Mobile Phone Companies Increasing Market Share through Innovations, R&D Spending and Patents

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Abstract
This study aims to analyze the market share of four leading mobile phone companies in the context of their spending on R&D and the number of filed patents. The study aims to identify whether the companies that invest the most in R&D and file more patents have a competitive edge and increased market share compared to others. The adoption and advancement of technologies throughout the documented history of humankind have revealed how employing specific devices has cultivated the power for people and society to communicate. Moreover, innovations in travelling have increased prospects for real-time communication, and innovations in virtual real-time communication like mobile phones and the internet have become a part of everyday life. Following innovations, many companies emerged from nowhere with unique mobile phone devices and continued the business. But, few of them were wiped out from the market because their mobile phone offering was inferior to other competitors. This paper explores the innovation journey of mobile phone companies. In addition, it focuses on four leading brand names and corresponding success failures as well as the role of R&D expense and patents regarding innovations. Usually, innovation is considered as the engine of economic growth that serves customers better products and services and stays relevant in the market. Measuring innovation is not easy, but focusing on R&D and the quantifiable patent indicates that individual companies consistently serve customers with newer and better products.

Keywords: Innovations, R&D Spending, Patents, Market Share, Mobile Phone

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I. Introduction

The mobile phone marketplace is incredibly competitive, and the market has numerous mobile phone brands with lucrative offerings. According to Gadgets 360, there are 170 mobile phone manufacturing companies (Gadget360, 2022). The Droid.com website lists 237 mobile manufacturing companies and suggests 7576 different models from different companies (Droidchart.com, 2022). According to the GSMArena website, there are 117 Mobile companies and 11197 models globally (Gsmarena, 2021). Not necessarily all mobile companies, and the mobile phone model still exists. At the same time, many companies are still present and producing various mobile phone models. The mobile phone market is perhaps the most volatile, challenging, and constantly in the race of competition among brands. Nevertheless, mobile companies deal with continuous technological change, and product innovation is astonishing. Since 1973, mobile phones have emerged from a luxury to a mass consumer market with many value-added services.

Figure 1 has a list of a few mobile phones since 1973 that indicates consistent innovations by various mobile companies (Križanović, 2020; Mobikyo, 2014; Uswitch, 2021).

II. R&D, Patents and Innovations

In general, an innovation endeavor is a complex process and is commonly described as the generation, implementation, and acceptance of new ideas, products, services, or techniques (Ferreira et al., 2020). Innovation capability can be stated as the experience and ability to enrich present products and technologies as well as creating something new by translating expertise into products and processes (Romijn & Albaladejo, 2002). Innovation capability signifies a company’s capability to build innovative tools & products to accomplish exceptional financial performance (Rangone, 1999). In addition, It encompasses the continuous enhancement of the resources and capabilities that a company holds and utilizes to exploit opportunities for developing new innovative outputs (Darroch & McNaughton, 2002; Keiningham et al., 2020).

In the connected global ecosystem, the market is highly competitive and unpredictable. Innovation is the means to meet such market demand, hence innovation...
capabilities are the key factor for the competitive advantage (Rajapathirana & Hui, 2018). Innovation capability requires significant spending on R&D, and it signifies an organization’s capability to build innovative tools & products to accomplish exceptional financial performance (Rangone, 1999). In addition, it encompasses the continuous enhancement of the resources and capabilities that a company holds and utilizes to exploit opportunities for developing new innovative outputs (Koc, 2007). The organization’s intangible property is the essential factor in making such development. Using this property is also an integral component of innovation capability (Saunila & Ukko, 2012). Innovation aids companies in dealing with the troubles triggered by external factors, hence it is an essential element contributing to the overall business success, primarily in a volatile market (Darroch & Mcnaughton, 2002; Keiningham et. al., 2020).

The concept of innovation capability (IC) has been approached from multiple perspectives and can be considered as a multi-faceted construct (Saunila, 2016). Broadly, the IC is classified as radical innovation and incremental innovation (Pascual-Fernández et. al., 2021; Quintane et. al., 2011). Radical innovation refers to developing entirely new expertise and building something that doesn’t exist; or introducing disruption to an existing technical path that enables current products/services to become obsolete (Damanpour, 1991; Mendoza-Silva, 2020).

On the other hand, incremental innovation refers to enhancing the effectiveness of present products by utilizing the insights from the end-users and creating better and more attractive solutions full of novelty, leading to significant profits (Acemoglu et. al., 2020; Lee, 2011; Mendoza-Silva, 2020). The dual-core innovation theory lists innovation into two components, i.e., management innovation and technical innovation (Kalay, 2016). Technological innovation pertains to innovation in organizations’ products, services, or processes corresponding to production, whereas administrative innovation relates to business processes beyond production (Kalay, 2016; Lee, 2011).

Administrative innovations indirectly boost technical innovations; hence, both management and technological innovation are essential and complement each other (Damanpour, 1991). A study suggests five components of IC: Product innovation (create or enhance existing products through modification), market innovation (approaches for advertisement and promotion of products through identification of new market opportunities), service innovation (usability of service processes), process innovation (expansion or enhancement of a production or delivery technique) and organizational innovation (creation of a new organizational technique related to everyday tasks, work environment, or possible external relations) (Mendoza-Silva, 2021).

The creation of patents by companies indicates that such companies are somewhat profoundly investing in innovations. Also, such companies are spending some money on research and development. According to Gautam & Curba, innovation refers to the commercialization of solutions (Ahuja & Lampert, 2001). Therefore, in general, R&D expenses and patents are considered innovation indicators (Kleinknecht et. al., 2002). The reason is that, through R&D activities, one reaches the stage of applying for a patent. The patent documents contain factual information about the innovation process evaluated by a patent office of a government organization (Kang & Motohashi, 2014). Of course, patents could not be the absolute indicator of innovation. But companies spending on research and development as well as the number of patent filings signify somewhat the overall innovation. According to John Adams, former executive vice president of Honda America Manufacturing, few companies delay filing patents about new ideas or solutions, so the world does not know what the company is doing (Heller, 2022).

Table 1 signifies various companies’ rapid launch of the new mobile handset from 1973 until 2020. These companies spend time and money on research & development (R&D) activities as well as filing patents. As a result, each company launched one of the best mobile phones in the past and continued its innovation journey. In this innovation journey, many products created a wow moment for customers and significant business growth in the overall business. Unfortunately, when the product was not welcomed by customers, then losing the market share was observed.

II. Literature Review regarding R&D, Patents and Potential Impacts on Innovation

Table 1: Literature Review Summary

| Authors | Journal | Year | Title | Table 1 | Abstract | Conclusion |
|---------|---------|------|-------|---------|----------|------------|
| Mendoza & Silva (2021) | Mobile Phone Companies Increasing Market Share through Innovations, R&D Spending and Patents | 2022 | | | | |

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IV. Research Hypothesis

The paper assumes that the innovative activities corresponding to R&D expenses and patents of mobile companies have a positive effect on the market share. Hence, the following research hypotheses and variables are proposed:

| Research Hypotheses | Variables |
|---------------------|-----------|
| H1: There exists a positive correlation between R&D expenses and increased patent filings with the market share of mobile companies. | % Market Share, Number of Patents, and R&D Expenses |
| H0: There is no positive correlation between R&D expenses and increased patent filings with the market share of mobile companies. | % Market Share, Number of Patents, and R&D Expenses |

Source: Authors’ own compilation

V. Analysis Method

The study applies the correlation technique to analyze the data, highlighting the nature of the relationship between the market share and innovation through R&D expense and the number of patents. The correlation between two variables is +ve when both variables change in the same direction. For example, when one variable increases, the other also increases, and the further declines when one declines. The correlation between two variables is -ve when both variables change in the opposite direction. For example, when one variable increases, the other decreases, and vice versa. The correlation measures the strength and direction of the linear relationship between continuous variables, i.e. market share, patents, R&D expenses for distinct brands such as Apple, Samsung, Nokia, and Blackberry). After conducting correlation analyses between the two variables using the below formula, this paper shows the matrix for distinct brands:

\[
 r_{xy} = \frac{\sum(x_i - \bar{x})(y_i - \bar{y})}{\sqrt{\sum(x_i - \bar{x})^2} \sqrt{\sum(y_i - \bar{y})^2}}
\]

Where:
- \( r_{xy} \) - Correlation coefficient of linear relationship between variables \( x \) and \( y \)
- \( x_i \) - Values of the \( x \)-variable in the sample
- \( \bar{x} \) - Mean of values of \( x \)-variable
- \( y_i \) - Values of \( y \)-variable in the sample
- \( \bar{y} \) - Mean of values of \( y \)-variable
VI. Analysis of Four Significant Mobile Companies

This paper considers four well-known phone brands to understand their competitiveness with ten years of data sets regarding market share, patents and R&D expenses (Federica Laricchia, 2022b, 2022a; GreyB, 2022c, 2022a, 2022b; Justina Alexandra Sava, 2022; Nils-Gerrit Wunsch, 2021; Statcounter GlobalStats, 2022; Thomas Alsop, 2022).

Nokia

Nokia is a Finnish company founded by Fredrik Idestam in 1865. The name Nokia originates from a town called Nokia and the Nokianvirta river in Finland (Borhanuddin et al., 2016). Traditionally, Nokia business units were paper, cables, rubber, televisions, telecom networks, phones, etc., that have transitioned and transformed into mobile telecommunication infrastructure and mobile handsets (Aspara et al., 2011). However, after numerous years of spectacular success and rising market share in the mobile phone market space, Nokia failed for the transition stage in terms of new era of phones to satisfy customers and keep them loyal to the brand (Doz & Kosonen, 2008).

Table 3: Nokia Ten Years Data (2010-2019)

| Year | % Market Share | R&D Spending (in million US dollars) | No. of Patents |
|------|----------------|-------------------------------------|----------------|
| 2010 | 37.02          | 75                                  | 6.250          |
| 2011 | 38.23          | 71                                  | 6.470          |
| 2012 | 29.91          | 61                                  | 7.471          |
| 2013 | 21.43          | 33                                  | 6.794          |
| 2014 | 13.70          | 20                                  | 5.988          |
| 2015 | 9.24           | 24                                  | 4.497          |
| 2016 | 5.54           | 53                                  | 3.745          |
| 2017 | 2.53           | 60                                  | 3.913          |
| 2018 | 1.47           | 52                                  | 3.883          |
| 2019 | 1.08           | 50                                  | 3.078          |

Source: Authors’ own compilation

**Nokia % Market Share Month-Wise Data is transformed to annually

Table 4: Nokia Descriptive Statistics

|          | % Market Share | R&D Spending (in million US dollars) | No. of Patents |
|----------|----------------|-------------------------------------|----------------|
| mean     | 16.01          | 49.90                               | 5.208          |
| std      | 14.66          | 18.75                               | 1.547          |
| min      | 1.08           | 20.00                               | 3.078          |
| max      | 38.23          | 75.00                               | 7.471          |

Source: SPSS Software Output

Table 5: Nokia Correlations of Variables

|                      | % Market Share | R&D Spending (in million US dollars) | No. of Patents |
|----------------------|----------------|-------------------------------------|----------------|
| % Market Share       | 1.00           |                                     | 1.00           |
| R&D Spending (in million US dollars) | 0.45 | 1.00 |
| No. of Patents       | 0.87           | 0.10                                | 1.00           |

Source: SPSS Software Output

Samsung

Lee Byung-Chul started a grocery trading store named Samsung Trading Co. in Taegu, Korea, in 1938, primarily involved in trading noodles and other items produced in the city and neighborhoods and exporting them to China regions (Peter Bondarenko, 2021). Samsung marked a footprint in the electronics industry in the 1960s. Later, the telecommunications hardware industry in 1980 and the phone market in 1998 with a phone SPH-1300 (Matthew Burris, 2020; Samsung Newsroom, 2013) reflected Samsung’s dominance in the market. Samsung remains one of the largest microprocessor manufacturers globally in the late 20th and early 21st centuries, which signifies that it is a significant player in the mobile phone domain (Bondarenko, 2021).

Table 5: Samsung Ten Years Data (2010-2019)

| Year | % Market Share | R&D Spending (in million US dollars) | No. of Patents |
|------|----------------|-------------------------------------|----------------|
| 2010 | 4.31           | 8.460                               | 7.646          |
| 2011 | 10.64          | 9.260                               | 7.100          |
| 2012 | 18.42          | 11.060                              | 8.706          |
| 2013 | 25.26          | 13.750                              | 11.151         |
| 2014 | 32.07          | 14.260                              | 10.884         |
| 2015 | 31.94          | 13.810                              | 10.096         |
| 2016 | 32.33          | 13.750                              | 8.498          |
| 2017 | 32.97          | 15.620                              | 7.202          |
| 2018 | 30.68          | 17.340                              | 8.348          |
| 2019 | 31.60          | 17.500                              | 2.840          |

Source: Authors’ own compilation

**Samsung % Market Share Month-Wise Data is transformed to annually
Table 7: Samsung Descriptive Statistics

| % Market Share | R&D Spending (in million US dollars) | No. of Patents |
|----------------|--------------------------------------|----------------|
| mean           | 25.02                                | 13.481         |
| std            | 10.37                                | 3.079          |
| min            | 4.31                                 | 8.460          |
| max            | 32.97                                | 17.500         |

Source: SPSS Software Output

Table 8: Samsung Correlations of Variables

| % Market Share | R&D Spending (in million US dollars) | No. of Patents |
|----------------|--------------------------------------|----------------|
| % Market Share | 1.00                                 | 1.00           |
| R&D Spending (in million US dollars) | 0.89 | 1.00 |
| Patents        | 0.07                                 | -0.20          |

Source: SPSS Software Output

RIM (Blackberry)

Mike Lazaridis and Douglas Fregin started a company, Research in Motion (RIM), widely known as Blackberry, a Canadian-based multinational company, in 1984 (McGrath, 2013). Blackberry predominantly provides software and hardware platforms as well as solutions to instant messaging, e-mails, browsing, Internet, intranet-based applications, etc. (Youssef, 2013). Before Apple's phone entered the phone business in 2007, it was a time when almost the entire corporate working people wanted Blackberry because of its unique e-mail features, ease of use, and excellent security (Trivedi, 2017). However, later 2007 onwards, Blackberry could not catch up with the leading innovation appearing in the market, primarily Apple, followed by Google Android (Sarno, 2010). Blackberry tried to tantalize the market in January 2013 with new smartphone models, Z10 and Q10, but it seems it was not enough compared to competitors like Apple and Android phones (Timmer, 2021; Hill, 2013). As a result, Blackberry's phone business collapsed significantly, and the company decided to sell patent assets (Amadeo, 2022).

Table 9: Blackberry Ten Years Data (2010-2019)

| Year | % Market Share | R&D Spending (in million US dollars) | No. of Patents |
|------|----------------|--------------------------------------|----------------|
| 2010 | 19.40          | 965                                  | 4.337          |
| 2011 | 14.72          | 1.351                                 | 4.916          |
| 2012 | 5.48           | 1.556                                 | 4.633          |
| 2013 | 3.63           | 1.509                                 | 2.565          |
| 2014 | 1.97           | 1.286                                 | 1.002          |
| 2015 | 1.25           | 711                                   | 725            |
| 2016 | 0.81           | 469                                   | 725            |
| 2017 | 0.32           | 306                                   | 624            |
| 2018 | 0.11           | 239                                   | 603            |
| 2019 | 0.04           | 219                                   | 545            |

Source: Authors’ own compilation

**Blackberry % Market Share Month-Wise Data is transformed to annually.

Table 10: Blackberry Descriptive Statistics

| % Market Share | R&D Spending (in million US dollars) | No. of Patents |
|----------------|--------------------------------------|----------------|
| mean           | 4.77                                 | 861            |
| std            | 6.79                                 | 539            |
| min            | 0.04                                 | 219            |
| max            | 19.40                                | 1.556          |

Source: SPSS Software Output

Table 11: Blackberry Correlations of Variables

| % Market Share | R&D Spending | No. of Patents |
|----------------|--------------|----------------|
| % Market Share | 1.00         |                |
| R&D Spending   | 0.47         | 1.00           |
| No. of Patents | 0.84         | 0.74           |

Source: SPSS Software Output

Apple

The Apple Computer Company was founded by Steve Jobs and Steven Wozniak in 1976. Their first computer circuit board was ready with sales orders for 200 units in two months of working in their garage (Oldcomputers, 2022). Apple was an established brand long before making smartphones. The company started with computers and followed up with iPods, and in the first quarter of 2007 company sold over 21 million iPods, corresponding to 48% of its revenues (Apple Newsroom, 2007). Steve Jobs presented the first iPhone in January 2007, which proved a revolutionary product because it combined the functionalities of the iPod into a small
mobile phone with a touch screen, and it was able to access the internet like a computer (Merchant, 2017). The company launched the iPhone in 2007 as the most advanced "smartphone," featuring many features and capabilities that were many years ahead of its competitors, creating excitement among customers, and becoming a formidable force among competitors (Rarick, 2011).

### Table 12: Apple Ten Years Data (2010-2019)

| Year | % Market Share | R&D Spending (in million US dollars) | No. of Patents |
|------|----------------|-------------------------------------|----------------|
| 2010 | 29.32          | 1.780                               | 4,171          |
| 2011 | 27.75          | 2.430                               | 4,519          |
| 2012 | 24.71          | 3.380                               | 6,424          |
| 2013 | 24.39          | 4.480                               | 6,095          |
| 2014 | 23.86          | 6.040                               | 5,562          |
| 2015 | 20.30          | 8.070                               | 6,080          |
| 2016 | 19.32          | 10.050                              | 5,812          |
| 2017 | 19.66          | 11.580                              | 4,814          |
| 2018 | 20.58          | 14.240                              | 5,233          |
| 2019 | 22.70          | 16.220                              | 4,727          |

**Source:** Authors’ own compilation

**App% Market Share Month-Wise Data is transformed to annually.

### Table 13: Apple Descriptive Statistics

| % Market Share | R&D Spending (in million US dollars) | No. of Patents |
|----------------|-------------------------------------|----------------|
| mean           | 23.26                               | 7.827          | 5,343          |
| std            | 3.42                                | 5.060          | 765            |
| min            | 19.32                               | 1.780          | 4,171          |
| max            | 29.32                               | 16.220         | 6,424          |

**Source:** SPSS Software Output

### Table 14: Apple Correlations of Variables

| % Market Share | R&D Spending (in million US dollars) | No. of Patents |
|----------------|-------------------------------------|----------------|
| % Market Share | 1.00                                |                |
| R&D Spending   | -0.75                               | 1.00           |
| No. of Patents | -0.41                               | -0.08          | 1.00           |

**Source:** SPSS Software Output

### VII. Conclusion and Recommendations

The correlation matrix for the companies Nokia, Samsung, and RIM (Blackberry) indicates that R&D spending and patents are correlated positively with the % market share. At the same time, the correlation matrix for the company Apple shows that R&D spending and patents are correlated negatively with the % market share. Out of all four companies, three have a positive correlation, hence both hypotheses tend to be valid.

Mobile phones have transformed considerably from simple to smart for becoming information and communication pivots essential to modern-day life (TigerMobiles, 2019). In the last 30 years, almost all mobile phone companies have launched phones with unique features to entice the end-users and gain market share. As a result, companies have a race to compete and increase their market share by servicing customers with the best phone features, and the race continues (Križanović, 2020; Zaman, 2020).

Moreover, spending money on research, development and patents signifies that companies are working towards innovations to build new products and services. Also, such companies have the potential to stay ahead of their competitors and maintain a competitive edge. Further research considering more than ten years of data and more than four mobile brands shall show a more precise correlation of market share with R&D spending and patents.

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