Analyzing the Gender Gap in Patents : A Lesson from Startups

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Abstract

A study by the World Intellectual Property Organization (WIPO) indicated a disparity in the ratio of men to women IP rights holders. The Indian Patents Act, 1970, vide its amendment in September 2019, allowed women applicants to seek expedited examination of their patent applications, leading to shorter timelines in obtaining a patent. This study attempted to forecast the impact of the new legislation on women applicants by drawing an equivalence of the effects of similar legislation on startups. We tried to study whether the nature or gender of an applicant influenced the time taken for the grant of a patent; if gender mediated between the nature of the applicant and the time taken for the grant of a patent. Lastly, the study evaluated the amendment's impact on the time taken to grant a patent for women inventors. Research showed that since an equivalence could be drawn between women and startups as applicants, the growth in the number of female applicants and the number of patents awarded to female applicants will be similar to the effect of the 2016 amendment to the Patents Act on startups.

Keywords : **law, legal economic, intellectual property law, patent law, innovation, research**

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Relations of gender are tiered because men and women are not mere social groups who can be impartially differentiated but are ranked and evaluated per a patriarchal system (Fox, 2005). In 2005, only 68 women from 57 countries held a top post in political leadership. The CSR spending of companies is directly proportional to the number of women directors (Kumar et al., 2021). According to one study, a company's reputation is enhanced by including women on board (Inamdar & Nagendra, 2017). This data relates to women in the upper echelons of society. However, when we speak of less privileged women — the mortality rate for female infants, maternal mortality rate, and female children who do not have access to education — these paint an unwelcoming picture.

The gender ratio in India is skewed towards males. This skew has occurred in the past few decades. In the decennial census, the number of girls per 1,000 boys aged 0–6 years was 962 in 1981, 945 in 1991, and 927 in 2001. This chasm widens because of higher mortality rates in females than in male children. We have to guarantee women's protection, development, empowerment, and participation (Palaniappan & Aniyan, 2010).

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Gender Disparities in Academia

Gender disparity stands out in the field of science. Science reflects and reinforces gender hierarchy (Fox, 2005). The number of women full professors in 1995 was 6% or less (Fox, 2005). Gender disparity in academia is evidenced by the 2.3:1 male-to-female total professor ratio in the US (Baptist, 2017).

Universities are the hotbed of research and development and are the primary applicants for patents. Universities are drivers of innovation and intellectual property (Drivas et al., 2016). Since universities are a primary source for research and patenting, the low number of women in STEM areas is a cause for concern. It leads to the conclusion that fewer women researchers imply fewer women inventors and patent holders.

Women in IP

A study by the World Intellectual Property Organization (WIPO) indicates a significant disparity in the ratio of men to women patent holders. Even in the United States of America, the number of women patent applicants/inventors may reach parity only in 2090. According to a study, women accounted for less than 8 % of inventors from 1976, which rose to 10.8 % in 2013. Only five countries are female-dominated, and the patents in these countries amount to fewer than 35 (Sugimoto et al., 2015). The proportion of females to males reaching each stage of higher education and research shows that the trend for women from research to inventorship is downward.

Women in IP - The Indian Scenario

Today, Indian women form almost 40 % of the undergraduates in science and about 25–30 % in PhD in the sciences. However, the rate of increase is not in proportion to the population of women in the country. PCT (Patent Co-operation Treaty) enables applicants to seek patent protection simultaneously in multiple countries. This figure considers international (PCT) applications filed by the inventors/applicants and not necessarily those filed in the country of residence/nationality.

Upon studying the share of women among listed inventors and the percentage of PCT applications with at least one woman as an inventor for the year 2018, India ranks mid-way among 20 countries with 14.4% of the total PCT applications filed having at least one woman. No data exists regarding women inventors and women patent applicants on the Indian Patent Office website. The entrepreneurial spirit of women has been emerging with increasing sensitivity to their economic role in society (Mathivannan & Selvakumar, 2009). According to Suriyamurthi et al. (2009), women are evolving as a force. There are several roadblocks to women entrepreneurs. Government, financial institutions, and employers' organizations work closely with women entrepreneurs to navigate these difficulties. Women entrepreneurs cannot progress much if the ground for entrepreneurship remains biased (Singh, 2013).

With this in mind, WIPO's theme for the year 2018 was *Powering Change: Women in Innovation and Creativity*. Consequently, the Indian government has introduced an amendment in The Patents Act, 1970, which allows examination of patent applications with at least one woman inventor/applicant on a priority basis, similar to startups. India is the first country among WIPO signatories to introduce such legislation.

Women patent significantly lesser than men. A mere 10.3 % of US-origin patents granted in 1998 were estimated to have at least one female inventor (Hunt et al., 2013). The number of women applicants from Europe ranged from 2.9 % (Austria) to 14.2 % (Spain) in 2005. A study across 14 European countries, though depicting an upward trend between 1991 and 2005, indicated that women patent applicants remained under-represented at 5.2 % in 1991, with an insignificant increase to 8.6% in 2005 (Jung & Ejermo, 2014). The percentage of women inventors accounts for less than 8 % of all inventors over four decades, and women contributed to only 10.8 % of inventors in 2013.

The need of the hour is to bridge the gender gap among science and engineering students, as research shows that doing so would increase the GDP significantly (Jung & Ejermo, 2014). The gender gap reflects inequitable treatment of women and less efficient use of women's intellect and ability to innovate. The extent of the gender gap in patenting begs the question of what causes the disparity and the remedy.

India filed a mere 3,044 patents in 2014, of which 0.50 % were women. As a signatory to WIPO, India has taken the first step to combat this gender disparity. In an attempt to close the gap between female and male patent inventors/applicants, India has recently issued an amendment allowing expedited examination of applications that contain at least one woman applicant.

Startups as a Global Phenomenon

Another beneficiary of the Indian Patents Act Amendment since 2016 is startups. Startups are injecting new life into traditional markets through the use of technology. There is rapid growth in some areas of technology. According to the Global Start-up Ecosystem Report (GSER2019), there are 25 startups with a value above $10 billion each, equalling nearly $1 trillion in economic value. Further, 57 startup ecosystems show a value between $1 billion and $10 billion, creating thousands of jobs and billions in economic productivity.

Startups in India

India is considered a "young" country, with 65% of its population under 35 (Adhana, 2016). Startups employ over 80,000 people, and new startups are born each day. Today, we have more startups and entrepreneurs than ever before, and the movement is now an uprising. India is currently ranked the third largest base of technology startups in the world (Adhana, 2016).

The Start-up India Policy

Many startups cannot grow to their full potential due to excessive barriers to entry. Some challenges unique to Indian startups are building and scaling a startup, diversity and the digital divide, low willingness to pay, availability of qualified employees, and complex regulatory environment. The Government of India has taken steps to increase the ease of business. The Government of India promulgated the Start-up India Policy in 2015, and the success is evident in the 108 % growth in total funding from 2017 to 2018. With 4,400 new-age companies, India now ranks third among global startup ecosystems according to a NASSCOM report titled *"Start-up India: Momentous Rise of the Indian Start-up Ecosystem,"* released in October 2015.

Startups and the MSME Sector

By virtue of their definition, startups fall under the broader sector of micro, small, and medium enterprises (MSMEs) (see definitions). The MSME sector contributes to India's gross domestic product (GDP), exports, and employment creation. The MSME sector is a highly vibrant and evolving sector of the Indian economy. The MSME sector provides increased employment at lower expenditures while helping industrialize and ameliorate rural and backward areas. The share of MSME gross value added (GVA) in total GVA during 2016–17 was 31.8%, and the MSME sector currently employs roughly 50 million people. MSMEs contribute around 45% of India's exports. The MSME sector has consistently maintained a growth rate of over 10 %.

Drawing a Parallel Between Women and Startups

The Raghuram Rajan Committee on Financial Sector Reforms, 2007 has defined financial inclusion as universal access to a wide range of financial services at a reasonable cost, including banking products and other financial services such as insurance and equity. The Rangarajan Committee on Financial Inclusions, 2008 defined it as ensuring access to financial services and timely and adequate credit where needed by vulnerable groups such as weaker and low-income groups at an affordable cost.

The MSME sector is a weaker section of society due to the deprivation of access to finance, availability of finance, the usage of financial products, and the quality of such products. Evidence shows that women publish less than men and that the quality of publications by women is lower than those of their male counterparts. One study showed that female inventors represented only 4.2 % of the total inventors (Hoisl & Mariani, 2017).

One study (Ding et al., 2006) found that women patented about 40 % less than men. Women are much less likely to be granted a patent than men and are somewhat less likely to commercialize or license the patents granted. The most critical determinants of the gender patenting rate gap among science degree holders are women's underrepresentation in patent-intensive fields of study and patent-intensive job tasks (Hunt et al., 2013). Given the above, the definition of the weaker section includes women as well as startups and MSMEs. The paper draws a parallel between women applicants and startups and assumes that women patent applicants will meet similar results as startup patent applicants.

Patent Law, Practices, and Procedure

Figure 1 shows a flow chart of the patenting procedure from application to grant and timelines where applicable.

Definitions

In India, as per the Micro, Small, and Medium Enterprises Development Act 2006, enterprises are broadly classified into micro-units, small units, medium units, and large units, depending on the investment in plant and machinery.

- ***Micro-enterprise.*** A micro-enterprise is one where the investment in plant and machinery (their original cost excluding land, building, and items specified by the Ministry of Small Scale Industries in its notification No. SO 1722(E) dated 5th October 2006) is less than ₹ 25 lakhs.

- ***Small Enterprise.*** A small enterprise is one where the investment in plant and machinery is more than ₹ 25 lakhs but less than ₹ 5 crores.

- ***Medium Enterprise.*** A medium enterprise is one where the investment in plant and machinery is between ₹ 5 crores – ₹ 10 crores.

The definition of MSMEs in the service sector is:

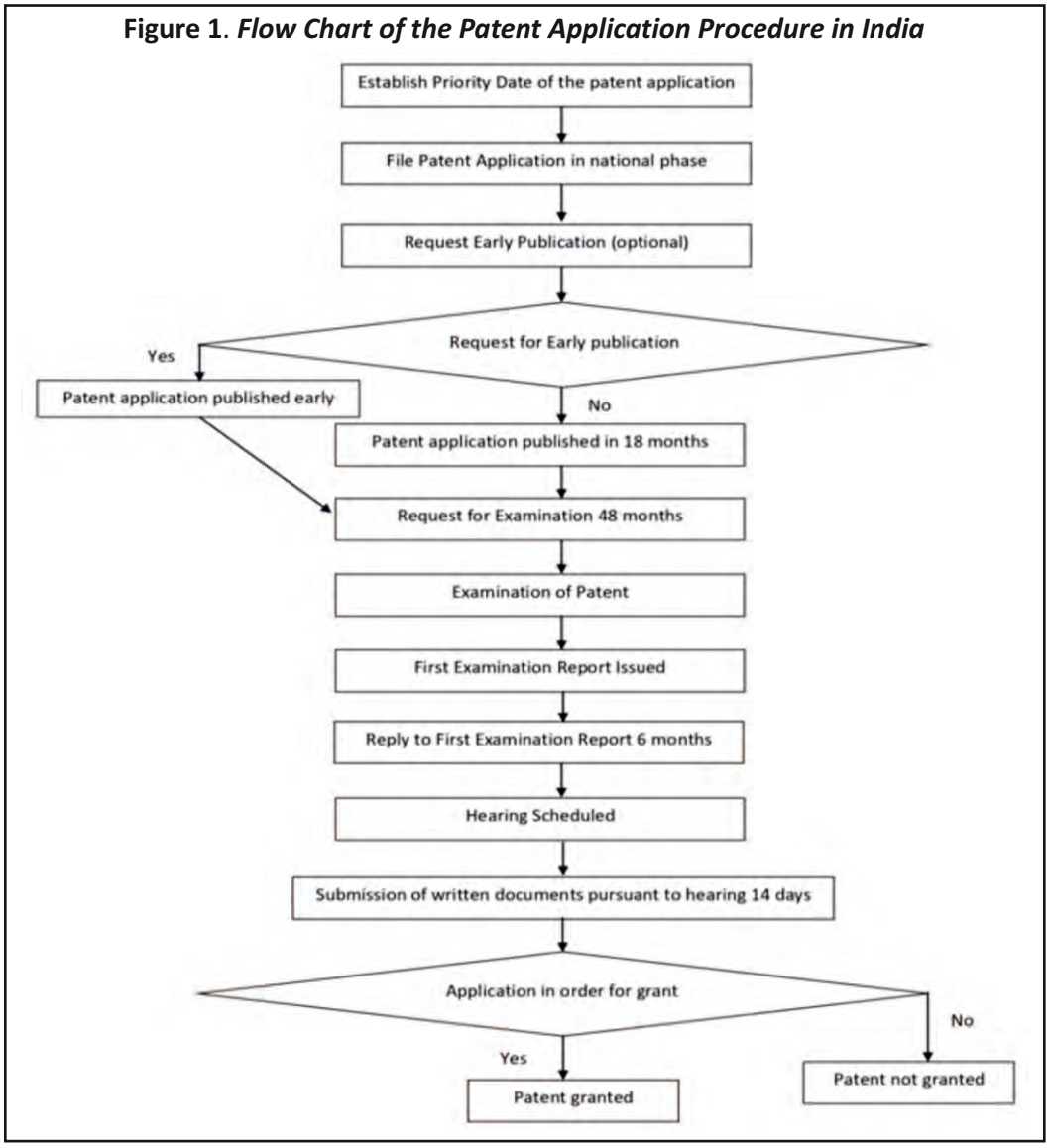
- ***Micro-enterprise.*** Investment in equipment does not exceed ₹ 10 lakhs;

- ***Small enterprise.*** Investment in equipment is more than ₹ 10 lakhs but does not exceed ₹ 2 crores;

- ***Medium enterprise.*** Investment in equipment is more than ₹ 2 crores.

- ***Startup.*** An entity is a startup if :

Figure 1. ***Flow Chart of the Patent Application Procedure in India***



↳ Up to 10 years from the date of incorporation/ registration, if incorporated as a private limited company (as defined in the Companies Act, 2013) or registered as a partnership firm (registered under section 59 of the Partnership Act, 1932) or a limited liability partnership (under the Limited Liability Partnership Act, 2008) in India.

↳ The entity's turnover for any financial year since incorporation/ registration has not exceeded ₹ 100 crores.

↳ The entity is working towards innovation, development, or improvement of products or processes, or services, or if it is a scalable business model with a high potential for employment generation or wealth creation.

↳ ***Other.*** For this study, the term "Other" includes all other corporate entities that do not fall under the definition of MSME, startups, and natural persons.

↳ ***Male + Female Team.*** A team of natural person inventors/applicants with at least one female applicant.

↳ ***Natural Person (NP).*** The present study has drawn a parallel between women and startups as being financially weaker sections, extrapolating the startup legislation's impact on women patent applicants. Since the amendment, there has been a lack of studies on the subject. One draws a comparison between startups and women. The aim is to study whether the gender of the applicant has a bearing on the time taken to process the patent and the impact of the amendment on the time taken to grant a patent for women inventors using startups as a proxy.

Research Design

The research conducted has the following research design:

↳ Objectives

↳ Research Methodology

↳ Sample/Sample Size

Objectives of the Study

The number of women in STEM areas and higher education is increasing. One expects the number of women inventors to show a corresponding increase in the field of IP. Table 1 lists the All India Enrolment of Girls as % of the Total Enrolment in University Education by Faculty. The highest representation of women is in the field of education, while a smaller proportion of women opt for engineering. In science and engineering, it is encouraging to note that the number of women enrolling has increased over the years.

Table 2 indicates that Gender Parity Index (GPI) in higher education has increased from 2017 to 2018. Keeping in view the growing yet a low number of women inventors as compared to the other categories of inventors and the disparity in the time taken from the application to grant of a patent for a startup versus other entities, we have the following objectives :

↳ **H1.** To study whether the nature of a firm has a significant impact on the time taken to grant of a patent.

↳ **H2.** To study whether the gender of the patent owner has a significant impact on the time taken to grant a patent.

↳ **H3.** To study whether gender mediates between the type of firm and the time taken to grant of patent.

↳ **H4.** To evaluate the impact of the amendment on the time taken to grant of a patent for women inventors using startups as a proxy.

Table 1. ***All India Enrolment of Girls as % of Total Enrolment in University Education***

Year	Arts	Science	Commerce	Education	Eng/Tech	Medicine
1960 – 61	18/6	****	1.1	32.5	0.8	20.4
1970 – 71	33.5	18.5	2.8	37.3	1.0	21.3
1980 – 81	37.5	27.9	15.2	46.7	4.6	23.8
1990 – 91	39.8	36.8	24.0	44.2	10.9	34.3
1995 – 96	41.5	35.5	29.0	41.2	14.2	34.5
1999 – 2000	44.9	37.4	34.0	42.6	16.2	37.8
2001 – 02	443.8	39.1	38.7	43.5	24.9	40.640.6
2003 – 04	45.5	39.8	36.7	52.1	23.1	46.3

Table 2. ***State-wise Gender Parity Index of Students Aged 18 – 23 Years in Higher Education in India for the year 2018 – 2019***

States/UTs	Gender Parity Index (GPI)
Andaman and Nicobar Islands	1.29
Andhra Pradesh	0.81
Arunachal Pradesh	0.99
Assam	0.95
Bihar	0.79
Chandigarh	1.54
Chhattisgarh	1.06
Dadra and Nagar Haveli	1.70
Daman and Diu	2.34
Delhi	1.16
Goa	1.33
Gujarat	0.85
Haryana	1.23
Himachal Pradesh	1.30
Jammu and Kashmir	1.09
Jharkhand	0.96
Karnataka	1.04
Kerala	1.40
Lakshadweep	3.40
Madhya Pradesh	0.97
Maharashtra	0.90
Manipur	1.01
Meghalaya	1.17
Mizoram	0.94
Nagaland	1.11
Odisha	0.82
Puducherry	1.24
Punjab	1.35
Rajasthan	1.00
Sikkim	1.00
Tamil Nadu	0.97
Telangana	1.02
Tripura	0.83
Uttar Pradesh	1.14
Uttarakhand	1.00
West Bengal	0.94
India	**1.00**

Sample Size

The sample size for this study was 497 granted patents filed between 2016 and 2019. These patents were chosen to start with the most recently granted ones and go back to 497 patents.

Research Methodology

At the first level, secondary data were collected from published sources, especially from the Indian Patent Office website. Of the 800 odd applications filed and granted between January 2016 and October 2019, 497 were chosen at random merely because they appeared first in the sorting list, where the date of application was the criteria for sorting. All patent applications selected have been post-incorporation of the Start-up Policy. The number of days from the date of application (App) to the date of First Examination Report (FER) being issued; the number of days from the FER being issued to the grant of the patent; and the number of days from the date of application to date of grant of the patent was computed for each applicant (Note: First Examination Report is also known as Office Action in other jurisdictions).

App to FER is the number of days from the date of application to the date the FER is issued. FER to Grant is the number of days from the date of issue of the FER to the date of grant of the patent. App to Grant is the number of days from the date of application to the date of grant of patent. Only ordinary applications are considered for uniformity in ascertaining the date of application, that is, no national phase applications stemming from PCT applications have been considered. The time taken from App to FER, FER to Grant, and App to Grant is divided into classes, as depicted in Table 3. Gender is per the definition given above and coded as shown in Table 4.

Table 3. ***The Classification of Time Taken from App to FER, FER to Grant, and App to Grant***

Days
0 – 50 days
51 – 100 days
101 – 200 days
201 – 400 days
Above 400 days

Table 4. ***Codification of Gender***

Gender
Male
Female
Male + Female team
Artificial Juridical Person (Startup + Other)

The natural person applicants were divided based on their gender. If an inventor had a highly gendered first name, they were classified accordingly. Where a question arose as to the gender associated with the first name, a search by that first name and last name was conducted on popular social media sites such as Facebook, LinkedIn, and a Google image search to identify the gender of the applicant.

Analysis and Results

The percentage of each type of applicant is given in Table 5. Table 5 denotes that other entities formed 50 % of the applicants, while startups and male applicants formed nearly the remaining 45 %. Female applicants and male + female applicant teams are at around 2 % each of the total number of applicants.

Table 6 denotes the number of days from the date of application to the date on which the first examination report (FER) was issued, the date from issuance of FER to the grant, and the date of application to the date of the grant.

Table 5. ***Tabulation of Type of Applicant***

Type of Applicant	%
Male	17.7
Female	2.0
M+F Team	1.6
Startup	28.6
Other	50.1
Total	100.0

Table 6. ***Number of Days and Percentage of Applications That Fall in Each Range***

No. of days	App to FER (%)	FER to Grant (%)	App to Grant (%)
0 – 50 days	4.2	1.0	–
51 – 100 days	11.5	4.6	–
101 – 200 days	13.7	39.2	0.2
201 – 400 days	14.9	51.9	24.3
Above 400 days	55.7	3.2	75.5

The data indicate that 4.2 % of the applications were granted within 50 days, while 55% of the patent applicants still take more than 400 days for the examination report to be issued. Table 6 shows that the number of days from the date of issue of FER to the date of grant is mainly between 200 – 400 days, followed closely by 101–200 days. Table 6 also shows the number of days from the date of application to the date of grant of patent. Typically, the number of days from application to grant is more than 400.

Cross-Tabulation of Data

Table 7 shows that the organization's nature significantly impacts the number of days to open up a case. Table 7 shows that startups take the least time, or their files are examined earliest, followed by others, followed by NP (M and F). Female – 40 % of cases were examined before 400 days. NP (Female - individually or team) is seen as not faring too well in terms of the number of days it takes to examine her application. However, startups fare better than other categories; 30% of women got the patent granted within 400 days, and 52 % of the applicants were "Other" (corporate entities plus startups) and got the patent granted within 400 days.

Table 8 shows the cross-tabulation of data for the nature of the applicant to the number of days from the date of application to FER, FER to grant, and FER to grant. The nature of the organization impacts the number of days to issue a FER for a given patent application.

From Table 8, we can infer that startups take the least time or their files are opened up earliest, followed by others, followed by individuals (male and female). For the female category, 40 % of the cases are examined before 400 days. The female (individually or team) category is not faring too well in terms of the number of days it takes for the application to be examined. However, startups fare better than other categories; 30 % of women get the patent granted within 400 days, while 52 % of startups get the patent granted within 400 days. The table shows that

Table 7. ***Cross Tabulated Data for Gender of Applicant***

		Male	Female	M + F	Startup + Others	Chi Sq. Significance	
						Value	Sign
APP-FER	0 – 50	1	0	0	20	11.25	0.508
	51 – 100	8	0	1	48		
	101 – 200	12	3	0	53		
	201 – 400	18	1	1	54		
	> 400	49	6	6	216		
FER-GRANT	0 – 50	1	0	0	4	12.27	0.424
	51 – 100	8	1	1	13		
	101 – 200	36	5	1	153		
	201 – 400	39	4	6	209		
	> 400	4	0	0	12		
APP-GRANT	0 – 50					1.08	0.983
	51 – 100						
	101 – 200	0	0	0	1		
	201 – 400	22	3	1	95		
	> 400	66	7	7	295		

Table 8. ***Cross Tabulated Data for Nature of Applicant***

		Individual	Start-Up	Startup + Individual	Others	Chi Sq. Value	Significance Sign
APP-FER	0 – 50	1	16	0	4	147.975	0.000
	51 – 100	9	41	0	7		
	101 – 200	15	33	1	19		
	201 – 400	20	20	1	33		
	> 400	61	29	1	186		
FER-GRANT	0 – 50	1	0	0	4	18.526	0.101
	51 – 100	10	1	0	12		
	101 – 200	42	50	0	103		
	201 – 400	49	83	3	183		
	> 400	4	5	0	7		
APP-GRANT	0 – 50					92.071	0.000
	51 – 100						
	101 – 200	0	1	0	0		
	201 – 400	26	72	0	23		
	> 400	80	66	3	226		

the gender of the patent applicant does not significantly impact the time taken from the date of application to file the patent to FER. It does not significantly affect the time taken from FER to grant of patent and the total time taken from the date of application to the grant of patent.

This data is counterintuitive. When studied in depth, the problem is visible with the data points with female applicants. Further, the gender policy on the patent was announced in September 2019, and the results will be seen now. Hence, though the data shows that gender has no significant impact, it is inferred that it is due to the sample size in gender and to a time frame well before the policy pronouncement. Therefore, we have used startups that are considered the "weaker section" as a proxy for women inventors to estimate the impact of the gender policy on time taken for patent registration.

ANOVA Analysis

Tables 9 and 10 give the variance between the groups and within groups. To reinforce the data obtained by the basic tabulation, we performed ANOVA to ascertain if there is a significant difference in the variance between the gender and within the gender. In the gender variance analysis (Table 9), there is neither a difference within nor between groups. We thus infer that gender has no bearing on the time it takes for a FER to be issued or the time taken to grant a patent, thus reinforcing the finding and conclusion stated above. After gender, the nature of the firm is analyzed to see if it significantly impacts the time taken from application to FER, FER to the grant of patent, and the overall total time taken to grant the patent.

Table 10 shows the variance between individuals, startups, and others within the groups named in the table. We see a significant difference between groups and groups for the date of issuance of a FER and for the grant of a patent, thus indicating that the nature of the applicant plays a substantial role in the time taken for the grant of a patent and for the issuance of a FER. The analysis, both basic cross-tabulation and ANOVA, thereafter, clearly

Table 9. ***Analysis of Variance Between and Within Groups for Gender***

		Sum of Squares	*F*	Sig.
App to FER	Between Groups	4.647	1.011	
	Within Groups	755.293		
	Total			0.388
FER to Grant	Between Groups	1.633	1.164	
	Within Groups	230.472		
	Total	232.105		0.323
App to Grant	Between Groups	0.148	0.258	
	Within Groups	94.411		
	Total	94.559		0.856

Table 10. ***Analysis of Variance Between and Within Groups for Nature***

		Sum of Squares	*F*	Sig.
App to FER	Between Groups	212..859	63.939	
	Within Groups	547.081		
	Total	759.940		0.000
FER to Grant	Between Groups	5.076	3.675	
	Within Groups	227.028		
	Total	232.105		0.012
App to Grant	Between Groups	17.457	37.207	
	Within Groups	77.102		
	Total	94.559		0.000

indicate a significant relationship between the nature of the firm and the time taken to grant of patent. There is an important relationship between the two variables, and the variance within the group and between the groups is very significant.

This significant variance within and between the nature of firms and the time it takes to grant a patent is measured in two different stages: date of application to the FER and FER to the date of grant of patent. The question is whether nature can effectively calculate the time it takes for the patent grant and if gender mediates between the nature of the firm and the time taken for the grant of a patent. Due to this difference in variance, we further question whether the nature of the applicant can predict the time taken for issuance of a FER and grant of a patent as well.

Multinomial Regression Analysis Results

Considering that the variance is significant, we attempt to study whether nature can predict the time taken by a particular type of applicant and the amount of time taken from the application to issuance of FER, FER to grant of the patent. Therefore, from application to grant, we also study whether gender mediates or moderates the probability of predicting the time taken by a type of applicant and the number of days it would take for the application to be taken up for examination (issuance of FER) or grant.

Table 11. ***Multinomial Regression Analysis Results – Nature***

	Model	Model Fitting Criteria	Likelihood Ratio Tests			Pseudo *R* - Square	
		-2 Log Likelihood	Chi-Square	Deg. of Freedom	Sig.		
APP- FER	Nature	53.617	147.538	12	**0.000**	Cox and Snell	0.257
						Nagelkerke	0.279
						McFadden	0.117
FER -GRANT		42.131	22.218	12	**0.035**	Cox and Snell	0.044
						Nagelkerke	0.050
						McFadden	0.022
APP-GRANT		17.079	91.172	6	**0.000**	Cox and Snell	0.168
						Nagelkerke	0.247
						McFadden	0.161

Table 11 depicts the results of multinomial regression. The predictor is the nature of the firm, and it shows the impact that the nature of the firm has on the time taken to grant of patent. The nature of the firm has an excellent predictive ability to ascertain the time it will take at every stage of granting the patent, that is, the time taken from the application to FER, time taken for grant of patent from the time of FER, and the overall time taken for granting patent from the date of application. The statistical results show overall significance at a 1% confidence level (from the date of application to the date of grant) and from the date of application to the date of issuance of the FER. However, the time taken from issuance of FER to grant of a patent though significant, is at a 5% level of confidence since the *p*-value is greater than the 1% level of confidence but lesser than the 5% level of confidence ($0.01 < p\text{-value} < 0.05$).

As seen from the column pseudo-*R*-Square in Table 11, the probability of the predictions being right is significantly high. One of the reasons for the *p*-values (multinomial logistic regression-nature) to be significant at a 1% level of confidence for the date of application to the date the FER is issued could be the preferential treatment meted out to MSMEs and Startups; whereas, from the date of issue of FER to the date of grant of the patent, the procedure followed is standard for all types of firms. However, startups show a significant relationship for the time taken from the date of issue of FER to the date of grant but at a 5 % confidence level. The time taken for FER from the application date is a critical reason for the relationship between the nature of the firm and the time taken for the grant of patent to be significant at a 1 % confidence level. In research, this is a significant finding. As seen from the results, startups are the biggest beneficiaries of this. It could be attributed to the startup policy of the Government of India.

From the ANOVA results, where the variance between the genders and within the genders is not significant, one would think that gender may not be a good predictor of the time taken to grant the patent. However, the logistic regression results in Table 12 show that gender is a significantly good predictor of time taken for grant of patent from the date of application. The time taken for FER from the date of application is significant at a 1 % level of confidence. However, the time taken from FER to grant of patent is not significant at a 1 % level of confidence. But since the *p*-value is less than 10%, it is considered significant at a 10% level of confidence ($0.05 < p\text{-value} < 0.10$). Overall, the time taken from the application to FER is significantly influenced by gender. Gender has a significant predictive probability for grant of patent from the time of application at a 1 % level of confidence.

The pseudo-*R*-squares are significantly low for FER to grant of the patent, which implies that gender has no

Table 12. ***Multinomial Regression Analysis Results - Gender***

	Model	Model Fitting Criteria	Likelihood Ratio Tests			Pseudo *R* - Square	
		-2 Log Likelihood	Chi-Square	*df*	Sig.		
APP- FER	Gender	61.355	154.661	20	**0.000**	Cox and Snell	0.267
						Nagelkerke	0.291
						McFadden	0.123
FER -GRANT		74.836	24.796	16	**.0730**	Cox and Snell	0.054
						Nagelkerke	0.063
						McFadden	0.028
APP-GRANT		21.418	92.060	10	**0.000**	Cox and Snell	0.169
						Nagelkerke	0.249
						McFadden	0.163

significant predictive capability to ascertain the time it will take for the grant of patent from the date of FER. However, gender plays a significant role in taking the patent application for scrutiny, which in turn is observed to influence the time taken to grant of patent positively. That spells optimism for women entrepreneurs/inventors in India.

Multinomial Regression Analysis – Nature and Gender

Table 13 indicates that nature plus gender impacts the number of days from date of application to date of issuance of FER in the range of 12.3 % to 29.1 %; from FER to date of grant in the range of 2.8 % to 6.3 % ; and from date of application to date of grant in the range of 16.3 % to 24.9 %.

Since, for both nature and gender, the time taken from FER to grant of patents is not significant at a 1% level of confidence, it is the significant advantage at the first stage that makes the overall relationship significant. Thus, to ascertain whether gender mediates the relationship for the time taken for the grant of the patent, we have used only the first stage, that is, the time taken from the application to FER.

Table 13 shows that gender does not mediate between the nature and time taken from the date of application to FER, but nature mediates between the gender and the time taken from the date of application to FER. Gender, which is a significant predictor at a 1 % level of confidence (see Table 12), becomes insignificant with the

Table 13. ***Multinomial Regression Analysis Results : Gender + Nature***

	Model	Model Fitting Criteria	Likelihood Ratio Tests			Pseudo *R* - Square
		-2 Log Likelihood	Chi-Square	Deg of freedom	Sig.	
APP - FER	Final	61.355	154.661	20	.000	Cox and Snell : 0.267
	Nature	201.678	140.323	8	.000	Nagelkerke : 0.291
	Gender	68.477	7.122	8	.524	McFadden : 0.123

introduction of nature in the model. Thus, gender is insignificant, though overall (final), the model is significant at a 1 % level of confidence.

Conclusion

The data, findings, and analysis very clearly show:

(1) The nature of the firm significantly impacts the time taken to grant of patents. Hence, H1 is accepted.

(2) The startup policy of the Government of India is seen to have a significant impact on the time taken to grant of the patent, especially when emanating from the startup firms.

(3) Gender plays a significant role in taking the patent application for scrutiny, which in turn is observed to influence the time taken to grant of patent positively. Hence, H2 is accepted.

(4) Gender does not mediate between the nature and time taken from the date of application to FER. Hence, H3 is rejected.

(5) Gender, which is a significant predictor at the 1% confidence level (see Table 12), becomes insignificant with the introduction of nature in the model. Thus, gender is insignificant, though overall (final), the model is significant at the 1% level of confidence.

(6) Startups and gender are both weaker sections in an Indian setup. Thus, startups are used as a proxy to predict if gender shall impact the time taken for the grant of a patent.

(7) The startup has an impact only till the date of issuance of FER from the date of application, but they shall be treated at par thereafter. Hence, H4 is accepted.

(8) Considering the social change in India with respect to the gender ratio and education of women, especially in the STEM area, entrepreneurs thereafter shall surely see a rise in the number of women applicants for patents.

(9) It is also predicted that women will have and reap the benefit of the gender policy on similar lines as the startup policy in India.

(10) It shall also see many women making their mark in India in inventorship.

The number of women students in higher education and STEM areas has been on the rise (Table 1 and Table 2). It is , therefore, expected that the number of women inventors will also increase. With more studies and policies such as these, the barriers to women pursuing science and making an IP footprint should fall away with time. The finding that the gender of an applicant doesn't impact the time taken to grant of a patent is counterintuitive, and a significant reason could be due to a skewed sample. If the number of cases with female applicants increases, we are confident that, like startups, gender will significantly impact the time taken to grant of patents. This conclusion is vindicated by the results of the multinomial logistic regression. Thus, the amendment in the Patents Act in 2016 significantly impacts the time taken from the date of application to the date of issuance of FER and from the date of application to the date of grant. Further, since an equivalence is drawn between women and startups, as applications from female applicants increased as a result of the 2019 amendment to the Patents Act, the growth in the number of female applicants and the number of patents awarded to female applicants will be similar to the effect the 2016 Amendment to the Patents Act had on startups. With the increase in the number of women applicants/inventors, the 2019 amendment is expected to aid the women applicants/inventors in obtaining patents in a shorter time.

Managerial Implications

Considering the equivalence we have drawn between the female gender and MSMEs, a gender policy can impact the time taken to grant of patents to females once the number of female applicants rises. This is a near-term possibility considering that female enrollments are on the rise in mainstream education in India, especially in STEM areas. With a gender policy announced by the Government of India and equivalence drawn between the gender (female) and the startups as a weaker section of the society, the future looks positive for women innovator entrepreneurs in India. Thus, if a woman entrepreneur applies irrespective of the nature of her firm, she benefits. Still, in the data, startups tend to take away the advantage a woman would have in taking up the application for scrutiny. It may be noted that with the rise in the numbers of women applicants in a startup category, the same will derive an advantage over other forms of businesses.

The 2016 amendment resulted in a steady increase in the number of startup applicants and a reduced time from the date of application to the date of grant. Research proves beyond doubt the similarity between startups and women and stands by the argument that gender would be a significant variable in deciding the timeline. The number of women in education is rising, along with STEM areas. More women innovators/applicants are expected to reap the benefit of this policy. We expect to see a steady and significant rise in the number of women applicants due to the 2019 amendment to the Patents Act.

Limitations of the Study and Scope for Future Research

The limitations of the study are :

(1) Four hundred and ninety seven patents were considered in this study going back from 2019. A study beginning from 2016 to present would provide a more accurate picture.

(2) The study was only conducted with respect to Indian patents granted by the Indian patent office.

(3) The gender of applicants was guessed based on whether traditionally the name is masculine or feminine. For gender-neutral names, a search on social media was conducted. In cases where no identity was established, the gender was guessed. This could contribute to an error in the results.

A significant amount of scope for future research exists in this field :

(1) Both start-ups and women applicants are required to submit proof of identity to the Indian Patent Office to claim their respective status. The time taken for obtaining a start-up certificate from DIPP (Department for Promotion of Industry and Internal Trade) versus the time for a woman applicant to procure proof of identity can be studied as one of the factors impacting the time taken for the grant of a patent.

(2) Studies can be conducted in other emerging geographies to study the relationship between women patent applicants and the time taken to grant of patent to women applicants.

(3) Future research can study the ratio of number of start-up applicants to women applicants to study whether the amendment impacts the ratio.

Authors' Contribution

Shalini Sitaraman, a patent agent and attorney, conceived this paper's idea when the amendment expedited patent applications of women applicants was announced. She extracted the data relating to patents. Dr. Nilesh Borde and

Dr. Purva Hegde Desai contributed to the data analysis and vetting of the paper. Shalini wrote the paper under the expert guidance of Prof. Borde and Prof. Hegde Desai.

Conflict of Interest

The authors certify that they have no affiliations with or involvement in any organization or entity with any financial or non-financial interest in the subject matter or materials discussed in this manuscript.

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