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Patents and Customer Satisfaction: A Relational Study

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ABSTRACT

This study will examine whether patents have an effect on customer satisfaction, specifically studying the smartphone industry. The first section of the thesis will focus on the background of patents and whether they are effective in their goal of innovation. A brief discussion of the infamous *Apple v. Samsung* case will provide some insight into the cost of maintaining the patents. This section will also discuss customer satisfaction and the effect it has on a company's financial performance. The second section will conduct an empirical analysis between customer satisfaction and patents. Using a correlation study between the number of smartphone patents each year for Samsung, Apple, LG and Motorola, and comparing that to the respective customer satisfaction rating, this thesis finds that there appears to be a correlation between the two. The thesis then concludes with an interpretation of these results and suggestions for continuing to improve the research.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

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Chapter 1: Introduction

Patents have been a heavily debated topic for years now. While many argue that patents spark innovation and new ideas, others say patents have the exact opposite effect, actually hurting small entrepreneurs from ever having the chance to prosper. However, both sides agree that patents play an important role in the business process.

According to the United States Patent and Trademark Office (USPTO), a U.S. patent is defined as a property right granted by the Government of the United States of America to an inventor to exclude others from making, using, offering for sale, or selling the invention throughout the United States or importing the invention into the United States for a limited time in exchange for public disclosure of the invention when the patent is granted ("Glossary"). This means that a person or corporation, for a limited time, can have the right to exclude others from the invention that they patented. This can be very valuable, especially in sectors such as pharmaceuticals, high technology and other complex sectors with high price goods requiring extensive knowledge to produce. Yet, as perfect as the definition makes patents sound, the actual patent system holding these values in place is anything but.

In 2017, the estimated number of global patents currently active was 13.7 million (Diakun). By now, this number has surely grown with approved patents consistently growing year over year (though a large number also expire every year). From 2008-2018, worldwide patent grants have increased at an average growth rate of 6.2% ("Patents"). With all these patents circulating around the globe, it is common sense that some of these patents will succumb to patent infringement, where another person or company come up with a similar invention that possesses the same characteristics of the already patented product. No infringement context gained quite as much attention as the Apple-Samsung case in the U.S. in 2012. More will be

explained in the next section, but to summarize, Apple alleged Samsung was guilty of infringing several of Apple's patents, and these claims spiraled into a long and extremely costly battle for both sides (Shin and Brown). With so much time and money put into the process, many wondered why these two leaders of the industry cared so much about these patents.

This question is the motivating issue for this thesis. The end goal of a patent is to develop a product that is more innovative than others. An overlooked part of this patent process is how the *customers* of those products feel. With the consumer being the one actually purchasing the products that these patents are protecting, it begs the question whether the time, effort and cost of securing these patents are noticed and appreciated by the customers.

The first part of this paper will dive deeper into some of the background of patents, as well as the "Patent War" between Apple and Samsung. The section will also focus on customer satisfaction ratings, and what they truly mean to a company. The second section will focus on an empirical research study behind the aforementioned question, that compares the number of patents by company over the recent years to the customer satisfaction ratings that those respective smartphone companies received. Using this data, we will attempt to see if there is any evidence that patents and the satisfaction of their customers are connected.

Chapter 2: Patent Background

As discussed earlier, a patent is a granted license that protects the new, non-obvious and useful work of innovators, whether it is an item or a process ("Glossary"). Patents cover the invention underlying a product or process rather than something physical ("Inventions and Patents"). The only one allowed to use, make or sell a patented item is the entity who owns the patent or has a license to it. In order to receive the patent, it also must be reviewed and approved after examination by the patent office (which, in the U.S., is the U.S. Patent and Trademark Office). This examination can take years, and there is no guarantee that a patent will be approved ("General Information"). This must also be done for each country that the person wants to use, sell or make the patented idea ("Protecting Intellectual Property Rights Overseas"). Many of the patents granted may never be worth anything, whether the thing patented was not commercially valuable or if it never became commercialized in the first place. Around 97% of patents will never recoup the cost to filing for them (Key). Arguably, a patent is very similar to a lottery ticket. You invest capital into an idea with low odds of winning, but occasionally they will reward the gambler. And sometimes those patents can pay off immensely; just look at Amazon and patent number US5960411 ("Bibliographic Data"). This patent contains Amazon's One-Click payment system. To put it simply, the one-click system allowed Amazon users to purchase items online in, you guessed it, one click. By saving all the users information, buying something online was made simpler than ever. Even Apple is paying Amazon for the use of the one-click system on their app store. Some say the patent accounts for up to 5% of the top line for Amazon, meaning in 2011 that would account for $2.4 billion in revenue (Arsenault).

Patents don't last forever though, as owners of the patent are given a period of time that the patent is effective. Currently, utility patents last for 20 years after the filing date, minus the

time for the examination. Design patents last 15 years from the date granted (35 USC 173). In the last example with Amazon, the utility patent was filed in 1997 and granted in 1999, so the patent ended in 2017, 20 years after the filing date. This left plenty of time for Amazon to get the competitive advantage though, and draw in millions of customers around the globe.

Patents: Are they effective?

Some researchers believe that patents spark innovation and allow for average citizens the chance to gain competitive advantage over the big firms with more resources and capability, and that patents help protect them and give them a chance to survive against the giants of the corporate world. However, there are also a large group of researchers with quite the opposite point of view. This group argues that the patent system is strangling the smaller firms and producing less value from their patents. The large companies with over 90% of the overall research and development spending are able to take advantage and either change their product to match the small firms at a higher quality, or just make a better product outright (Bessen et al. 19). This side also argues that patents themselves are providing minimal incentives, and in most cases, actually costing the company more than helping it.

The skeptical group does argue that patents do in fact have some positive gross value. According to a study done by James Bessen in 2006, the mean patent value for US patents is $78,168 (Bessen et al. 102). In this same study, the median patent value was $7,175. This means that the patent value is heavily skewed right, with the majority falling below $10,000. This also means that there are some outliers resulting in the much larger mean.

An additional way to think about patent value is to look into the maintenance fee to renew the patent. These fees are due at 3.5 years, 7.5 years and 11.5 years for US patents ("USPTO Fee Schedule"). If the owner of a patent does not pay this fee, then it can be inferred the patent is worth less than the fee, as an owner is not even willing to pay for the extension and

continued protection offered by the patent. In a 1984 study done by Pakes and Schankerman, they examined the percent of patents that expired in the year that the renewal fee was due. The author used this study with 1991 granted patent data to find the following percentages (Bessen et al. 100).

	4th Year	*8th Year*	*12th Year*	*17th Year (Full term)*
Percent expired in year	20%	21%	17%	42%
Average fee due in 1992 $U.S.	$814	$1,562	$2,327	—

Figure 1. Patent Renewal Rates (Bessen et al. 100)

This data shows that almost 60% of patents were worth less than a few thousand dollars, with only 42% of patents being renewed throughout the entire available time period. The current renewal fees for 3.5, 7.5 and 11.5 years today are $2,000, $3,760 and $7,700, respectively ("USPTO Fee Schedule"). Assuming these percentages stay the same, the majority of patents would fall below $15,000 today. The authors of the textbook note that this is just the gross value of these patents, so it is important to look at the other costs associated with patents to determine the true value.

When looking at the net value, they show that most of these values are actually negative. Much of the costs of patents originate in two areas: research and development, and patent litigation. To put into perspective, Apple spent $16.25 billion on research and development spending in 2019 ("Apple's Research and Development"). In this same year, Apple was granted 2,490 patents (Lunden). Assuming the mean patent value is $80,000, which is probably low considering the Bessen study was conducted in 2006, this would put the value of those patents at around $200 million. Now, this is not saying those patents are necessarily worth $200 million; they could be worth a lot more or less. But if one were to imagine all of that research and

development spending is going into patentable ideas, this means the patents would have an average value of over $6 million just to break even to the R&D costs.

Another large portion of the costs are the litigation costs. As more patent applications are being filed, litigation cases rise. According to a 2018 PWC study, around 4000 patent infringement cases were filed in 2017, with a compounded annual growth rate of 3.4% (Ansell et al.). The median damage award was $6 million, but the time to trial was a median of 2.5 years. So, while you may get the award eventually, it may take a few years to receive it. A 2007 study by Bessen and Meurer also looked into the news of litigation and the effect it has on publicly traded firms stock price, for both the plaintiff and defendant (Bessen et al. 137). According to the study, it first looked into companies where the news was displayed in the Wall Street Journal. On average, the defendant lost 2.6% on their price per share, while the plaintiff was unaffected. In another methodology, it looked into litigation news breaking for companies that were both public. In this example, the defendant dropped an average of 0.62%, while the plaintiff also dropped 0.38% respectively. This shows that the market has a negative view on patent litigation, both for the defendants and plaintiffs.

Wall Street's negative view of patent litigation is most likely due to the costs that arise from the cases. In a study done by James Bessen from 1996-1999, it showed the annual litigation costs for both small and large firms, as well as several sectors, such as software. The cost was in terms of 1992 dollar value. For firms with over 500 employees, which for the most part is any publicly traded company, the annual litigation cost was $10.8 billion, which is about $20 billion today (Bessen et al. 143). Of this, software companies paid $3.8 billion, or about $7.2 billion today ("in2013dollars"). This is a massive amount to spend on patent litigation. In this same text, it claims of the cases that made it to trial, only 4% were deemed to be intentionally copying the

patent and required to pay *enhanced* damages (Bessen et al. 126). While many cases could settle early and recoup some money, this shows that companies are paying lots of money for these cases and receiving little in return.

Smartphone Patent Litigation: Apple v. Samsung

Patent litigation shows the costs and efforts that are needed in order to get the most out of a company's respective patent portfolio. Enforcing patents is costly, and one of the largest lawsuits in the past decade featured two of the leaders in the smartphone industry. The *Apple v. Samsung* case captured the attention of the world and is a prime example of the effort needed in order to protect the power and seize the benefits of patent holdings. In April 2011, Apple sued Samsung for patent infringement for both design and utility patents (Shin and Brown). Most of the litigation focused on design patents, specifically the black rectangular face, sixteen grid icon format and the rounded corners, all of which were not found in previous Samsung phones, but were in the models following the initial iPhone release. After the first ruling of the case, the jury awarded over $1 billion in awards, citing both patent infringement and trade dress. After appeal to the Federal Circuit, the court found Samsung liable for $399 million, removing the trade dress damages. Samsung, still unsatisfied, appealed to the Supreme Court (Shin and Brown).

Samsung took its appeal to the Supreme court to contest the calculation of the design patent award. For the design patents, the total profit method was used, meaning all profits made from infringing Samsung products must be paid to Apple in damages. The Supreme Court ruled that this was not necessarily true, as a design patent may cover only a piece of a sold good (137 S. Ct. 429 (2016)). In other words, the "article of manufacture" on which a defendant owes damages may be less than the entire product sold to the public (Klantschi). The jury ended up using a four-factor model to figure out the payment, resulting in a larger award for Apple (Kusha). The U.S. District Court in San Jose determined the final award to be $539 million. Of

that, $533.3 million was from the design patents and a much smaller $5.3 million was due to utility patents (“Reuters”).

Importantly, to focus the analysis, this paper will consider utility patents only. Since design patents don’t cover useful inventions, but instead cover the design or look of an article of manufacture, they can be separated from the analysis in this paper. The relevance to the Samsung and Apple litigation is of course not insignificant and might be relevant for future study. This also helps show the large difference between how utility patents and design patents are priced in litigation. As stated earlier, for a design patent, the owner of the patent can recover the defendant’s profits made from infringement of the patent. For utility patents, the owner of the patent can recover only their own lost profits from the infringer’s use of the invention. This will usually result in utility patents having lower rewards (Vittengl).

In the Apple-Samsung Case, it is also important to understand the costs of the litigation. The first lawsuit was filed in April 2011. The award was finally determined in May 2018. This means that the litigation lasted over seven years. While the final legal fee was unavailable, public reports suggest that Apple spent $60 million on legal fees between the filing date and December of 2013 (Wakabayashi). This most likely means the end fee exceeded $100 million. While the end award still allowed Apple to make money off this litigation, it is important to think about how much time and effort went in to the process.

Chapter 3: Customer Satisfaction, The Forgotten Metric

When assessing the value and health of a company, many ratios and equations come to mind. Price to earnings ratio, market capitalization, debt-to-equity ratio and market value per share are just a few of the countless calculations financial analysts look into when discussing how well or poorly a company is performing. A metric that is rarely talked about is the customer satisfaction rating for the company.

A company cannot profit without customers. If no one is purchasing or using the respective product or service, it is not making money, and not making money is a quick way for businesses to become extinct. Having customers is one thing, but having returning or prolonged customers is another. Keeping customers satisfied should help retain them. So why is a metric that helps explain the satisfaction of customers, who are the driving source of all revenues and whose satisfaction helps them return to the respective company, not discussed more often?

To examine the importance of customer satisfaction, this thesis considers a study done in 2008 by Christina Chi and Dogan Gursoy (Chi and Gursoy). The study focused on the hotel industry, and conducted analysis of several different correlations between employee satisfaction, customer satisfaction and financial performance. The most interesting for purposes of this thesis is the impact of customer satisfaction on financial performance. In the study, Chi and Gursoy surveyed customers from 250 hotels across five destinations, and the financial data was collected from all the managers. The summed scores for all the survey questions were used based off each hotel financials. When the correlation between customer satisfaction scores and financial performance was performed, it showed a strong positive correlation, helping to prove the hypothesis that higher customer satisfaction ratings will lead to increased financial performance.

Although this study is performed in the hospitality sector, it is possible this same correlation could hold true when looking at other industries. According to the same study, customer satisfaction is a prerequisite for loyalty and word-of-mouth behavior. This is key in both retaining customers, as well as attracting new ones. It is also proven that existing customers are cheaper to retain than acquiring new customers. While these are particularly important for service-based industries such as hotels, it would seem to relate to the product markets as well.

This is not the only study that proves the correlation between customer satisfaction and financial performance. Phil Bak of Exponential ETFs put an ETF together consisting of some of the companies with the highest customer satisfaction ratings, according to the American Customer Satisfaction Index. The following shows the results of that ETF compared to the market (S&P 500) over several time periods.

	1 month	3 months	1 Year	3 Years	5 Years	10 Years
Performance of Index based on Customer Satisfaction	-0.10%	6.50%	18.90%	16.20%	16.00%	16.20%
S&P 500	0.60%	7.70%	10.60%	18.00%	17.30%	14.00%

Figure 2. Customer Satisfaction ETF return vs. S&P 500 (Kestenbaum)

This shows that no matter how the market is doing, these companies consistently perform well. A big reason for this consistency is higher customer satisfaction ratings allow for more capacity to change processes or fall below expectations without the same consequences that other competitors face. For example, Amazon, the highest rated company, raised their Amazon Prime services, yet received no negative consequences since people will still use their services. On the other hand, if Walmart, one of the lowest rated companies, decided to raise prices on their products, they may receive more backlash since customers may now switch retailers since they are not satisfied with the services that Walmart provides (Kestenbaum).

Chapter 4: Event Study

Purpose of Study and Hypothesis

This thesis has highlighted many studies that have been performed to identify the value of patents to their respective companies. There have also been studies correlating customer satisfaction and financial performance. However, there is a gap between the two studies. This paper will attempt to fill that void and see if there is a correlation between patent ownership and customer satisfaction. If a correlation is found, this could possibly be combined with previous studies to show that patents have a positive effect on financial performance.

In order to run the correlation, I identified patents relevant to the smartphone industry. With tens and hundreds of thousands of patents surrounding the product and services of a smartphone, this is far from an easy process. As discussed earlier, thousands of patents have very little value, but a few may hold tremendous value. By using a process that is collecting these patents in bulk, there is no real way to decipher each individual patent value. Since I do not have background to review individual patents and decide which ones are valuable and which are not, all patents in the search are used. As described later, I used classification codes to distinguish the relevant patents from the irrelevant. This methodology was discovered while analyzing a 2012 Fordham study observing the impact of patent acquisition on companies (Reidenberg and Debelak). While these codes contain many smartphone patents, there is the definite possibility of underestimating or overestimating the data collected. Other smartphone patents can fall outside of the selected classifications, resulting in patents being missed in the search. Conversely, patents may be overestimated since not all patents in that classification necessarily relate directly to a smartphone, especially for a company like Samsung that manufactures many different products. However, as an introductory study, the classification codes used will suffice in allowing us to analyze the connection between the two areas we are focusing on.

My hypothesis for the study was that the number of patents for each company would directly correlate to their customer satisfaction rating, and thus, as more patents were issued, the customer satisfaction rating would also tend to increase. With companies investing so much time and money into the research and development of their products, one would assume that these investments and enhancements are resulting in a better product. This prediction assumes that consumers are acknowledging the new additions to the products, and that those additions that companies deem as benefits are also deemed so by the consumers. If this hypothesis is proved incorrect, it could help show that the investment and process of gathering patents is more intensive than it is worth.

Methodology and Data Collection

For my customer satisfaction ratings, I utilized the scores from the American Customer Satisfaction Index (ACSI). The ACSI surveys over 500,000 customers per year, ranging across 47 different industries and approximately 400 firms (Fornell et al.). The index measures the satisfaction of U.S. household consumers with the quality of products and services offered by firms with a significant share in U.S. markets ("About the American Customer Satisfaction Index"). The index is measured on a 0-100 scale, with the key inputs to this score revolving around perceived quality, customer expectations, and perceived value. Using the surveys, the ACSI software determines the correct weights to assign to each of the three inputs, which then applies these weights to each respective input to compute the final score ("The Science of Customer Satisfaction").

Since the inception of the ACSI, there have been several studies relating to the index and how it affects certain areas of business. Manufactured goods have consistently had higher customer satisfaction ratings than services. For example, a cell phone manufacturer, such as Apple, has had higher ratings than the cell phone carrier company, such as AT&T. The index has

also found that for almost all industries measured, quality of the products has played a more important role than the price. Price has resulted in short term benefits, but it has failed to prove sustainable ("Key ACSI Findings"). An additional study outside of the ACSI was done to measure how the index compared to the financial markets. In the study, the authors chose portfolios based off ACSI index scores, both high and low, and compared those portfolios to the S&P 500 index over a ten-year period. With each portfolio starting as a $100 investment, the high ACSI score portfolio end value was around $312, the S&P was around $205, and the low ACSI score portfolio was around $98. They also found no significant risk differences between portfolios while using the CAPM, Fama-French and Carhart, all of which adjust for risk. With this study, they helped show the financial value of the intangible resource that is customer satisfaction (Aksoy et al. 112).

For my patent research, the data process was not as simple to find or set up. With hundreds of thousands of patents involved in a smartphone ("Too Many Patents"), figuring out a way to find the most relevant patents was a key. During my research, I encountered a study done by Fordham University, which focused on new patents deriving from the smartphone industry. The study focused on how the new patents were distributed between three categories: Software, Hardware and Communication. For each category, they picked several different United States Patent Classification (USPC) codes to focus on that defined each category. A total of 14 USPC codes were chosen. While my research does not focus on these different categories, it was valuable to see which USPC codes Fordham was using in their study, since these were deemed to be the closest that they could get to picking the "smartphone patents" (Reidenberg and Debelak).

Unfortunately, the U.S. Patent and Trademark Office switched from USPC codes to Cooperative Patent Classifications (CPC) codes, which are used globally, starting in December

31st, 2014 (“Searching with CPC”). In order to use the same methodology as the Fordham study, I had to use statistical mapping provided by the United States Patent and Trademark office to correspond the USPC codes used in the Fordham study to the current CPC codes that would be utilized in my current study (“Classification Symbol Lookup”). For each of the USPC codes, I recorded the CPC codes related to the respective USPC code. After this step, I had all the CPC codes needed to complete my research. All of the classification codes derived from the USPC codes can be found in Appendix B. Using the USPTO patent search database, I then performed search queries that encompassed the three important aspects needed for my data analysis: Assignee Name (AN), Issue Date (isd)[1] and the Current CPC Classification Class (CPCL). For the assignee name, the company name was inserted. The issue date was a range of January 1st- December 31st for each year, in order to match the number of patents each year with the corresponding ACSI score. The current CPC classification classes were the same for each company. An example of a search query can be found below:

AN/samsung AND isd/1/1/2020->12/31/2020 AND (CPCL/G02$ or CPCL/H04$)

The complete search queries can be found in the appendix. For each company, I would perform this query, only changing the issue date years (For example, changing the above 2020 year to 2019). I would record the number of patents produced for each search. To increase the amount of data to analyze, I also performed a similar search as above, but narrowing it to the classification sections. I broke it down into G sections, H sections and others. Thus, any classification codes starting with G would fall into the G section, H into the H section, and

[1] Issue Date was chosen rather than Application date due to the nature of the study. Since patents can be applied for but not approved, those patent applications may never be put into a final product. Therefore, the issue date was utilized since all issued patents have the possibility of being put into an end product for a consumer to use, which could eventually receive a customer satisfaction rating.

anything else would fall into other, since most of the patents fell into the aforementioned sections.

With this data now collected, I conducted a correlation study between the number of patents for each year and the respective ACSI score. I chose a correlation in order to find if there was a relationship between the two variables. While correlation is unable to prove causation, it shows how the two variables move together over time. The equation for correlation is shown below:

$$r = \frac{\sum(X - \overline{X})(Y - \overline{Y})}{\sqrt{\sum(X - \overline{X})^2}\sqrt{(Y - \overline{Y})^2}}$$

where:

r = the correlation coefficient

$\overline{X}$ = the average of observations of variable X

$\overline{Y}$ = the average of observations of variable Y

Figure 3: Correlation Equation and Variables (Hayes)

The correlation ranges from -1 to 1, with 1 being an exact positive correlation (an increase in patents results in a proportionally equal increase in ACSI score) and -1 being an exact negative score (an increase in patents results in a proportionally equal decrease in ACSI score). A correlation around 0 explains that there is no correlation between the two variables (Hayes). No lag effect was chosen when looking into the year range used for each correlation. The number of patents issued in a year were matched up directly with the ACSI score of that same year. To explain, all 2012 patents for Samsung were correlated against the 2012 ACSI score for Samsung. When discussing with my supervisor, we found no clear evidence suggesting to use a lag effect in one way or the other. Patents differ in this variable often, with some innovations being used

before even having the patent issued, and others waiting a few years to be implemented once the patent has been issued. With the smartphone industry also being a rapid moving innovation market, one can argue that an issued patent will be used as soon as possible after issuance (if it is a valuable patent), and thus that it will most likely be used in a product that same year or soon in the future.

I also plotted the data into line graphs to visually represent the information, as it is difficult to visualize the correlation results. The following tables and graphs will be found below in the following section.

Results

This section will present and give a brief explanation of the findings of this study. While the overall findings are a bit mixed, when looking deeper into the trends, it seems that we can find a positive correlation between the number of patents and the overall customer satisfaction score given by the ACSI ("Benchmark By Industry"). The first four tables found in the Appendix show the results of the patent search for each company, as well as the ACSI score for each respective year.

An important and interesting discovery to note is the total number of patents for each company over the nine-year period. Samsung had 70,080 patents, which is more than the other three companies combined, showing the importance of patents to Samsung. LG had the second most patents with 32,281, Apple third most with 18,349 and Motorola ranks last with 2,980. Since LG and Samsung have additional manufacturing lines other than just smartphones, this could show that not all of these patents necessarily relate to smartphones. While this analysis was determined to be a way to get the "smartphone patents", this may show that the search results are picking up on some other industries outside of the smartphone industry.

With the patent data found, the correlation function on Microsoft Excel was used to find the correlation between the number of patents for each company and the respective customer satisfaction rating throughout the 2012–2020 time frame. This correlation was also run for each patent section, so results below will also be shown for Section G, Section H. The correlation value is found in the bottom left of each table. In addition, the graphical representation will be shown below the correlation tables in order to visually see the how the correlation is shown. These graphs were also designed for Section G, Section H and other patents. Correlation tables and graphs for "other" patents can be found in Appendix. Due to a much smaller volume of patents in the other category, for the discussion of the thesis, the main focus will be on all patents together, as well as Section G and Section H.

Table 1: Correlation Values, All Patents (2012-2020)

Company	***2012 - 2020***	***Number of Patents***
Samsung	Customer Satisfaction Ratings	0.833581821
Apple	Customer Satisfaction Ratings	-0.215093642
LG	Customer Satisfaction Ratings	0.682314614
Motorola	Customer Satisfaction Ratings	-0.497698909

Figure 4: Samsung Patents vs. Customer Satisfaction (All Patents)

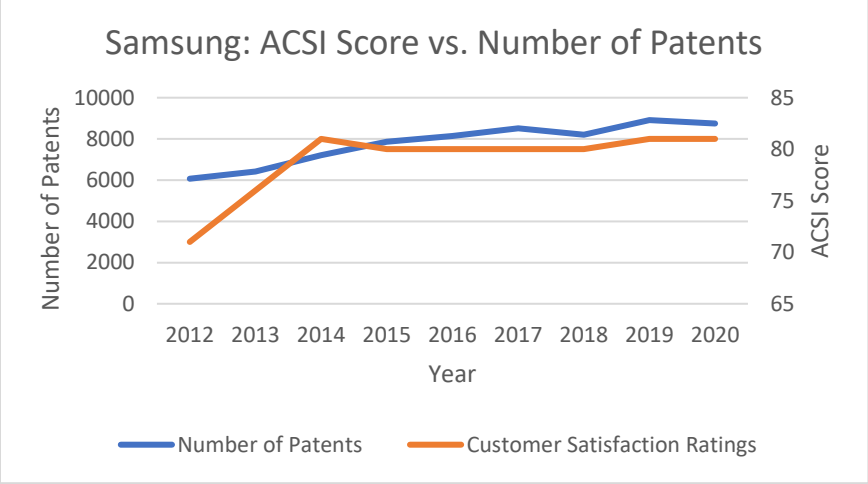


Figure 5: Apple Patents vs. Customer Satisfaction (All Patents)

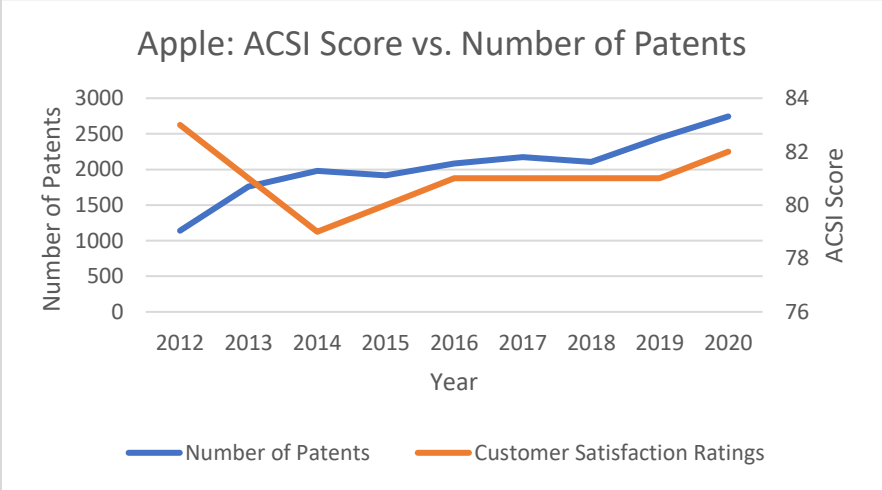


Figure 6: LG Patents vs. Customer Satisfaction (All Patents)

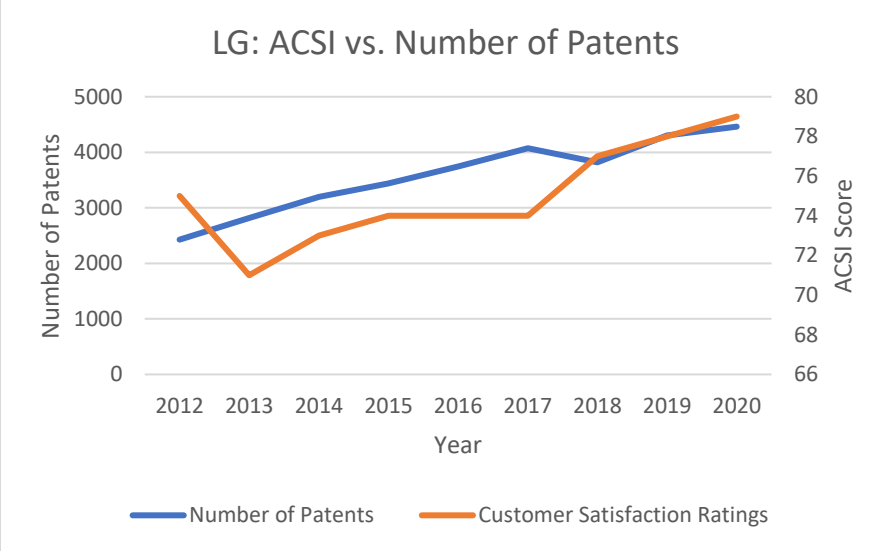
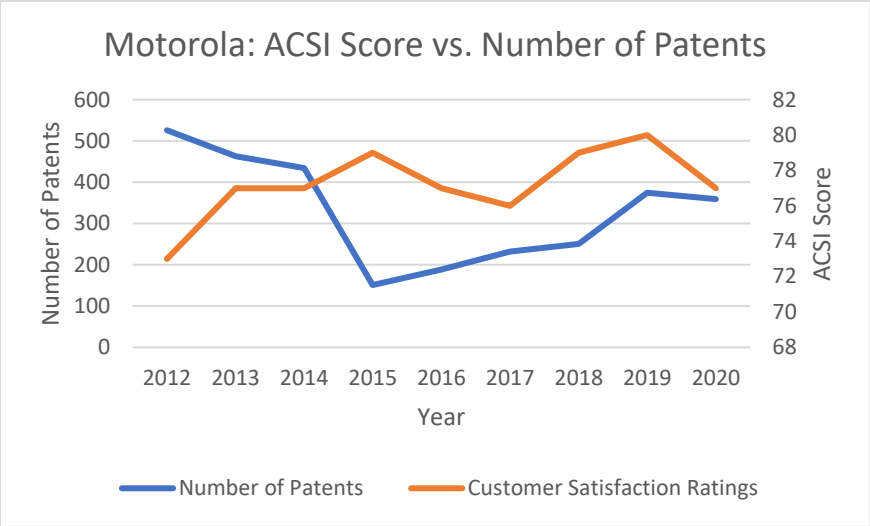


Figure 7: Motorola Patents vs. Customer Satisfaction (All Patents)



The charts above show a fairly strong correlation with Samsung and LG, with patents increasing almost every year for both with mostly rising or stable customer satisfaction ratings. Apple and Motorola overall have inverse relationships, especially over the first few years of the study. Their ratings are increasing while their patents were decreasing.

Table 2: Correlation Values, Section G patents (2012-2020)

Company	***2012 - 2020***	***Section G Patents***
Samsung	Customer Satisfaction Ratings	0.72789619
Apple	Customer Satisfaction Ratings	-0.238847515
LG	Customer Satisfaction Ratings	0.831107747
Motorola	Customer Satisfaction Ratings	0.160425852

Figure 8: Samsung Patents vs. Customer Satisfaction (Section G)

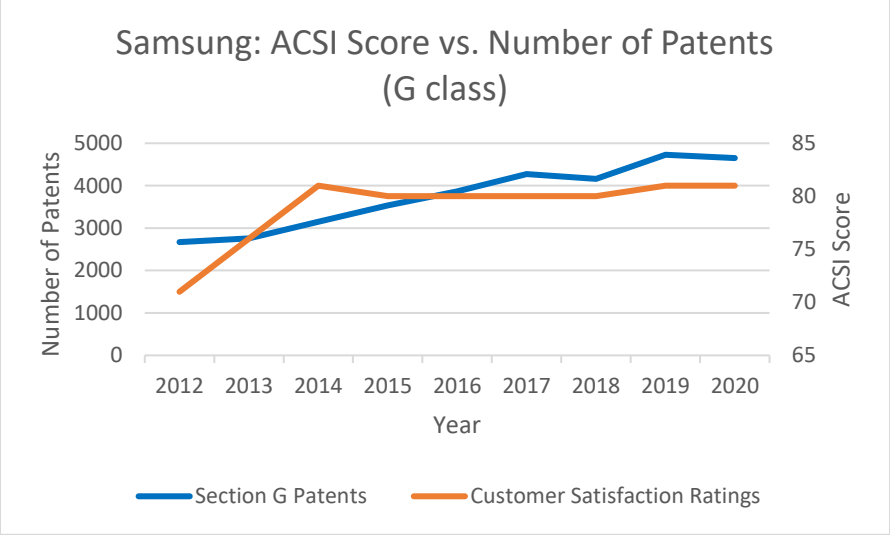


Figure 9: Apple Patents vs. Customer Satisfaction (Section G)

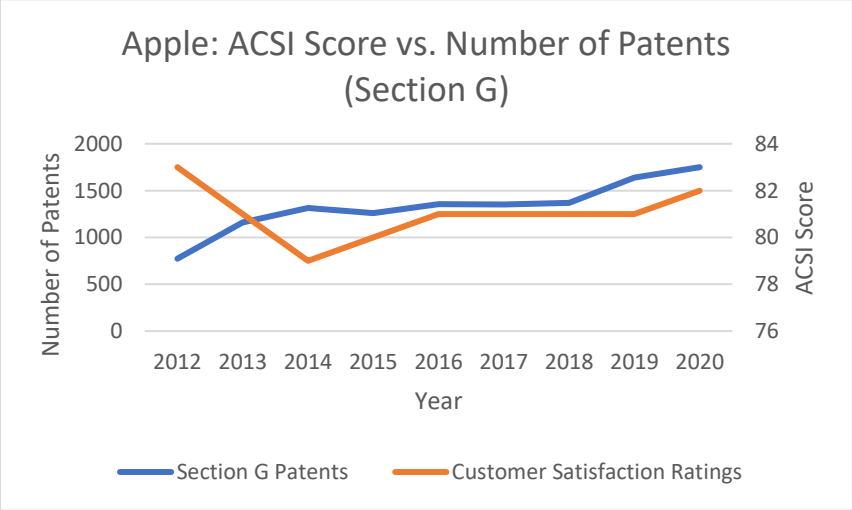


Figure 10: LG Patents vs. Customer Satisfaction (Section G)

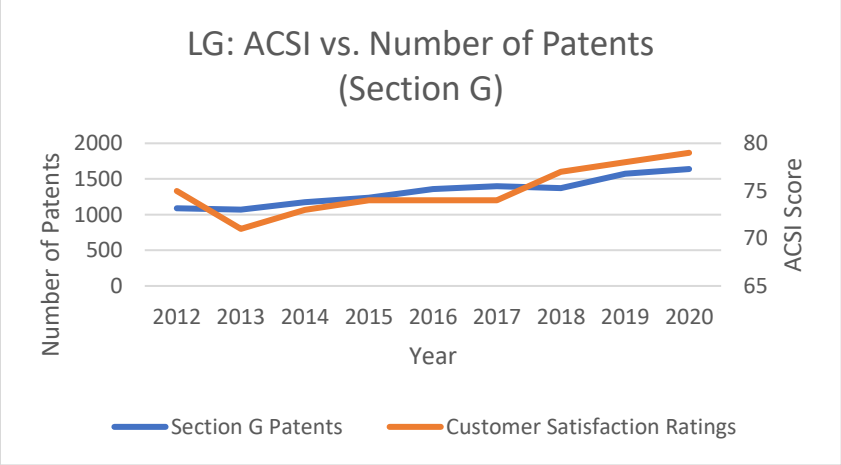
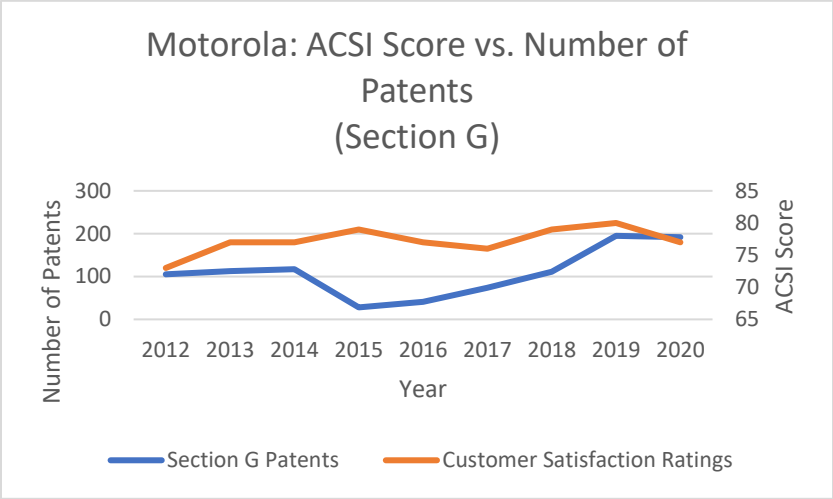


Figure 11: Motorola Patents vs. Customer Satisfaction (Section G)



With the same ratings used, they are now compared to section G patents only. Compared to all patents, these correlations values are slightly lower for Samsung and Apple, and higher for LG and Motorola. The growth rate of section G patents is similar for all the companies involved, all increasing at a small positive rate.

Table 3: Correlation Values, Section H (2012-2020)

Company	***2012 - 2020***	***Section H patents***
Samsung	Customer Satisfaction Ratings	0.863059243
Apple	Customer Satisfaction Ratings	-0.110251128
LG	Customer Satisfaction Ratings	0.643999544
Motorola	Customer Satisfaction Ratings	-0.564810888

Figure 12: Samsung Patents vs. Customer Satisfaction (Section H)

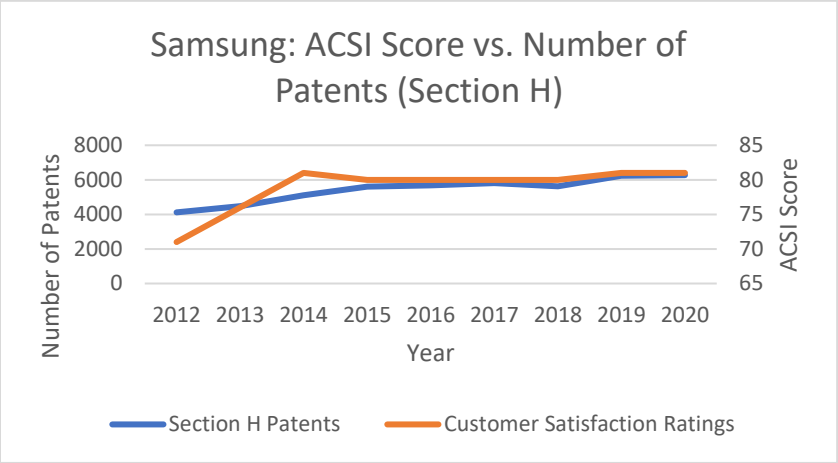


Figure 13: Apple Patents vs. Customer Satisfaction (Section H)

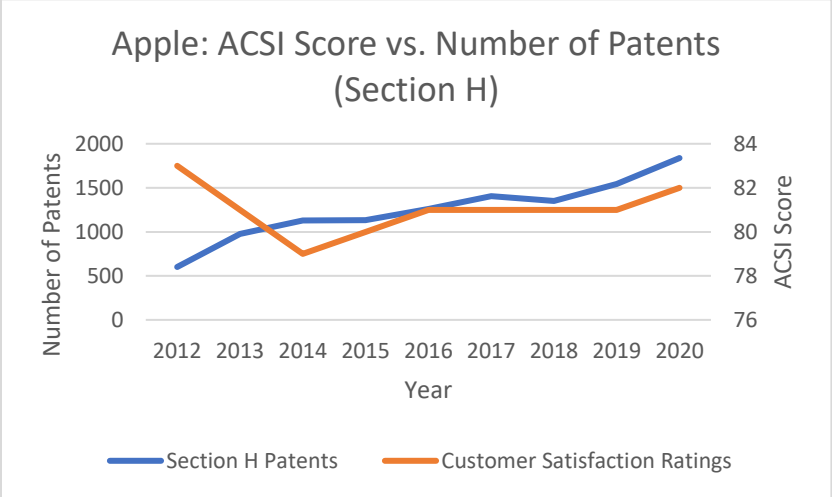


Figure 14: LG Patents vs. Customer Satisfaction (Section H)

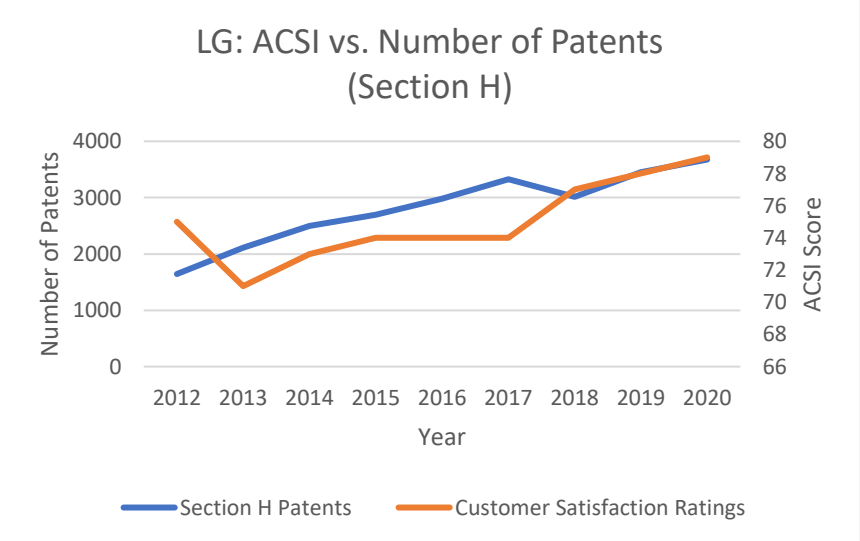
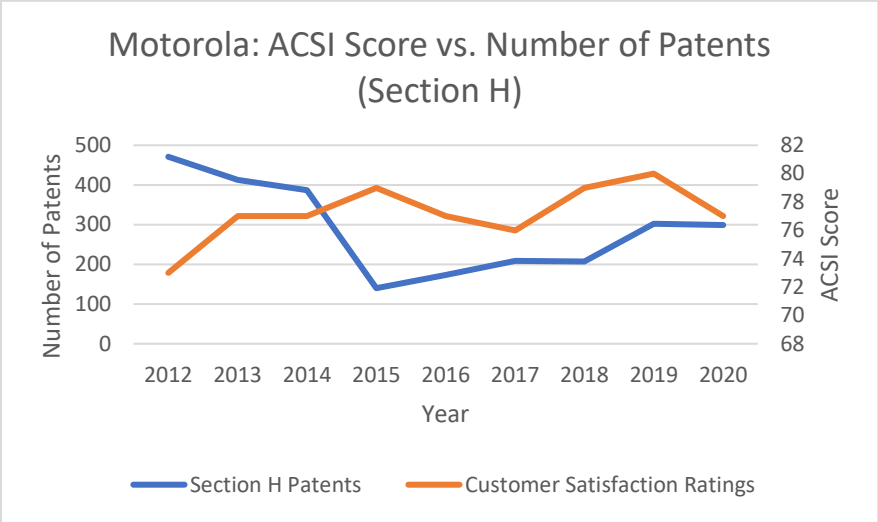


Figure 15: Motorola Patents vs. Customer Satisfaction (Section H)



After examining these results, it was hard to conjure a definitive statement. While Samsung and LG had strong positive correlations, Apple and Motorola actually produced negative correlations. When examining the graphs however, they appeared to be two sided. All of them except Samsung have an inverse relationship starting in 2012, meaning that the number of patents and customer satisfaction move in opposite directions. This is especially true for Apple, which had its highest rating in 2012, the first year of the study, followed by the lowest rating in 2013. However, there seems to be a shift in the middle of each graph. When observing this, I decided to run an additional correlation for each of the companies and patent types as done above, but using a different time frame. Using a five-year time from (2016-2020), I once again ran the correlations, and these produced some very interesting results. By doing this, it can help display a more recent time frame, rather than just every year the data allows. The goal of this was to see if the correlation values displayed a more clear and definitive picture by taking away the first few years, which seemed to provide a different correlation than the most recent years.

Table 4: Correlation Values, All Patents (2016-2020)

Company	***2016 - 2020***	***Number of Patents***
Samsung	Customer Satisfaction Ratings	0.891623292
Apple	Customer Satisfaction Ratings	0.861114305
LG	Customer Satisfaction Ratings	0.712955694
Motorola	Customer Satisfaction Ratings	0.503316874

Table 5: Correlation Values, Section G Patents (2016-2020)

Company	***2016 - 2020***	***Section G Patents***
Samsung	Customer Satisfaction Ratings	0.906663097
Apple	Customer Satisfaction Ratings	0.763569662
LG	Customer Satisfaction Ratings	0.827914296
Motorola	Customer Satisfaction Ratings	0.532572904

Table 6: Correlation Values, Section H Patents (2016-2020)

Company	***2016 - 2020***	***Section H patents***
Samsung	Customer Satisfaction Ratings	0.974328338
Apple	Customer Satisfaction Ratings	0.88876639
LG	Customer Satisfaction Ratings	0.642845131
Motorola	Customer Satisfaction Ratings	0.411201274

Interpretation

After performing the correlations from 2016-2020, the picture becomes much clearer. All companies have a positive correlation above 0.5 from the years of 2016-2020. All four companies also have experienced a higher positive correlation than the 2012-2020 range. This growth is particularly prominent in Apple, who had a slight negative correlation (-0.22) from 2012-2020 but a significant positive correlation (0.86) from 2016-2020. Thinking about what

was occurring around 2012, this seems to make sense. As mentioned before in this study, the infamous “Smartphone Patent War” was occurring during this time, starting in 2011, with most of the trials over the next few years. This certainly could have had an effect on the effort Apple was putting forth during this time, as much of their focus was on the patent litigation. While the number of patents didn’t necessarily decrease, there is a chance that the quality of those patents may have suffered.

The correlations also seem to show a stronger positive correlation between Section H patents and customer satisfaction for the two strongest competitors in the smartphone industry, Samsung and Apple (0.97 and 0.89, respectively). Section H consists of patents falling under electricity, which makes sense given the products the companies are making. Section G, the other main section, consists of patents in the Physics section (“CPC Scheme – Section G”). LG and Motorola have a stronger correlation (0.83 and 0.53, respectively) to customer satisfaction with the Section G patents. This could show a point of difference between the two “powerhouse” companies versus the smaller volume competitors. It is important to note that the companies themselves are not assigning the classifications, but rather the patent office (Bachmann et al). This helps show that it may not be intentional, but the nature of the patents issued for each company may help give them the required advantage they seek. If LG and Motorola feel they cannot compete with the electronic patents that Apple and Samsung are receiving, their strategy could be to put more effort and quality into the Section G patents.

In order to make sure the search was finding the correct patents, I also looked specifically into some of the searches to see some of the patents. For Samsung, the first patent in the search is patent 10,881,004 (Lee et al.). This patent focuses on an electronic component embedded substrate. The description says it focuses on shorter wiring circuits and improved performance,

while also mentioning smaller, minimized products. This would definitely seem to focus mostly on smartphones for Samsung. Using the search with Apple, we find patent 10,162,392, which is for electronic device structures joined using shrinking and expanding attachment structures (Bushnell and Sauers). This patent focuses on the assembly of the electronic devices, and this once again seems to focus on smartphones, as it mentions needed this process for smaller and thinner products. Now while these patents seem important for the manufacturing of smartphones, it is important to recognize the weaknesses of this study as well.

As discussed earlier in the study, many patents are found to actually have no value and are in an essence worthless. By counting the number of patents, there is no way to actually know which patents are being used in products and which ones were issued but haven't been used in any products. In order to properly perform this study, the observed patents should only be patents actually used in the end products. Unfortunately, it is not necessary for a company to publicize any of this information. With that seeming impossible, it would at least be an improvement to have an expert in the smartphone industry to take the time and see which of the patents from the search are actually related to smartphones and which ones may be for other products and/or are outdated and no longer used. A full patent research study should focus on not only the search, but also the cleaning and curating of that search, and with the help of expert validation, eventually reach the optimal patent data for the study (Bubela et al.).

Chapter 5: Discussion

The results from this study produce some important findings for both firms and the industry. The study helps in bridging a gap that has rarely been looked at before, concerning the customer point of view with intellectual property and patents. Because there appears to be a correlation between the number of patents and customer satisfaction ratings, companies can use this to put even more emphasis into the research and development.

A possibility for future studies could be to look more specifically into the different patent sections and categories, and see what correlates best with the customer satisfaction ratings. For example, while this study looked into section G and H patents, one could go a step further and look into patents classes (H06) or even patent subclasses (H06B). Performing this study can break down which items and innovations in a smartphone have the strongest correlation to better customer satisfaction ratings. This could help firms invest heavily into research and development in these specific areas.

Something companies also can observe from the study is the relative flattening on customer satisfaction ratings over the recent years. While the earlier years in this study featured some large ups and downs, recently, especially Apple and Samsung, have had stable customer satisfaction ratings. Over this same time, patents have also been more stable, and large increases in patents have correlated to increases in customer satisfaction. However, with the highest customer satisfaction rating (Apple, 83) coming back in 2012, it is fair to wonder how many upgrades these companies can keep making. Companies have been upgrading battery life, making higher resolution screens, but consumers seem to be waiting for the next big revolution. If companies keep investing in research and development and searching for that innovation, they could break out of the rut and come up with a higher rated product. On the other hand, if companies continue to see the flattened ratings, they could experiment with less patents and

saving money with less research and development to see if this does in fact correlate to a decrease in customer satisfaction ratings. These experiments could help see if patents and customer satisfaction continue to be correlated.

An additional component that firms and the industry could attempt to improve from this study is the method for customer satisfaction ratings. While the ACSI has been around a long time and has refined their process over the years, since they take a similar approach to all industries ratings, companies could find a process that better relates to the smartphone industry. Along with this, while the ACSI asks consumers generally how they feel smartphones perform in terms of battery life, ease of text messaging and video quality, among others, they do not ask this for specific phones or companies. If companies instead focused on these components in the customer satisfaction ratings, they may be able to get more details in exactly what they need to focus on and where new patents should be filed.

While the methodology of this study was effective, it was also relatively simple and more of an overview and introduction to the concept. To best move forward with improving this study and verifying the findings, one must first attempt to find the best data. If continuing with the data collection method used, it is recommended to perform a data cleaning process in order to remove some patents that may not be directly associated with smartphones. It is also possible to come up with a different way of finding the patent data, possibly trying to work backwards from phone patents the company files. With no way to directly see which patents are associated with smartphones, this is definitely the toughest step in the process of the study. The quality of the data is the foundation for the analysis, and while the data in this study provided enough quality for analysis, there are definitely ways to improve the process with more time and resources.

The analysis itself could also take on a different process. The correlation analysis done in this study once again allows for a solid introduction to research on this topic, but in order to fully be able to announce the relationship patents have on customer satisfaction, another method of analysis must be used. Correlation does a great job of showing a relationship between two items, but correlation does not mean causation, so while it looks like patents have an effect on customer satisfaction, at this time we can not say patents are the cause for the direct relationship. Perhaps now that a relationship has been found between the two, setting up a regression testing method would be possible. This method could better explain how patents have an effect on customer satisfaction ratings, and possibly even help project customer satisfaction ratings based off of those findings. Other methods could also be used to better explain the study, but for this study, correlation seemed like the best way to introduce the topic and lay the foundation for similar studies performed later.

Chapter 6: Conclusion

In summary, the value of patents continues to be a question among the business community. While many argue patents help businesses protect their ideas and innovation, others believe that patents are failing innovation. Still, companies are investing more research into research and development year after year, attempting to stay ahead of the competition and find the next innovation in their industry. With patent applications and grants increasing steadily over the past decade, the potential for patent litigation has also increased. Companies must continue to be mindful of this possibility, as earlier-noted reports suggest that news of patent litigation is not favorable for either party involved.

By the same token, customer satisfaction continues to be a highly debated topic as well. The value of investing in increasing customer satisfaction is unknown, though there have been studies directly relating customer satisfaction to financial performance. In an age where consumers scroll through reviews to choose products, having a high-quality product is essential to surviving in today's market. Poor products or service are easily replaceable in most instances, and losing customers means losing revenue. If companies believe the correlation in this study is valid, it could lead to them to investing more in patents in order to increase financial performance.

Within the smartphone industry specifically, change and improvements have come so quickly that new and exciting products are basically expected annually at this point. Smartphone manufacturers are searching for the new improvements and products, sifting through ideas of foldable smartphones, larger screens, enhanced battery life and everything in between. Smartphones have changed drastically since the turn of the century, and it is difficult to comprehend that the first iPhone debuted just 14 years ago ("Steve Jobs"). Intellectual property and patents importance in this industry continues to grow in order to gain a competitive

advantage. Not only do patents act as a way for companies to enhance their own products, but it also blocks competitors from attempting to do the same thing. With such specific verbiage and vocabulary, companies have often found ways to make similar patents without overstepping and being accused of patent infringement. With companies finding ways around patents of competitors, this has led to some people to question to value of patents. This study shows that there is a correlation between the number of patents and customer satisfaction, helping prove to some doubters that patents do in fact hold value. Due to the process of this study, there is no way to show the true value of individual patents, but it does show a larger quantity could lead to higher customer satisfaction. Each patent may not hold value, but the more patents a company has, the higher chance that some of them will be valuable.

This paper is just the beginning of this discussion. With customer satisfaction gaining more attention and being an increasingly important metric, companies will continue to find ways to improve that rating. For a product like a smartphone, having the best product will lead to the best ratings. If researchers can further this study and validate the correlation found, companies may soon realize the best way to satisfy customers is putting even more effort into patent research. How companies plan on investing in patents in the future will be interesting to observe, as well as to see if increasing patents could be the step in continuing to raise customer satisfaction ratings, or if there is a barrier that patents can only help so much. Whether you believe in the system or not, patents and intellectual property will continue to play a vital role in the industry, and how companies handle them could determine their future success.

Appendix A

Table A-1: Samsung Patent Search Data

Samsung Patent Research										
	2012	2013	2014	2015	2016	2017	2018	2019	2020	Total
Number of Patents	6069	6425	7217	7858	8140	8507	8211	8912	8741	70080
Customer Satisfaction Ratings	71	76	81	80	80	80	80	81	81	
G class patents	2670	2756	3148	3534	3867	4270	4163	4729	4650	33787
H class patents	4117	4472	5103	5605	5681	5805	5617	6227	6271	48898
Others	131	172	216	285	305	360	368	391	397	2625

Table A-2: Apple Patent Search Data

Apple Patent Research										
	2012	2013	2014	2015	2016	2017	2018	2019	2020	Total
Number of Patents	1140	1761	1981	1919	2083	2171	2107	2443	2744	18349
Customer Satisfaction Ratings	83	81	79	80	81	81	81	81	82	
All G class	773	1161	1315	1260	1355	1353	1369	1639	1750	11975
All H class	601	978	1128	1131	1260	1404	1349	1545	1838	11234
Others	17	20	33	29	35	33	63	104	90	424

Table A-3: LG Patent Search Data

LG Patent Research										
	2012	2013	2014	2015	2016	2017	2018	2019	2020	Total
Number of Patents	2427	2818	3198	3436	3746	4073	3819	4303	4461	32281
Customer Satisfaction Ratings	75	71	73	74	74	74	77	78	79	
All G class	1087	1070	1173	1237	1358	1398	1370	1572	1639	11904
All H class	1644	2112	2500	2698	2982	3329	3015	3453	3676	25409
Others	99	130	198	267	294	346	374	458	430	2596

Table A-4: Motorola Patent Search Data

Motorola Patent Research										
	2012	2013	2014	2015	2016	2017	2018	2019	2020	Total
Number of Patents	526	463	434	151	189	232	251	375	359	2980
Customer Satisfaction Ratings	73	77	77	79	77	76	79	80	77	
All G class	105	113	117	28	41	74	111	195	192	976
All H class	471	413	387	140	173	209	207	302	299	2601
Others	3	1	3	3	5	4	3	6	4	32

Table A-5: Correlation Value, Other (2012-2020)

Company	***2012 - 2020***	***Other***
Samsung	Customer Satisfaction Ratings	0.782245939
Apple	Customer Satisfaction Ratings	0.103552352
LG	Customer Satisfaction Ratings	0.779288139

Figure A-1: Samsung Patent vs. Customer Satisfaction (Other Patents)

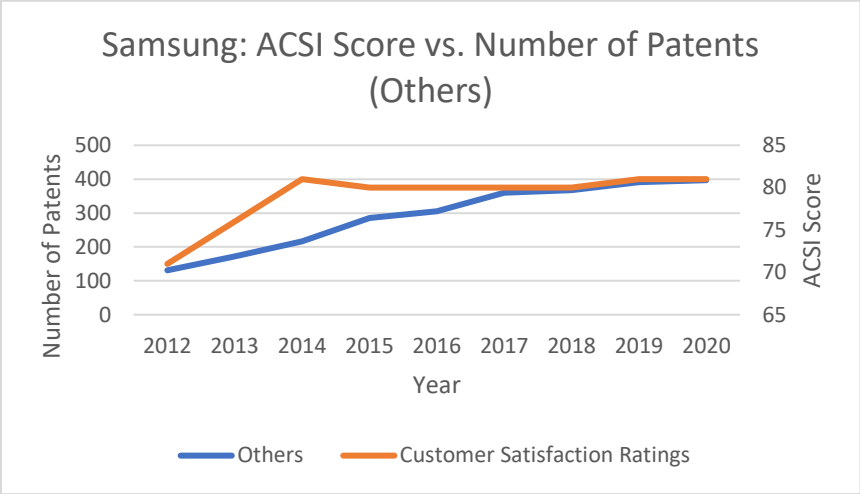


Figure A-2: Apple Patents vs. Customer Satisfaction (Other Patents)

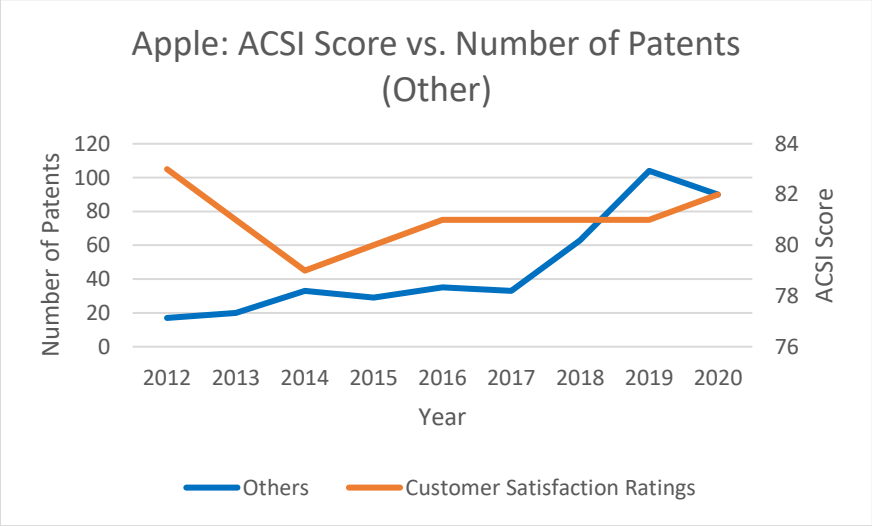


Figure A-3: LG Patents vs. Customer Satisfaction (Other Patents)

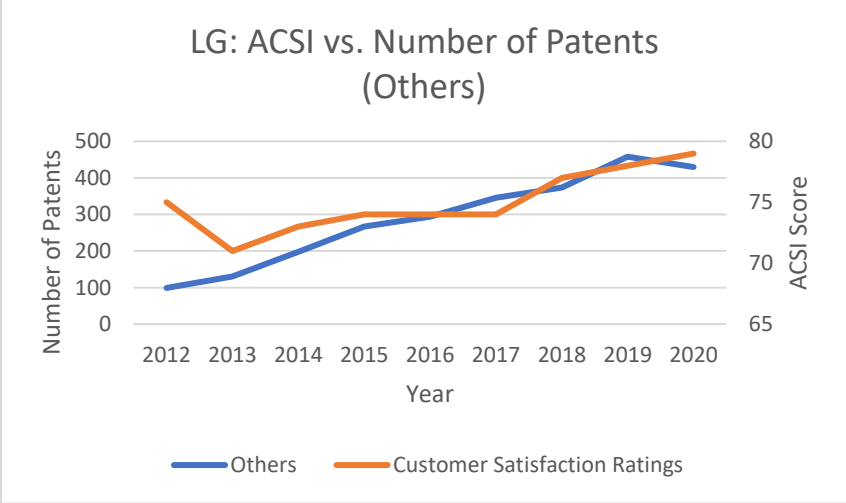


Table A-8: Correlation Values, Other Patents (2016-2020)

Company	***2016 - 2020***	***Other***
Samsung	Customer Satisfaction Ratings	0.745177001
Apple	Customer Satisfaction Ratings	0.437909637
LG	Customer Satisfaction Ratings	0.893679158

Appendix B

Figure B-1: USPC to CPC codes

Hardware

349: G 02F, H 04N, G 02B, G 09G, H 01L, H 05K, C 09K

361: H 02H, H 01H, H 01F, H 02P, H 01L, H 05B, H 03K, H 02M, H 01T, H 05K, H 01C, H 01B, B 23Q, G 05F, H 04N, G 11B, F 02D, G 05D, F 23N, H 04Q, H 03M, G 07C, B 60Q, G 01N, G 01F, G 08C, F 16P, H 05F, F 16L, B 60C, B 64D, B 60R, A 43B, G 03G, B 05B, F 41H, G 01P, B 60T, F 23Q, F 42B, F 42D, F 02P, F 24B, H 01G, G 01L, C 10M, C 04B, H 02B, H 01R, G 01R, F 21V, H 02G, G 06F, F 16M, F 15B, H 04M, H 01M, A 61N

320: H 01M, H 02J, Y 02T, G 01R

Software

341: H 04N, H 04L, G 06N, G 06F, H 03M,

704: G 10L, G 06F

706: G 06N, G 06F, G 06K, G 05B, G 01S, H 04L, G 06Q, G 10H, F 16H, B 66B, B 60G, G 21Y, G 09B, G 01V, G 08B

707: G 06F, H 04L, G 11B, H 04N, G 05B, G 07B, G 06Q, G 01C

715: G 06F, H 04N, A 63F, G 11B, H 04L, G 06Q, G 09G, H 04M, G 05B

Communications

370: H 04L, H 04B, H 03M, H 04J, H 04M, H 04N, H 04Q, H 04W, G 06F

375: H 04B, H 04L, H 03G, H 03M, H 04N, G 11B, H 03F, H 04J, H 03L

379: H 04M, H 04W, H 04L, G 06Q

398: H 04J, H 04Q, H 04B, H 04L, G 02B, G 08C, G 05B, H 04R

455: H 04K, H 04H, H 04L, H 04N, H 04B, H 04M, H 04W, H 04Q, H 01Q, H 01P, H 02J, B 60R, H 03F, H 03B, H 03C, H 03H, H 03J, H 03D, H 04R, G 05B, G 04C, G 04G, H 03G, G 08B, H 03L, G 09G, H 01L, H 05K, H 01J, G 07C

719: G 06F

Classifications (Summarized): G02$, H04$, G09$, H01$, H05$, C09K, H03$, G05$, G11$, F02$, F23$, G07$, B60$, G01$, G08$, F16$, B64D, A43B, G03G, B05B, F41H, F42$, F24B, C10M, C04B, F21V, F15B, A61N, Y02T, G06$, G10$, G04$, A63F, B66B, G21Y

Figure B-2: Query Search Examples

EX: AN/samsung AND isd/1/1/2020->12/31/2020 AND (CPCL/G02$ or CPCL/H04$ or CPCL/G09$ or CPCL/H01$ or CPCL/H05$ or CPCL/C09K or CPCL/H02$ or CPCL/H03$ or CPCL/G05$ or CPCL/G11$ or CPCL/F02$ or CPCL/F23$ or CPCL/G07$ or CPCL/B60$ or CPCL/G01$ or CPCL/G08$ or CPCL/F16$ or CPCL/B64D or CPCL/A43B or CPCL/G03G or CPCL/B05B or CPCL/F41H or CPCL/F42$ or CPCL/F24B or CPCL/C10M or CPCL/C04B or CPCL/F21V or CPCL/F15B or CPCL/A61N or CPCL/Y02T or CPCL/G06$ or CPCL/G10$ or CPCL/G04$ OR CPCL/A63F OR CPCL/B66B OR CPCL/G21Y)

For G class:

AN/samsung AND isd/1/1/2020->12/31/2020 AND (CPCL/G02$ or CPCL/G09$ or CPCL/G05$ or CPCL/G11$ or CPCL/G07$ or CPCL/G01$ or CPCL/G08$ or CPCL/G03G or CPCL/G06$ or CPCL/G10$ or CPCL/G04$ OR CPCL/G21Y)

For H class:

AN/samsung AND isd/1/1/2020->12/31/2020 AND (CPCL/H04$ or CPCL/H01$ or CPCL/H05$ or CPCL/H02$ or CPCL/H03$)

For other:

AN/samsung AND isd/1/1/2020->12/31/2020 AND (CPCL/C09K or CPCL/F02$ or CPCL/F23$ or CPCL/B60$ or CPCL/F16$ or CPCL/B64D or CPCL/A43B or CPCL/B05B or CPCL/F41H or CPCL/F42$ or CPCL/F24B or CPCL/C10M or CPCL/C04B or CPCL/F21V or CPCL/F15B or CPCL/A61N or CPCL/Y02T or CPCL/A63F OR CPCL/B66B)

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Academic Vita

Corey Pasternak

EDUCATION

The Pennsylvania State University, Schreyer Honors College Class of May 2021

Major: B.S. in Finance

Intended Minors: Supply Chain in Information Sciences Technology & Information Systems Management

WORK EXPERIENCE

Boeing Ridley Park, PA

Cost Schedule Analyst Intern June 2020 – August 2020

Working in a virtual environment enabled me to find creative solutions to connect not only with my team mates but also with cross functional partners. Ensuring success in this internship meant acclimating myself to new and unknown situations with an open mind. Being a self-starter and taking initiative throughout my internship allowed me to find special projects, trainings to enhance my education, and opportunities to collaborate with fellow employees

- Reconciled data in CSPR to EAC templates, processing change documents to adequately load budget and EAC
- Experienced both schedule building and review sessions, working cross functionally with scheduling, engineering and finance to create and review the baseline schedules
- Communicated with prime planners and scheduling managers to update the proposal status sheet and align priorities
- Participated in a business case with four interns, collaborating ideas and solutions to produce a detailed action plan and presenting findings to senior leadership
- Identified system errors through automated reports, resolving issues and ensuring Earned Value Management compliance
- Utilized software to create cost and schedule variance presentations, allowing the program manager to understand the control account manager's execution of their statement of work
- Led restructuring efforts within CSPR by using administrative change documents, while validating changes with IPTs and CAMs to maintain accurate distribution of information

Saxbys University Park, PA

Student C.E.O. (Café Executive Officer) July 2019 – December 2019

- Had full responsibility for an operation that employs 70 team members, generated over $850,000 in annual revenue and served 1,000+ guests on a daily basis, while mastering each of Saxbys' Three Pillars of Leadership

Team Development

- Provided hands-on training and in-café onboarding for new team members, who serve close to 6,000 guests a week
- Learned and applied interpersonal skills via on-shift coaching, feedback, and task delegation with all 70+ team members so those individuals feel more supported and respected as part of our team

Community Leadership

- Coordinated and executed 3-5 catering orders per week to serve the Smeal community
- Worked with local startup to increase donations to THON and the surrounding Penn State community

Financial Management

- Fully responsible for all P&L (Profit & Loss Statement) items including: ordering and inventory, vendor relations, labor schedule, as well as the marketing budget to drive revenue, manage cost, and maximize profitability
- Completed weekly financial reviews to project—and meet—business demands
- Presented monthly P&L Statements to Saxbys executive team at Philadelphia headquarters

Received offer to stay on team as a Senior Team Lead, which I still presently operate as

Pennsylvania State University University Park, PA

Teaching Assistant for Basics of Excel Jan 2019 – May 2019

- Educated over 150 students about the basics of business information systems
- Answered any questions students had and tutored students whenever requested

LEADERSHIP & INVOLVEMENT

Smeal Student Mentors University Park, PA

Team Leader March 2018 – Present

- Welcome group of 10 incoming students to the Pennsylvania State University and the Smeal College of Business, showing them available opportunities so students can acclimate to college and build their skills
- Guide freshman through resume reviews, scheduling advice and other events to prepare them for professional opportunities

Springfield THON Organization University Park, PA

Special Events Chair for THON 2019 March 2018 – March 2019

- Managed logistics for events by contacting businesses and organizations to run efficient and profitable fundraisers