection

The data used in this research was obtained from annual reports from the three smartphone manufacturers with the largest market share: Samsung, Apple, and Huawei as well as several statistical resources (Maxham, 2014).

Annual reports from 2011 to 2016 was defined as a sample for this study. They are collected from international data corporation (IDC) website and analyzing the all tables in results section.

2.3 Data analysis

After extracting all of the relevant data into database software (Microsoft Excel, version 2010), some specific variables were chosen for further analysis as examples of innovations among smartphones manufacturers. This study took us six (6) months from December 2016 to May 2017.

3. RESULTS

3.1 The market environment and innovation by smartphone manufacturers

In the decade preceding 2010 the mobile telecommunications industry was largely based on feature phones, i.e. those using a proprietary OS and with restricted capabilities (see Section 3.2). The market then rapidly shifted towards smartphones with powerful and feature-rich OSs that support third-party applications, allowing personalization of the user experience (Shinde & Nandkumar, 2016). Vendors such as Apple, Samsung, and Huawei took advantage of this wave to break into the new markets created in this budding industry by launching their own mobile phone products. In terms of manufacturing, these vendors were predominantly large technology merchants based in China(Alan F., 2015). These vendors have grown their share of the smartphone market year-on-year (YoY), fueling innovation. However, innovation in the smartphone industry is an ongoing process, and new companies such as

OnePlus are now starting to enter into the field in competition with manufacturers who are already well-established in this arena. Thus, as the industry continues to grow and the competition intensifies, smartphone manufacturers must also simultaneously advance their technologies in order to retain their positions.

3.2 Contrast between feature phones and smartphones

Most feature phones are limited in their capabilities in comparison to modern smartphones; they generally provide voice calling and text messaging services, and basic multimedia such as FM radio and internet capabilities, whereas smartphones typically use a mobile OS and have significantly improved architecture and functionality. Feature phones broadly have a dual structure comprising a LCD display and analogue keypad, and they sometimes have a complex hinge design. In contrast, most smartphones have a touchscreen design with a digital keypad and display and the design is both smoother and slimmer than that of feature phones. After the introduction of the touch screen innovation in 2008 by RIM it became a standard smartphone feature (Hattersley, 2010). This shift from feature to smartphone also stimulated further innovations to invent the technologies required to support innovations related to tactile screens, as well as in providing increasingly higher-definition displays. Moreover, while smartphones run on OSs with computational power that can compete with personal computers, feature phones run on firmware from third-party software platforms such as Symbian. The Android and iOS OSs were developed to support applications, and the latter only became open to third-party application developers in 2007 (Puder & Antebi, 2012).

3.3 Investment in research and development in the smartphones industry

R&D is linked to companies' concepts of innovation: For instance, Samsung was formerly a mid-level television manufacturer, but incrementally gained a foothold in the mobile telecommunications trade well before the development of smartphones. Among other things, it did so first by developing and perfecting the manufacture of more complex and expensive key industry components (e.g. semiconductors and microprocessors); they then transformed themselves into expert manufacturers of high-end products, leveraging their size to heavily invest in new technologies and product categories (e.g. their huge range of smartphone screen sizes or their own semiconductor factories) where other smaller companies could not (Seshan, 2011). Indeed, their Human Resources Development Centre, Changjo Kwan, translates from Korean as 'Creativity Institute', and drives both creativity and discipline, essentially as directives from the chairman, Lee Kun Hee, as seen in their many corporate mantras such as "change begins with me", bonuses for cost-saving innovations made by individual employees, and their philosophy of "perpetual crisis" which helps them to prevent stagnation and complacency (Lin, 2013).

Table 1 shows the market share of all new smartphone products brought to market by Samsung, Apple, and Huawei across the whole marketplace. Although Samsung's investment in R&D remained the highest of the three, in 2015 it spent less on R&D than the previous year (\$12.62 billion vs. \$13.03 billion, Figure 1), which also coincided with relative drop in its market share after 2014 (Figure 2). Huawei and Apple's R&D investments have increased YoY since 2012 (Figure 1), suggesting that their capacity for innovation may have also increased during this period. Surprisingly, given that Huawei have only been in the

marketplace since 2009, they released a significant number of new products between 2012 and 2015 (Table 1) which may be related to their R&D expenditure and increased relative market share (Figure 2). Since June 2007, Apple have produced 15 different smartphone products, which have all been successful in terms of sales (Figure 2) and have helped to cement the company’s leading position.

Table 1: Percentage of new products released by Samsung, Apple, and Huawei from 2012 to 2015

Percentage of new products per year	Samsung	Apple	Huawei
2012	30%	19%	4%
2013	31%	15%	5%
2014	24%	15%	6%
2015	23%	16%	8%
Average number of new products per year	21.50%	16.25%	5.75%

Source: iRunway analysis 2016

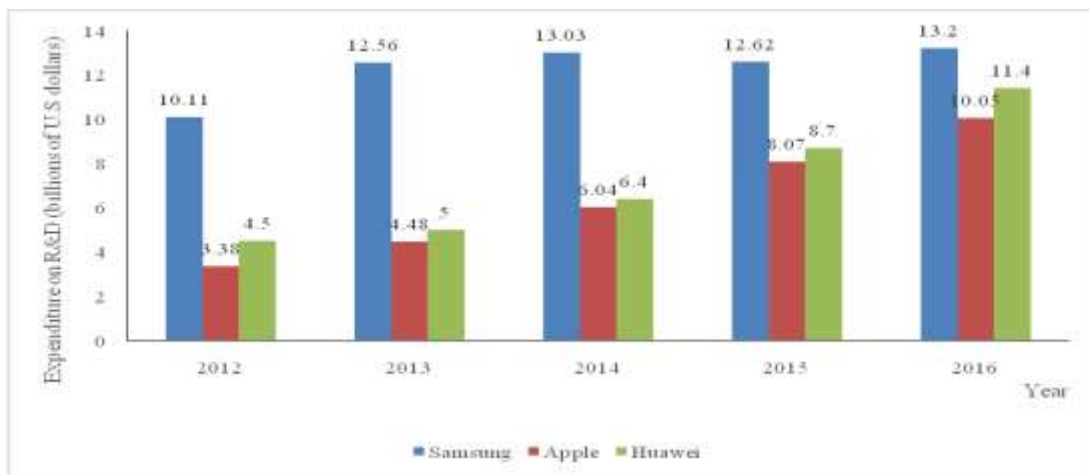


Fig. 1: Research and development investment by Samsung, Apple, and Huawei between 2012 and 2016. Source: The statistics portal, 2016

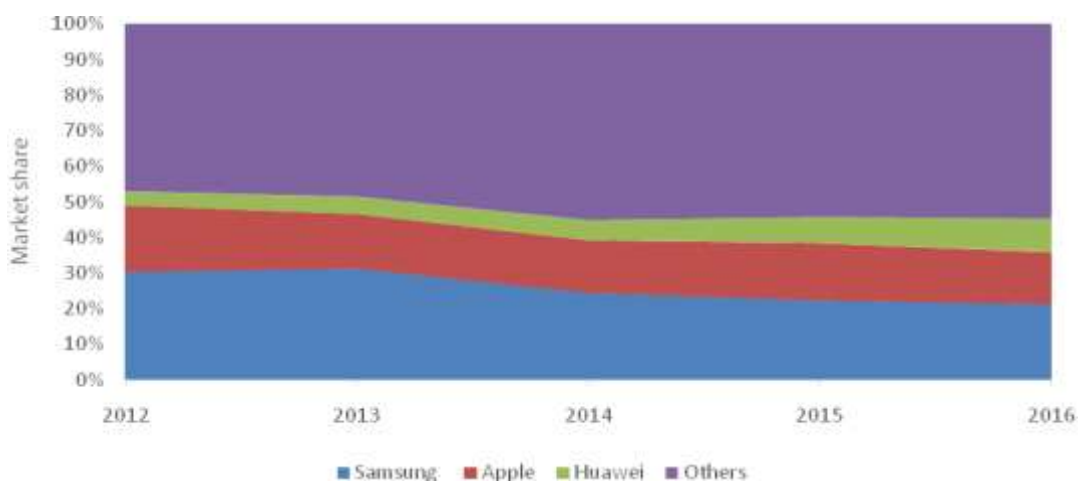


Fig. 2: Market share of the top three smartphone manufacturers (Samsung, Apple, and Huawei) versus their competitors (Others) between 2012 and 2016; Source: IDC: January 2017

3.4 Horizontal versus vertical innovations in the smartphones industry

The functionality and ergonomics of smartphones has substantially improved over time; in order to understand how dominant products emerge, two types of product-innovation frameworks can be applied. Vertical innovations, i.e. those focused on the quality of goods, aim to produce items that are perceived as sophisticated, elegant, stylish, exclusive, upmarket, and/or fashionable by consumers (Nottingham, Spirk, & John, 2011). The main focus is quality, and past innovations which can be considered vertical include the introduction of features such as touch screens, wireless internet connectivity (Wi-Fi), or the improvement of ergonomic characteristics (such as reducing handset weight) which are universally appreciable by users (Chesbrough, 2003). Different users’ reception of vertical innovations can widely vary according to their specific preferences and needs, and this usually also means that some user subgroups are willing to pay premium prices for them (Koski et al., 2007). An example is the introduction of Apple’s first tactile screen (Pegoraro, 2007), or different customers’ preferences for certain products from among Samsung’s range of screen sizes (Danova, 2013). In contrast, horizontal innovations refer to improvements upon pre-existing innovations and/or the discovery of parallel technologies (which also avoid copyright infringements), and may also result from the transfer and application of prior technologies and knowledge in different industrial sectors (Nuclear new build, 2017). These innovations are usually valued equally by every customer, and as such, vertical innovations tend to become more standard features as they start to appear as horizontal innovations. Table 2 shows some generalized examples of horizontal and vertical smartphone innovations in software and hardware.

Table 2: Examples of horizontal and vertical smartphone innovations

	Hardware components	Software components
Horizontal innovations	Screen size,	Number of ringtones, games
Vertical innovations	Secondary camera, multiple touchscreen, Weight, 4G and Wi-Fi	Application

To highlight different smartphone innovations, the incorporation of eight of the most common hardware specifications into mobile phone handsets over time is explored below. Six of these are vertical product innovations: tactile screen, cellular data (4G), secondary camera, micro USB port, Wi-Fi connectivity, and weight (Figure 3). The other two, size and dimensions, are horizontal innovations (Figure 4).

3.4.1 Analysis of selected vertical smartphone innovations

The major difference between feature and smartphones is their use of analogue versus touch screen keypads, respectively. The majority of smartphones are now designed with a tactile screen, their use increasing from 75% in 2011 to 97% in 2016. Of the overall sample, touch screens, analogue-keypad devices, and mixed-design smartphones (those with analogue keypads and a tactile screen) represented 75.24%, 8.45%, and 16% in 2011, and by 2016, analogue keypads accounted for only 0.65% of devices (Figure 3a). The popularity of third-party applications such as Facebook, Twitter, QQ, WhatsApp, and Skype, created a huge

demand for functions facilitating communication and content sharing, especially photos. As a proxy for innovation in this area, 60.05% of the phones in our sample had a secondary camera; 71% of phones included one in 2011, rising to 95.04% by 2016 (Figure 3a). Similarly, the weight of mobile devices is an important ergonomic factor for many users and so manufacturer R&D investments have focused on reducing the average smartphone weight, resulting in the steady decline between seen 2011 and 2016 (Figure 3b).

Connectivity is also a very important factor which allows users to fully take advantage of the device’s features. Most products (90.2% in 2011, rising to 98% in 2016) had basic wireless local area network (WLAN) connectivity (Wi-Fi; Figure 3a). Moreover, when not connected to Wi-Fi the majority of devices can now retain their internet connection by accessing global networks such as 2G/3G and 4G; in 2011 only 25% of phones had 4G but by 2016 almost all manufacturers (78%) had incorporated this feature (Figure 3a). Smartphones can also be connected as portable hardware to personal computers in order to transfer files; this requires the presence of a mini or micro USB port on the device, with the latter being the latest innovation. As such, the incorporation of micro USB ports into mobile devices rose by 19% between 2011 and 2016 (from 79% to 98%; Figure 3a). Taken together, these results show how smartphone specifications are progressively converging, and highlights the dominance of certain vertical product innovations.

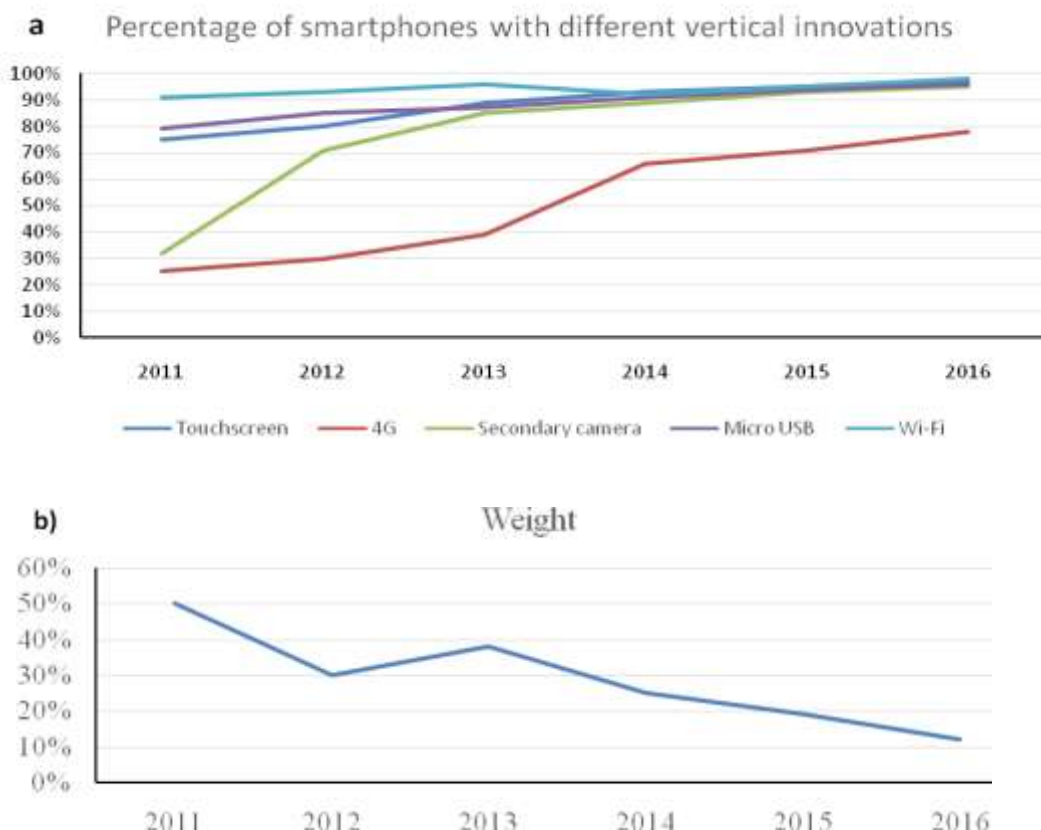


Fig. 3: a) Percentage of smartphones with different vertical product-innovation specifications between 2011 and 2016, and b) Change in smartphone weight (as a vertical product innovation) from 2011 to 2016. Source: graphs elaborated by the author based on data collected from company website

Data represented is the mean \pm the standard deviation. The percentage was calculated to the total number of smartphone sold by dividing the total number of customers' preferences.

3.4.2 Analysis of selected horizontal smartphone innovations

To assess horizontal production innovations, we evaluated the dimension and screen size of devices. Smartphone size is a particularly competitive area for Samsung and Apple, especially with introduction of iPhone models with curved edges. Furthermore, to facilitate the personal computer-like functionality of smartphones, relatively large screen sizes are required, especially for touch screen devices. The data presented in Figure 4 show that the coefficients of variation were positive and constant between 2011 and 2016, indicating that there was a very wide variation in screen size and device dimensions among the different products on the market during this period. Furthermore, it appears that these two variables are continuing to become more differentiated among the products on the market, thus indicating that a change in horizontal product innovations has not yet emerged in the same way that it has for vertical innovations.

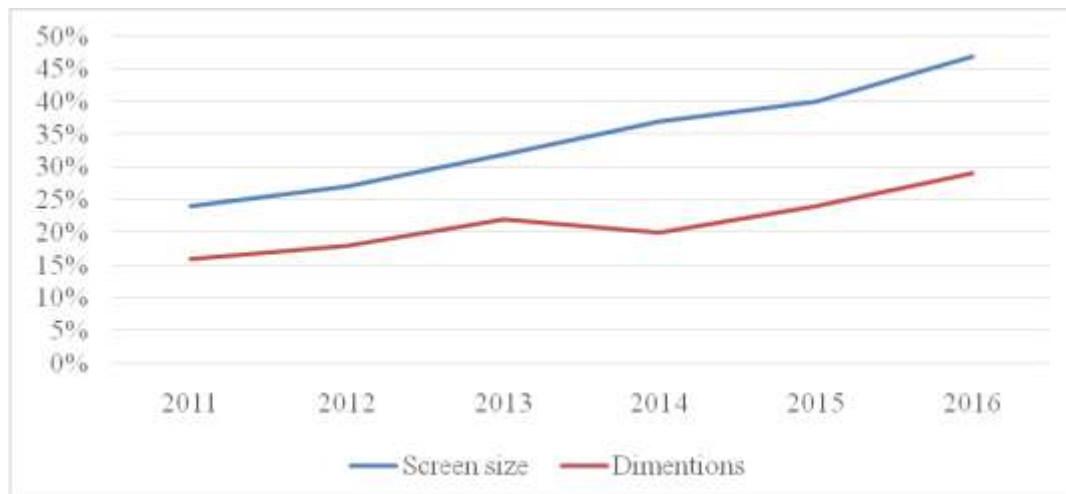


Fig. 4: Coefficients of variation for smartphone dimension and size (horizontal product innovations) between 2011 and 2016. Source: graphs elaborated by the author based on data collected from mobile phone company website.

Data represented is the mean \pm the standard deviation.

3.4.3 Changes in smartphone operating system use

Finally, Figure 5 represents the increase in the number of users with smartphones implementing the Android OS (by 10% between 2011 and 2016), accounting for 79% of all OSs in use in 2016. Concurrently, there was a steady decline in smartphones using the Windows OS between 2011 and 2016 (from 10% to 1%). Use of the Symbian OS also dropped off from about a 2% market share in 2011 to all but disappearing from the marketplace by 2014. In contrast, the use of Apple's iOS remained relatively constant between 2011 and 2016 probably because it is a proprietary OS pre-installed on all iPhones, thus the 3% increase (to a 22% market share) over this period is representative of Apple's market share itself (Figure 2).

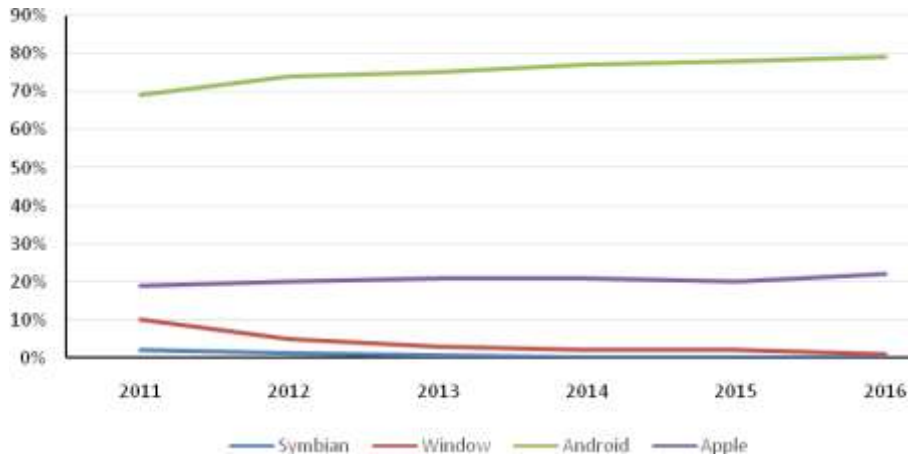


Fig. 5: Changes in the percentage use of the Symbian, Windows, Android, and Apple operating systems on smartphones. Source: graphs elaborated by the author based on data collected from mobile phone website.

Data represented is the mean \pm the standard deviation.

In summary, these results show that despite some convergence in vertical product innovations such as Wi-Fi and USB connectivity and a shift towards the dominance of tactile screens, horizontal smartphone innovation, derived from the transfer of technology or knowledge in other technological fields, has not yet emerged. Furthermore, expanding competition between brands is linked with this constant technological advancement and has guided the evolution towards domination of certain vertical features like touch screens. Nonetheless, companies still compete within the sphere of horizontal product innovations, especially in terms of screen size and device dimensions. In addition, even though the Android OS is dominant for smartphones, there are still comparatively high levels of competition in that domain.

3.5 Analysis of competition in the smartphone industry

The increase in the global demand for smartphones has created a competitive marketplace. We measured this competition among smartphone manufacturers in terms of hardware, OSs, and content by comparing the shipment volumes, market shares, net income, and R&D investments of each manufacturer, published in their annual reports.

3.5.1 Key hardware-manufacturer strategies

According to a 2016 International Data Corporation (IDC) study, on the back of its innovations with prototype smartphones and its own OS, Samsung is now the leading smartphone manufacturer, with a market share of 20.8% in 2016 (Table 6). In the same year, Apple had the second largest market share, and Huawei, having made great strides in terms of its hardware production, OS, and service of application, was third (Table 3). Samsung shipped the most smartphones worldwide, at 309.4 million units in 2016 and 319.7 million units in 2015. This was followed by Apple, with a shipment volume of 215.4 million units in 2016, compared to 231.5 million in 2015. Huawei also increased its YoY shipments to take the third position in smartphone market share at 107.1 million units in 2015 and 138.8 million units in 2016. Unlike Apple and Samsung, Huawei recorded both an increase in their sales

and their market share between 2015 and 2016, suggesting that the market is becoming increasingly concentrated (Table 6). These trends become even clearer by comparing these companies' market shares between 2012 and 2016 (Figure 2).

Table 3: Smartphone vendor shipments (millions) and market shares (%) for the top three manufacturers

Company	2016 Units	2016 Market share (%)	2015 Units	2015 Market share (%)
Samsung	309.4	20.8	319.7	22.2
Apple	215.4	14.5	231.5	16.1
Huawei	138.8	9.3	107.1	7.4
Others	824.6	55.4	781.9	54.3
Total	1488.2	100	1440.2	100

Table 6 shows the market shares and volume of shipments in the smartphones market for the top three smartphone vendors. Smartphones vendors shipped a total of around 1488.2 million units in 2016, compared to 1440.2 million units in 2015, representing an increase of 4.82%. Source: IDC, January 2017

There are two main strategies that hardware brands such as Samsung, Apple, and Huawei can take. The first is to concentrate on continuous improvement while maintaining competitiveness. For example, since 2000s, Samsung have produced 1116 smartphone models ranging from feature to smartphones (thus, also from analogue to touch screen keypads), as well as using many different display technologies. In fact, Samsung have made unending hardware-concentrated competitiveness their key strategy and as such, it has become part of their corporate image. This includes innovations such as the production of an array of different screen sizes, making their devices lightweight, increasing internal memory, and giving them high-definition screens, among others. Nevertheless, with this strategy they still risk compatibility issues between current hardware and smartphone-specific technologies.

The second strategy is to cultivate a new OS. Samsung, Apple, and Huawei are each currently adopting different approaches to establishing their own OSs. Samsung already has experience in this area, for example in creating Bada in 2009 which was designed for smartphones and other mobile devices (Song, 2014). Additionally, in 2015 Samsung introduced the improvement of its own new OS, TIZEN, to rival Android. Huawei is also increasingly turning away from the use of Android-based platforms towards improving its own OS, and since 2007, Apple has used its own OS, the iOS, on all of its smartphone range. However, this strategy is risky in that there is a huge barrier to entry that must first be overcome and which is exacerbated by the OSs released by software giants such as Google's Android. Therefore, hardware producers that do not already have a competitive OS must choose between maintaining their particular competitive edge by continual investment in hardware or by investing huge amounts of R&D effort in improving their proprietary OS providing them with massive opportunities, but with immense risks.

3.5.2 Strategies implemented by the key operating-systems producers

OSs are becoming increasingly important to Samsung, Apple, and Huawei in the context of the current smartphones market. This is even more urgent because personal computer OSs are currently expanding into the smartphones OS market, bringing with them improved

technology for hardware connection and internal and external memory allocation. The design of innovative strategies and the progression of hardware characteristics (described in Section 3.4), are defined by the industry’s dynamics. On the one hand, the convergence of vertical product innovations means that the two market leaders are increasingly in competition for the mass market based on the accumulation of innovations into their devices. On the other hand, as demand grows, so does user diversity, meaning that horizontal innovation should become increasingly important for allowing new companies to enter and survive in particular market segments. Thus, Samsung and Apple, as generally so among all smartphone manufacturers, are particularly concerned with patenting their innovations, especially their new device models, the shape of their smartphone coverings, and their user interfaces. Furthermore, they compete both in terms of horizontal and vertical innovations.

The market currently centers on six major OSs: Android, iOS, Microsoft, RIM, Bada, and Symbian. The wide range of competitors, which include smartphone manufacturers, large internet companies such as google, and dominant software manufacturers such as Microsoft, suggeststheir heterogeneity. Some OS manufacturers are also smartphone manufacturers: Apple (iOS), Nokia (Symbian), and Blackberry (RIM). Android was introduced by Google and is used by several companies including Samsung and Huawei, while the Windows mobile phone and OS was created by Microsoft. Figure 6 shows details of the OS market share occupied by these different OSs between 2012 and 2016.

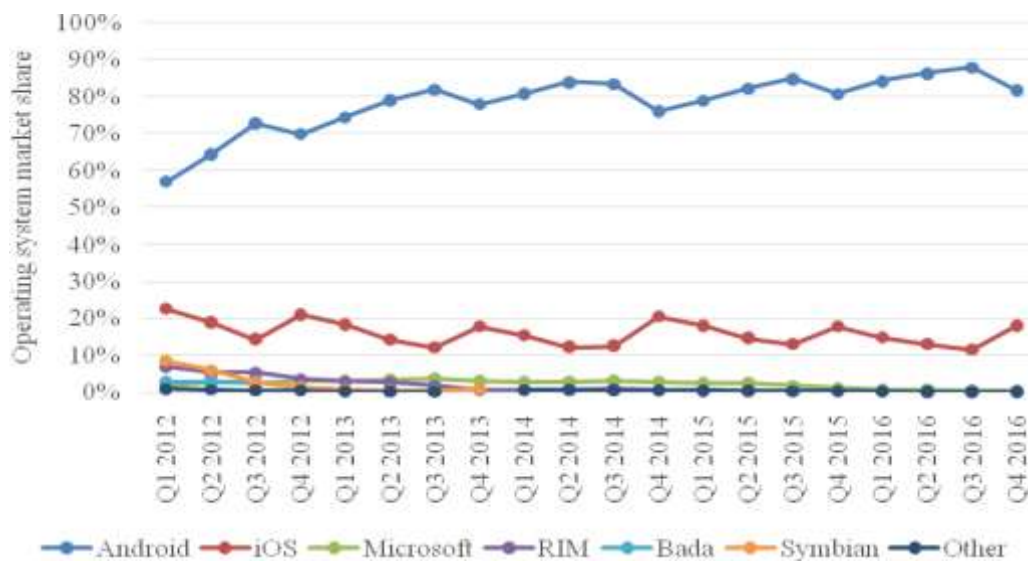


Fig. 6: The evolution of the operating system market share occupied by the six main operating system producers. Q: quarter. Source: IDC January 2017

As shown in Table 4, Android had the highest smartphone OS market share at 81.7% in 2016 (compared 80.7% in 2015). Incidentally, Samsung was Android’s first collaborator, which may have contributed to at least in part to its initial recognition and success. Android increased both their YoY and quarter-on-quarter (QoQ) market share between 2012 and 2016 (Figure 6), and this was accompanied by strong increases in unit shipments by newer competitors on the market such as Huawei, Xiaomi, and OPPO (Table 4). In addition, the third quarter (Q3) of 2016 saw the launch of Apple’s iPhone 7 and iPhone 7 plus as well as

Google's pixel and pixel XL smartphones which also greatly contributed to Apple and Android's dominance in the OS market in 2016 (Figure 6 and Table 4). Indeed, compared with the previous year, Apple's iOS market share increased by 0.2% to 17.9% in 2016 (Figure 6). Apple also saw its market share increase YoY, however at 17.9%, the company still lags far behind Android in terms of OS market share (73.8% in Q4 2016; Figure 6). In comparison, Microsoft experienced a QoQ drop of 0.8% (equivalent to 1.1% of market share), in 2015 compared to its 0.3% market share in 2016 (a total of 1,092 thousand units shipped compared to 4,395 in 2015; Table 4). Moreover, with Windows smartphone's focus on business buyers, the decreased share in the consumer market is expected to continue through 2017.

Table 4: Smartphone operating systemsales (thousands of units) and market share of the top four operating system producers.

Operating system	2016 Units	2016 Market share (%)	2015 Units	2015 Market share (%)
Android	352,670	81.7	325,394	80.7
iOS	77,039	17.9	71,526	17.7
Microsoft	1,092	0.3	4,395	1.1
RIM	-	0	907	0.3
Other	738	0.1	887	0.2
Total	431,539	100	403,109	100

Source: IDC January 2017

3.5.3 Strategies implemented by content developers

Because the evolution of technology influences customer preferences for hardware, the development and marketing of content has also become a significant component of the general smartphone market. Customers benefit from access to the many free and paid third-party applications on mobile websites and free-to-use application stores available within the constantly-updating mobile internet ecosystem. The convenience of using smartphones to access the mobile internet and applications has also created the potential for smartphone-linked content-building businesses, based on virtually limitless business models with potentially unlimited profitability, including mobile betting, web advertising, e-food, e-commerce, match-making, education, global positioning systems (GPS), and so on. It is also important to emphasize that smartphones, and their associated internet applications, provide an innovative opportunity for mobile stores and advertising businesses. Google and Apple introduced their OSs to their effective internet support, and in the case of the Android OS, then allowed smartphone manufacturers to use them. Understanding the strong innovation within the smartphone market and customers' changing preferences, manufacturers can also benefit by investing in online content. As smartphones become increasingly personalized, customized, or specialized paid content is also predicted to increase. GPS-linked businesses such as social media and social match-making are also likely to increase, alongside traffic-management businesses as new potential business models for smartphone manufacturers.

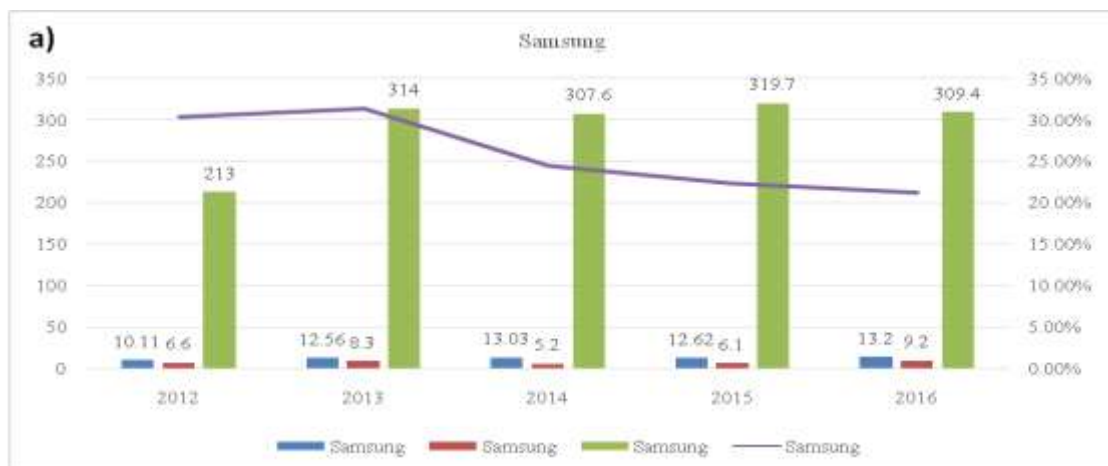
3.6 Analysis of selected companies' smartphone hardware strategies

The following section aims to combine this research in order to address the hypotheses and research questions set out in Section 2, in order to try to identify any relationship between the innovative capacity and competitiveness of the three most dominant smartphones

manufacturers (according to market share; Samsung, Apple, and Huawei; Figure 2) in terms of income (hypothesis 1) and market share (hypothesis 2).

This research examines the effects of companies' capacity for innovation and competitiveness on customers' perceptions of the hardware and software products they create, using their R&D investment, market share, shipment volumes, and net income as proxies. R&D expenditure is linked to companies' concepts of innovation; therefore, we assume that this metric is strongly linked to innovation. R&D expenditure by Samsung ranged between \$10.11 and \$13.2 billion, but was not constant nor was it linked to their net income which may have contributed to a YoY decrease in their hardware market share (Figure 7a). Samsung had a net 5-year-average income of $\$23.782 \pm 61.52$ billion per billion dollars it invested in R&D (Table 5). This was second only to Apple. Even though Apple had fewer devices than Samsung and Huawei, their average investment in R&D was relatively higher than the other two companies in 2015 at \$8.07 billion (Figure 7b). This may have also directly affected Apple's net income giving it the highest net 5-year-average income (28.938 ± 32.02 billion) per billion dollars invested in R&D (Table 5). This difference between Apple and Samsung is perhaps even clearer when analyzed in terms of shipment volumes to R&D investment: where Apple sold a 5-year-average of 6.788 ± 926.6 million units per billion dollars invested in R&D, Samsung sold only $0.575 \pm 1,463.7$ million units (Table 5), which equates to an 11.8-fold difference between the two companies.

Hence, in accordance with hypothesis 1 (Section 2), as Apple increased their R&D expenditure their net income also increased (Figure 7b). This effect can also be very clearly seen for Huawei—Samsung and Apple's third biggest competitor (Figure 2): Huawei's market shares more than doubled (from 4% to 10%) while its shipments increased by 4.3-fold (32 to 138.8 million units) between 2012 and 2016, and this was accompanied by a more than 2.5-fold increase in R&D investment made over the same period (Figure 7c). Interestingly, the fact that Huawei are relatively new competitors is also reflected in their 5-year average R&D investment to market share ratio, which was $0.878\% \pm 36$ per billion US dollars invested in R&D, compared to $2.105\% \pm 61.51$ and $2.482\% \pm 32.02$ for Samsung and Apple, respectively (Table 5). This also fits with hypothesis 2 (Section 3) in that as companies increase their R&D expenditure (thus likely making them more innovative), their market share will also increase in line with that R&D investment (Figure 7 and Table 5).



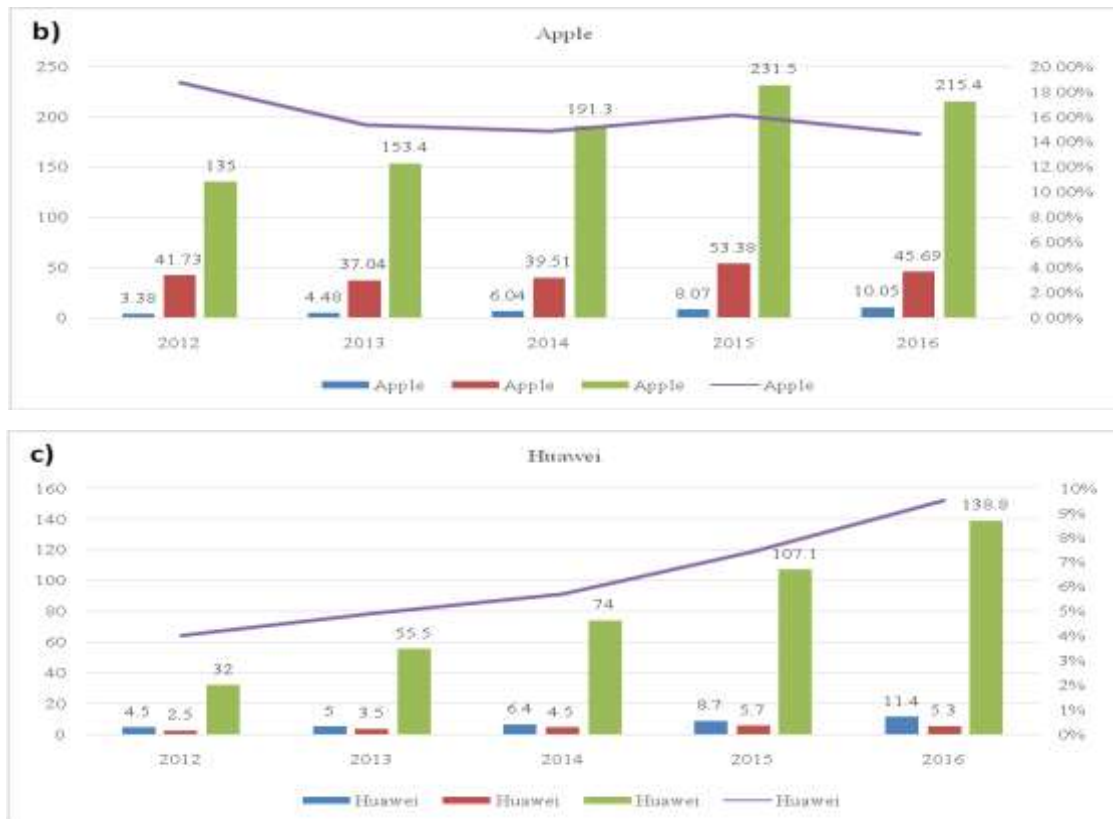


Fig. 7: The research and development (R&D) investment (blue; billions of US dollars), net income (orange; billions of US dollars), shipment volumes (gray; billions of units), and percentage hardware-market share (yellow) between 2012 and 2016 for a) Samsung, b) Apple and c) Huawei smartphone manufacturers; Source: IDC January 2017

Table 5: Ratio of research and development investment by smartphone manufacturers to proxy measures for these companies’ innovation over the past 5 years

	Samsung	Apple	Huawei
Net Income/R&D	23.782 ±	28.938 ±	11.317 ±
Shipment Volumes/R&D	0.575 ±	6.788 ±	0.597 ±
Hardware Market Share/R&D	2.105 ±	2.482 ±	0.878 ±

Table 8 shows the average net income (billions of US dollars), volume of smartphone shipments (millions of units), and percentage share of the hardware market divided by the spending on research and development (R&D; billions of US dollars) between 2012 and 2016 for Samsung, Apple, and Huawei. Data shown are ± the standard deviation of the mean. Source: Elaborated by the author from data from the IDC, January 2017.

3.7 Analysis of selected companies’ smartphone software strategy

As previously discussed in Section 3.5, there are three smartphone market segments: hardware, OSs, and content, with the latter two being considered software. This section will lay out each manufacturers’ specific strategies in terms of software, as summarized in Table 6. Samsung currently dominates the hardware market segment, followed by Huawei which is fairly competitive in terms of hardware. Both these companies produce a large number (Figure 7a and b) and wide range of devices, but use a third-party Android OS, applications,

and content. On the other hand, Apple dominates the OS and content sectors with its own strong OS and content, however its iPhone hardware technology is relatively weak compared to Samsung and Huawei. None of these companies currently enjoy complete success in all three sectors. Huawei is currently investing large amounts in innovation through R&D expenditure, allowing them to create new products and launch them worldwide. This strategy of increasing YoY investment in R&D is paying dividends in terms of customer satisfaction with their smartphone products, as shown in their increasing annual sales (Figure 1) and they are now the third largest smartphone technology company in the world (Huawei annual report, 2016). Indeed, as noted elsewhere (Richard, 2016), Samsung and Apple must carefully choose their future R&D investment strategies in order to stimulate innovation, because if Huawei continue on their current trajectory they could become the worldwide market leader.

Table 6: Software marketing strategies adopted by smartphone manufacturers

Market segment	Market potential	Samsung	iPhone	Huawei
Hardware (H/W) production	Lightweight, mass storage, and high-end smartphone H/W			
Operating systems (OSs)	A significant hub connecting H/W and content			
Content (e.g. applications, web)	The core of the smartphone, enabling different appropriateness models			
Strategic option		Maintaining advantage in H/W and entering content market	Expansion of content business by producing a proprietary OS	Expenditure on R&D and expansion of market share in global market

Source: Elaborated by the author

- Major competitive advantage
- Average competitive advantage
- No competitive advantage
- Technology hub and/or source of steady profit
- Direction required to enter into a new market sector or to increase competitiveness and innovation

4. DISCUSSION

4.1 Implications for future management strategies

There are complex reasons, different competitors in the global smartphone market have varying strengths and weaknesses: some are more competitive in hardware manufacturing (e.g. Samsung and Huawei), while others like Apple, have an edge in the software market. Importantly, it is very difficult for manufacturers to predict the future of the smartphone market. Therefore, hardware manufacturers should continuously invest in hardware R&D, while software developers must focus on developing new content and OSs through technological innovation and marketing. Despite the increasing importance of software, current smartphones are a composite of both hardware and software technological innovations, and so manufacturers must continue to find ways to combine both of these elements in order to remain competitive. Competitors would ideally like to be uniquely and specifically competitive in all three market segments, and undoubtedly, any company able to achieve that in both hardware and software will strongly influence the smartphone market. However, overcoming such marketing and technological barriers will be extremely time-consuming and expensive. Hence, in the medium-long term, manufacturers' management strategy is likely to remain the establishment of both hardware and software technologies.

Manufacturers need a constant source of steady profit in order to support any new business ventures, and so each smartphone producer must consolidate their operations within their core-business segments before looking towards penetrating any other markets. In this sense, extensive knowledge of manufacturing and technology remains a huge advantage. Thus, to overcome the entry barriers to new markets, businesses should use their pre-established competitive competencies and expertise as a starting point. This requires a good marketing strategy and constant financial support for R&D in order to stimulate innovation and creativity. As indicated in Table 6, there are two main points of entry onto a new market: from hardware into software, or vice versa. Manufacturers who have technologies which produce high and steady profits or who are competitive in two technology hubs can take a more flexible approach, or a dual-track strategy.

Competitive and innovative OS developers can move in both directions because they play a core role in connecting hardware and content. They have fewer technological problems, and can focus on improving their proprietary content more efficiently than hardware manufacturers. Moreover, there is a constant demand for stable and secure OSs for smartphones, and customers are attracted towards specific OSs and content (e.g. Apple's iOS). In this sense, the major OS developers such as Apple have greater opportunities because they can generate a competitive edge via their OS and content. Apple have two major sources of stable high profits and thus, in the future they could choose to two develop their business either starting from their iOS or based on the strength of their content. Additionally, Apple can leverage the synergy between their two software technology hubs to accelerate and reinforce their future marketing strategy.

Thus, companies must be strongly innovative and in order to gain the competitive advantage required to dominate all three market segments and therefore corner the smartphone market. Specifically, companies must have excellent product lines and expertise in their manufacture,

a proprietary OS, and exceptionally high-quality content; this can only be archived by vertical and horizontal innovations. In this regard, Apple is in an excellent position for future expansion. Based on their strength in terms of software, along with their medium-level hardware technology, Apple can move towards synergizing their technologies in all three market segments. Nevertheless, Apple must build strategic collaborations with telecommunications companies in individual countries in order to counterbalance weaknesses in the international market. In contrast, Samsung and Huawei have created a strong and mutually beneficial strategic collaboration with Google, which provides its Android OS and content to manufacturers in exchange for their hardware support, giving Google the opportunity to showcase the value of its applications and web services to users. Both large manufacturers and software developers could easily increase their income by stabilizing the inherent competition between their hardware and software advances in the smartphone global market, allowing them to invest in international marketing in the short-medium term, rather than technology.

4.2 Summary

There is no doubt that investment in innovation and competitiveness is the best way to improve companies' profitability. This paper analyzed how smartphone manufacturers implement strategies of continuous innovations to give them a competitive advantage in the global market, in so creating designs and features that have become standard across the industry. In particular, this article focuses on vertical and horizontal product innovations as well as the hardware and software development strategies of three key smartphone manufacturers: Samsung, Huawei, and Apple. This empirical research was based on an original dataset with data regarding most smartphones launched since 2012 by companies operating in various countries or serving a global market.

There was a strong increase in the percentage of new products reaching market YoY, in part because of the appearance of new companies in the smartphone industry market, and in terms of features, smartphones have significantly developed over time, especially regarding new hardware, software, and content functionalities. From the standpoint of innovative activity, these three market leaders have adopted very distinct strategies; Samsung is the most productive in terms of the new hardware its launches onto the global market, while Apple introduced less (although arguably, more anticipated) new hardware. They are followed by Huawei, who currently has the third largest smartphone market share, who have nonetheless, managed extend their market reach much faster than Samsung or Apple. Thus, there was an increase in innovation between 2011 and 2016, driven not only by progression in hardware, but also by companies' specific competitive strategies and management.

Although the market is largely concentrated in a few companies, especially Samsung and Apple, the data suggests that the smartphone industry is very innovative in terms of hardware progression and OS innovation. In this context, the presence of a wide variety of types of smartphone is significant for two reasons: 1) it supports competition among different manufacturers in the global market, encouraging innovation and cooperation between hardware producers and software developers; 2) it serves various types of consumers all over the world. This allows manufacturers and developers to build new features and product

characteristics, which is equally important to companies as non-technological and marketing innovations. In turn, the continued development of these devices strongly influences the technology sector, for instance in converting the permanent network to a mobile one. Because the wide popularity of smartphones is driving this change, it is important to evaluate and monitor the evolution of innovation and competitiveness in this market segment in order to identify future trends in this industry.

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