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Does It Matter Who Owns It? A Comparison Study and Demographic Profiling of Patent Ownership and Its Impact on Commercialisation in Sri Lanka

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Abstract

Purpose: This study compares the demographic profiling of patent ownership in Sri Lanka with counterparts in other parts of the world. The study also seeks to understand the impact of patent ownership on patent commercial success as Sri Lanka is one of the few countries where a significant number of independent individuals are involved in the innovation process as inventors. Sri Lanka, as a country, struggles to make economic headway through the commercialisation of innovation. This factor of ownership could be an influencing factor for non-commercialisation. The study explores this aspect by comparing ownership between individual held patents with organisational patents on a national scale. The study also compares the findings with other similar global studies. **Methodology:** A sample of 220 respondents from a national sample comprising individual patent holders and organisational patent holders, including universities (IHL's), Government Research Organizations (GRI's) and commercial enterprises, was used in this cross-sectional study and analysed using SPSS version 21. The study uses descriptive statistics and Chai square analysis to address the research questions. The study is limited to patents granted between 2010 and 2014. **Findings:** The empirical findings confirm that ownership does influence the probability of commercialisation in favour of organisational ownership. The study also reveals a near equal match in demographic profiling with developed countries, indicating a mature inventor community. This finding draws policymakers' attention to the support required for the most crucial stage of patent commercialisation. **Research Implications/Limitation**: The study contributes to comparing the demographic profiling of patent holders by ownership category, gender, education, experience, the propensity in the inventions, patent strength, and patent commercialisation with other global studies and helps benchmark the achievement of the SL patents in a global perspective. The limitation of the

study is the period selected for analysis as the study setting is set relatively early in the stage of the country's innovation policy development and should be replicated through the analysis of more recent patents. **Originality:** Despite the increased interest in patent studies and innovation, very few studies have provided empirical evidence that compares different patent ownership in a single study, especially in the context of an emerging country and the tracking of the patent commercial potential. Therefore, this study contributes to this body of knowledge and the findings valuable for patent holders and policymakers.

Keywords

Patents, IP Ownership, Academic Patents, Independent Inventors, Invention, Innovation, Commercialisation, Technology Transfer

1. Introduction

Sri Lanka is one of the few countries where a significant number of independent individuals are involved in the innovation process as inventors. The national patent database indicates that over 70% of registered patents are owned by individuals. These independent inventors could be a driving force of innovation in the country by developing technology that is deemed new and granted patent status for the inventions. Amongst them are inventors who have won international acclaim and awards for their inventions. However, many patent holders, including award winners, have not been successful in commercialising their patented inventions and creating economic value through the patented technology. Whilst it is accepted that not all inventions and patents will be commercialised due to various factors, Sri Lanka, as a country, struggles to make economic headway through the commercialisation of innovation (Ratnasiri, 2015; Ministry of Technology and Research, 2010). This skewness of ownership could be an influencing factor for non-commercialisation. The study explores this aspect by comparing ownership between individual held patents with organisational owned patents on a national scale and benchmarking with global findings.

Patents are considered the cutting edge of technology as they represent new and radical knowledge and hence a valuable asset of a country (Motohashi, 2018; Griliches, Peks, & Hall 1986). If exploited, patents could contribute to the economic progress of a country. Patents could be owned by independent inventors, inventors employed by institutes of higher learning (IHL's), research organisations (GRI's) or commercial establishments. As a lower-middle-income country with a GDP per capita of US $ 3682 (Department of Census and Statistics Central Bank of Sri Lanka). Sri Lanka could benefit well from exploiting its portfolio of patents to add value to its manufacturing and exports. However, with a large proportion of its patent portfolio being individually owned, Sri Lanka has not significantly improved its innovative ranking or economic competitiveness. Could

ownership of patents be a cause that hampers this progress? How could this be rectified for the greater good of the county and reap the economic value from its radical technological inventions, its patents?

Past studies indicate innovation as an economic uplifter and a value creator and an essential component in gaining economic progress for countries (Raghupathi & Raghupathi, 2017; Han, 2017). Countries that recognised this aspect and increased their innovation capability increased their GDP's significantly and surged ahead in economic prosperity through wealth creation (Capello & Lenzi, 2014). Solow, the Nobel laureate for economics, attributed to the economic value gained through technology, flagged this disparity between developing and developed countries. This disparity is seen as a technological gap between developed and developing nations (Solow, 1957). The disparity between the economically strong and the weaker countries is reflected in the countries' GDPs and innovation indexes. Therefore, it is no coincidence that the most innovative and wealthy countries are generally the same (Raghupathi & Ragupathi, 2017). The Global Innovation Index (GII) 2020 top 10 Innovative countries also have the highest Gross National Income (GNI) with per capita income exceeding US$ 45,000 in 2022. They are classified as High-Income economies except for China, classified as an Upper Middle-Income country (Global Innovation Index, 2022).

Recognising this fact, the government of Sri Lanka drew up its policy to achieve progress in this area. The GOSL drew a national policy for Science, Technology and Innovation to achieve economic advancements through technology in export substitution, increase the value-added and technology exports and increase the national gross domestic product. The policy was drawn in 2009 but the objectives set were not achieved, leaving the country wanting in economic progress and remaining ranked at 95th position as a lower middle-income country (World Population Review, 2020). According to the global innovation Index 2022, Sri Lanka is ranked 85 out of 132 countries. The Global Innovation ranking is based on several criteria. Criteria on aspects such as human capital and research, university rankings, coutry spending on Gross Expense on Research and Development (GERD), number of scientific publications, patents filled, infrastructure in ICT developmet and usage, Business sophistication in terms of knowledge workers, innovation linkages, Market sophistication in terms of investment diversication and market scale of the respective country. An increase in these activities will better the country's innovation index.

Further, the exploitation of scientific inventions and patents will lead to the economic progress of the country. This economic progress will add value only when the inventions realise their market potential through commercialisation. A patent unleashes its economic value only when it converts to a product or process through its commercialisation.

Patents are considered radical innovation with a potential to yield higher economic returns than incremental innovations (Stevens, Greg, Burley, & James, 1997). Patent commercialisation is viewed as the ultimate proof of patent suc-

cess. Independent assessors on its technological novelty endorse the invention before being awarded patent status (Katila & Ahuja, 2002) and endorsed by the market through product or process acceptance.

The exclusive right granted for a patent is confined to geographical boundaries that generally remain within the country's geographical boundaries in which the patent is registered. The inventor could extend the boundaries of exclusivity to other geographical areas by registering the patent in the respective countries. The number of countries the patent is registered with is termed "patent family". The larger the family size of a patent, the more valuable it would be and possess a greater potential to be commercialised across many countries (Putnam, 1996). Patents also assist in increasing knowledge by building upon existing technical knowledge. As a patent's applicability increases through its relevance in an industry or across different industries, it would get cited, indicating its greater commercial potential due to its wider usage (Simpson, 2017; Bloom, Van Reenen, & Williams, 2019). Research also indicates that patents that received citations across industries were renewed longer than those cited within the same industry (Maurseth, 2005). At the same time, patents renewed for their entire statutory period were found to be cited more than patents that had prematurely expired (Harhoff et al., 1999; Griliches, Peks, & Hall, 1986). These two factors of citation and family size have been mentioned in literature as determinants of the strength of a patent which increases the likelihood of commercial success (Pakes et al., 1989; Jaffe et al., 2000; Crespi, Geuna, & Verspagen, 2006; Krishna, Jain, & Chugh, 2017).

Theoretical arguments also indicate the patent commercial success varied based on ownership due to the availability of resources and skills such as financing, marketing and manufacturing capabilities (Hellman, 2007). Commercial organisations or large firms would invariably possess better resources, required skills and negotiating power than IHL's, GRI's and individual inventors. Furthermore, since IHL's and GRI's mainly concentrate on research (Sohn & Han, 2019), they seldom possess the core commercialisation competencies. At the same time, independent Inventors may have little or none of these resources or capabilities. Therefore, based on the findings, it could be assumed that the variance in commercial success could be attributed to ownership and based on the resources and expertise owned and available by the owners of the new patented technology.

Literature also suggests that ownership influences the ability to search for commercial partners. Independent inventors or patent holders are less efficient than their counterparts in either institutes of higher learning or research Institutes (Hellman, 2007). Commercialising depends on the effective transfer of technology and intrinsic knowledge to develop further and meet market criteria. Commercialising could be done by retaining ownership and launching start-ups, spin-offs, or selling the patent via licensing to a third party with commercial capabilities (Krishna, Jain, & Chugh, 2017; Sohn & Han, 2019). There are many avenues by which a patent could be commercialised. Past studies have found that

while IHL and GRI's preferred method of commercialising was through licensing, individually owned patents were commercialised most often through start-ups as they preferred to retain ownership than to license as it offered more control (Wilkins, Remias, & Kharoujik, 2008). A further reason for poor commercial success has been attributed to patented technology by independent inventors being classified as low technology (Weick & Eakin, 2005; Wickramasinghe & Ahmad, 2011) or being too embryonic compared with inventions arising from academic research or by a commercial enterprise. Patent law permits patent filing at the early stages of the innovation process, at which time the patented invention may be prematurely embryonic. A patent being embryonic indicates the innovation has not yet reached a commercially accepted form. It may necessitate further transformation through more testing. This process increases the development cost and the risk due to uncertainties surrounding new technologies. These uncertainties are often hampering commercialisation (Sichelman, 2009). As a result, commercial partners would often negotiate to their advantage in these instances, which may not be advantageous to the patent holder and remain commercially unexploited. Based on the literature findings, it is assumed that the ownership of patents impacts the patent's commercial success. Therefore, the study puts forward the hypothesis:

Hypothesis 1: There is a relationship between patent ownership and achieving commercial success.

In pursuit of empirical evidence validating the hypothesis, this study contributes as one of the few studies that integrates divergent patent ownership influence on the probability of commercializing. The analysis also highlights the demographic profiling of patent owners and benchmarks with global studies.

This article is structured as follows, after this introduction in section one, section two reviews the theoretical background relating to patent ownership and attributes relating to patent commercial potential. Section three explains the methodology employed for the collection of data and its analysis in this study, followed by section four, where the key results pertaining to patent ownership demography and commercial success and probability of success is discussed. Section four addresses the theoretical and managerial implications based on the findings and suggest direction for future research based on the findings and the study limitation.

2. Literature Review

Innovation studies have shown that ownership, complexity, and size are vital factors determining innovativeness and commercial success (SAPPHO study by Rothwell et al., 1974; Freeman & Soete, 1997; Camisón-Zornoza, Lapiedra-Alcami, Segerra-Cipres, & Boronat-Navarro, 2004; Aghion et al., 2013). Complex organisations facilitate idea generation, acquiring of knowledge and cross-fertilisation of them to spur innovation. It also determines the ability to access financial backing necessary for inventions with high technical potential and those that require economies of scale. Therefore, organisations with access

to knowledge and finance invariably have a better potential for commercial success (Damanpour & Schneider, 2006). Thus, the ownership of patents links with patent commercial success based on access to knowledge and access to financial backing.

Literature reviews indicate a large body of study in the area of patent ownership. This body of literature fragments by type of inventor or segments, class of technology, or by industry. The majority of studies undertaken on ownership of innovation and new technology focus on a single category of ownership and are based on Institutes of Higher Learning (Jensen & Thursby, 2001; Mazzoleni & Nelson, 2005; Crespi, Geuna, & Verspagen, 2006) or Government Research Institutes (GRI's) or based on commercial firms (Cohen, Nelson, & Walsh, 2000; Landabaso, Oughton, & Morgan, 2001). Fewer studies track the commercial success of independent inventors (Svensson, 2012; Wickramasinghe & Ahmad, 2011, Wilkins, Remias, & Kharoujik, 2008; Weick & Eakin, 2005). Therefore, there exists a scarcity of study that explores divergent patent ownership in a single study on a national scale that includes different types of patent ownership ranging from independent inventors, academic researchers and those inventors and researchers employed by a commercial enterprise. Studies based on inventors that are relevant and noteworthy are carried out by Georgia Tech 2007; Pat Val EU 2005; Pat Val2 2010. The Pat Val studies capture data on a national scale across many European countries such as Spain, Germany, France, UK, Italy & the Netherlands and include all inventor groups. The Georgia Tech study captures data of independent inventors only in the state of Georgia, USA. This study was done by Jung and Ejermo (2014) is a longitudinal study of Swedish inventors, while Weick and Eakin (2005) study captures data on independent inventors, not necessarily patent holders across the USA.

In Sri Lanka, studies carried out on either inventors or patent holders are scarce. Amongst the few existing, one noteworthy study of profiling patent holders is a study carried out by Wickramasinghe and Ahmad in 2011. However, this study only captures independent inventors who have applied for patents, not granted patents. The study also does not include patent holders attached to IHLs or GRIs, or commercial establishments. Therefore, the literature is fragmented on ownership and could be classified by ownership groups. Studies are either focused solely on individual ownership (Weick & Eakin, 2005; Wickramasinghe & Ahmad, 2011; Wilkins, Remias, & Kharoujik, 2008) or academic ownership (Mazzoleni & Nelson, 2005; Crespi, Geuna, & Verspagen, 2006). Studies on commercial patent ownership are scarce, limited to industry-specific (Krishna, Jain, & Chugh, 2017). Most patent studies involving commercial enterprise is based on academic patent transfer and academic Industry collaboration (Aghion & Tirole, 1994; Malik & Wickremasinghe, 2015).

Thus it could be stated that most studies are limited in either scope or scale. For example, a national study covering all groups of patent holders is limited to the PatVal surveys, which covers European inventors in 6 countries in Europe. However, even the Pat Val study does not compare all its findings on patent ownership but by technological class. Studies covering different categories of in-

ventors, especially in a developing country with low innovation propensity, are scarce, which this study addresses. The study also contributes by validating the relationship between ownership and commercial success of patents.

Evaluating the existing literature on the various aspects of ownership demography indicates low female participation that varies by country and scientific fields. For example, female contribution to patents in European countries vary, with 2.9% in Austria to 14.2% in Spain (Gambardella, Giuri, & Mariani, 2005; Frietsch et al., 2009). The literature also reveals the women's most substantial contribution is in the fields of Pharmaceutical and chemical fields and least active in mechanical and engineering (Jung & Ejermo, 2014).

Age comparison is less studied, with studies indicating the average age of patent holders ranging from 37 years in Finland (Toivanen & Vaananen, 2016) to the average age of 45.4 years in six European countries (Gambardella, Giuri, & Mariani, 2005). Age was also associated with the productivity of inventions, and patents with higher economic value were associated with older inventors due to the knowledge accumulation over time (Jones, 2009) and validated again in the Sri Lankan context (Wickramasinghe & Ahmad, 2011).

Education was also associated with two key issues—the propensity to invent and increase the productivity of the invention (Toivanen & Vaananen, 2016; Hunt et al., 2012; Jones, 2009; Mariani & Romanelli, 2007; Gambardella, Giuri, & Mariani, 2005). These studies positively associate education with propensity and productivity. Higher education levels were also found in large firms and amongst inventors involved in larger scientific projects (Mariani & Romanelli, 2007).

Studies in the past have used aspects such as patent citation (Katila, 2000; Harhoff et al., 1999; Dahlin & Behrens, 2005), patent family size (Deng, 2007; Eaton & Kortum, 1996; Putnam, 1996), and renewals to evaluate the patent value (Harhoff et al., 1999; Datta & Jessup, 2013). These proxies indicate the commercial potential of a patent. They hence will get invested only if the potential is seen as the financial commitment to increase the patent family size through registration in other countries. This process necessitates high financial investment and financial risk. Renewing patents also indicates the continuous commitment and belief by the patent owner of the patent potential, which gives the owner the option to keep the patent or let it expire (Svensson, 2012). Thus many patent studies use these factors as proxies to assess the quality and predict the commercial success of patents but fall short in real commercial success, which is another identified gap in innovation literature and is addressed by this study.

Past patent studies on commercial success indicate an overall commercial success rate between 60% - 70% for organisations (Sichelman, 2009) while 25% - 40% commercial success achievement for the independent inventor's category (Wilkins, Remias, & Kharoujik, 2008; Weick & Eakin, 2005). Most independent inventors' commercial success is attributed to the patent holders starting their own business to commercialise it rather than licensing their patent. Therefore, most independent inventors prefer to retain their control over the commercialisation process of their invention. However, the literature also states that being an

inventor and an entrepreneur may not yield all the skills required for continued success or expansion (Wilkins, Remias, & Kharoujik, 2008). This study seeks to compare the demography of patent holders and the value of its country's patents with studies carried out globally. Based on existing literature review it is evident that a gap exists in comparing different patent ownership groups with varied technological classes and the commercial success achievement of patents in a single study. Thus, this study addresses this knowledge gap in literature.

3. Research Methodology

The study objective was to empirically validate the research hypothesis to ascertain if there was a relationship between patent ownership and commercial success of the patented invention as the majority of the country's patent portfolio is owned by independent inventors. The answer to this question would give insight and direction to policymakers and patent holders. The study addresses these questions through a quantitative cross-sectional study. The study is based on a national framework of patents held by Sri Lankan nationals registered through either the National Intellectual property Office of Sri Lanka or registered through the Patent Cooperative Treaty (PCT). The framework of this study is limited to the registration of the patent between 2010-2014. The reason to select this period is attributed to the fact that the first national policy for science, technology and innovation was drawn up in 2009, signalling the government focus on this area for development. The total number of registered patents by Sri Lankan nationals with both databases collectively was 435. The research sample was estimated based on the t-table developed by Krejcie and Morgan (1970), which estimated 205 respondents. The researcher factoring for non-response, the respondents' number was increased to 330. With much follow up by the researcher, a response rate of 66% was achieved, with 220 responding to the research questionnaire. Since the National Intellectual Property Office database of Patents registers 70% independent individuals, it was necessary to collect sufficient numbers from other ownership groups. However, the IHL's GRI's and commercial establishments' patent registration was inadequate to form three separate ownership categories. Therefore, the sample was limited to two ownership categories. The ownership groups were classified as Independent individuals and organisational ownership comprising IHL's, GRI's and commercial enterprises. A random disproportionate stratified sampling method was used to obtain adequate representation for analysis purposes from the two patent ownership categories. The sample was equally distributed among the two patent ownership categories so that adequate representation for each ownership category was in place for concluding the study (Refer **Table 1**). The unit of analysis was the patent holder. The identity of individual patent holders is straightforward. However, in organisational patent ownership, identifying the respondent or the unit of analysis gets complicated as the patent outcome could result from several people. In such instances, the respondent selected was either the lead researcher or named patent researcher or the research director or a key senior executive involved with

Table 1. Sample selection.

Categories	%	N	n	Response
Individual	70%	304	215	106
Organisation	30%	131	115	114

the patent idea, prototyping and commercialising it.

The questionnaire was developed based on the Pat Val study and sought details on ownership and the success of patent commercialisation with one dichotomous answer (Yes/No). The strength of the patent was assessed through three dichotomous questions relating to citation, family size, and commercial success. The questionnaire also captured demographic data relating to the patent holders sex, age, experience as inventor, highest qualification, number of patents owned, authorship, method of commercialisation and patent registration.

The data collection commenced in November 2018 and continued for over six months till April 2019. The questionnaire was initially sent by post but received a low response rate due to inaccuracies in the postal addresses of patentees. Therefore, after obtaining details of emails and telephone numbers from the NIPO database, a combination of online administered questionnaires and a personally administered questionnaire was adopted, which enabled the researcher to obtain a 66% response rate and deeper understanding. The difficulty of contacting the respondents was the primary reason for the extended data collection period.

Before the main study, a pilot study was carried out with 32 respondents from a diverse representation of inventors from IHL's, GRI's Corporates, and Individual patent holders to ensure the questions' content, clarity, and validity. The questionnaire was also run by two senior research scientists and two senior managers involved in the commercial operation of inventions. Based on the feedback, minor changes to terminology to be better suited to the scientific community were made. The questionnaire was also translated into the vernacular as many independent patent holders preferred the questionnaire in the Sinhala language. A sworn translator was used for this purpose. The analysis was done using SPSS version 21.

The study findings were tabulated using descriptive statistics on demography and patent details, comparison between the two ownership categories and chi-square test was used to verify the relationship between the two nominal variables to test the study hypothesis. The chi-square test is one of the most used statistical analyses in research when examining cross-classified categorical data to ascertain questions of association between categorical variables (Franke, Ho, & Christie, 2012; Turkson, Addor, & Kharib, 2021).

The Socio-Demography profile of the respondents who participated in the research is given in Table 2. The majority of respondents were males (86%), with females being the minority with 14%, while the majority fell into the age groups between 35 - 55+ indicating the Sri Lankan inventors as a mature profile of inventors. The majority of surveyed respondents were tertiary qualified (78%)

Table 2. Socio-Demography profile of respondents.

	n	%
Gender		
Male	189	86
Female	31	14
Age		
14 - 20	3	1
21 - 34	39	18
35 - 44	55	25
45 - 54	60	27
55+	63	29
Education		
O/L	8	4
A/L	39	18
Graduate	56	32
Masters	46	20
PhD	71	26
Experience		
less than 5 years	15	7
5 - 10 years	52	24
More than 10 years	153	69
Patents Owned		
Single patent	91	41
less than 5 patents	105	48
More than 5 patents	24	11

and well experienced, with most respondents (70%) having over ten years experience as inventors. In addition, 58% of respondents held more than one patent, while 10% owned more than five patents. These statistics indicate a well experienced, knowledgeable and active profile of Sri Lankan patent owners. The three respondents under the age of 21 were students who patented their inventions after winning at the annual national school's inventors competition organised by the Ministry of Science & Technology to foster an innovation climate in the county.

4. Results

The researcher undertook the study to understand if the low commercial success of patents in Sri Lanka was attributed to the fact that a significant large proportion of the country's patents were owned by independent individual inventors. Therefore, it was necessary to compare the two ownership groups demographics,

the patent quality and achievement of commercial success to validate.

The first step was to analyse the demographic profile of the two ownership groups for deeper understanding. In the comparison based on patent ownership, the narrative changes and insight is seen in the differences between the two ownership categories of independent individually held patents and organisational owned patents. Table 3 gives the narrative of the demographic differences between the two ownership categories. The difference in demography profiling is seen in gender, age, education, patent traction, authorship and experience.

In comparing gender, more females are found in the organisational patent group than the independent individual patent group. Overall, the female participants are low compared to the male participation, where 14% represents total

Table 3. Demographic comparison between ownership groups.

	Organisation		Individual	
	n	%	n	%
Gender - Female	25	22	6	5
Male	89	78	100	95
Age				
Under 20	0	0	3	3
21 - 34	18	16	20	19
35 - 44	26	23	29	27
45 - 55	34	30	26	25
+55	35	31	28	26
Education				
O/Level	0	0	8	8
A/Level	1	1	38	36
Graduate	19	16	50	47
Masters	35	31	10	9
PhD	59	52	0	0
Experience				
Less than 5 years	8	7	6	6
5 - 10 years	24	21	28	26
More than 10 years	82	72	72	68
Patent Owned				
Single patent	25	22	65	61
Less than 5 patents	75	66	31	29
More than 5 patents	14	12	10	9
Authorship				
Co-authored	107	94	1	1
Sole	6	6	105	99

female participation. In the organisational group, 22% female participation is seen compared to 5% in the independent Individual patent group. This finding compares to earlier studies carried out wherein female participation is low in all studies, including the global studies. However, though the female participation is low as a %, the Sri Lanka female participation is higher than other European countries where female participation is represented in all ownership categories were 2.8% (Gambardella, Giuri, & Mariani, 2005).

Comparing the age demography, the independent patent group has a slightly younger profile of patent holders than the organisational patent group. Approximately 50% are under 45, while 61% of organisational patent holders are above 45. Overall, more than 50% of respondents were between 35 - 50 years, and only 19% were under 34 years of age, and the findings compare with the European Pat Val study.

Experience of inventors in terms of the number of years in innovation activities is similar in each group with a marginal skewness to less experience inventors in the independent patent group with 32% claiming less than ten years experience. In comparison, 72% claimed more than ten years of experience in the organisation patent group, while 68% claimed over ten years of experience as inventors in the independent patent group. This finding differs from the study carried out by Weick and Eakin (2005) in which they found over 55% of individual patent holders having less than ten years of experience. Therefore, the findings in this study indicate a well-experienced profile of inventors in both groups in Sri Lanka.

The most significant difference between the two ownership groups is seen in the education levels. In the independent patent holder group, 83% are either secondary or graduates. In comparison, the patent holders in the organisation group are more educated with post-graduate qualifications, and approximately 30% hold a Masters' degree, and 51% hold a PhD's. This study's overall demographic results compared with other studies on inventors and patent holders showed that 78% are tertiarily qualified (Gambardella, Giuri, & Mariani, 2005; Sirilli, 1987) while 26% are PhD holders. This finding indicates that the inventor profile of the Sri Lankan inventor is similar to most other developed countries with higher innovative propensity countries across Europe.

A significant difference is also observed in the number of patents owned. 62% of Independent individuals owned single patents, while the majority of organisational owned more than one patent and less than five patents indicating more innovative traction within the organisation ownership. This finding compares with past studies researching independent inventors (Weick & Eakin, 2005; Wickramasinghe & Ahmad, 2011; Wilkins, Remias, & Kharoujik, 2008; Gambardella, Giuri, & Mariani, 2005). However, those who owned more than five patents in both categories indicated similarities, with 9% independent individuals owning more than five patents and 12% owning more than five patents in the organisation group. This finding indicates that a select few very active inventors within

both ownership groups are involved in keeping the ongoing innovation traction with a robust, innovative mindset that is valuable for a country.

The study also captures patent quality through data on patent family size, citation, and commercial success (Table 4). Overall the findings of the family size of Sri Lankan patents indicate weak patents, with only 11% of overall patents claiming registration outside the country. Within the patents registered outside the country, 18% were organisational owned patents, and only 3% were individually owned patents. The citations of patents were also low, with 32 patents being cited in the organisation group and four cited in the individual category.

Based on the proxy achievements, the value of the patent quality was then determined. Patents were categorised as strong if they met all three proxies, fairly strong if they met two proxies, weak if they met 1 proxy and very weak if they did not meet any proxies. The study findings reveal that a majority of patents fall into the weak and very weak categories due to not achieving any of the patent success proxies. Furthermore, a comparison of the two ownership groups indicates a significant number of weak patents in the individual ownership group, with 95% of individually held patents falling into either the very weak category or the weak patent category (Refer Table 5).

The low patent value could be attributed to either weak technology or a lack of funds and resources needed for patent registration in foreign countries. It could also be due to the inventors not being the best informed on citations. Patent examiners add citations to avoid legal infringements (Harhoff et al., 2006; Alcacer & Gittleman, 2006) and hence this information is not available with the patent owners who were respondents of this study.

The demographic and descriptive comparison of patent commercial success between the two ownership categories in this study indicates a difference between the two patent ownership groups that is noteworthy and enables understanding

Table 4. Patent success by proxie comparison.

	Organisation		Individual	
	Frequency	%	Frequency	%
Commercial Success	60	53	21	20
Cited	32	28	4	4
Patent Family	21	18	3	3

Table 5. Patent value comparison.

	Organisation		Individual	
	Frequency	%	Frequency	%
Very Weak	45	39	85	80
Weak	33	29	16	15
Fairly Strong	23	20	3	3
Strong	13	11	2	2

of the patent commercial success. The study reveals the share of patent commercial success in organisation held patents being higher than for the individually held patent group with 60 patents or 53% of organisation patents being commercialised while only 21% or 20% of individually owned patents being commercialised. The overall commercial success rate of patents in Sri Lanka of 37% compared with commercial success rates in other countries is lower, where an average of 60% commercial success rate is documented (Svensson, 2012; Morgan et al., 2001; Sichelman, 2009).

In the analysis of the method of commercialising, the study reveals patents were either licensed out to outside parties or commercialised through start-ups or by patent owners own establishments (Refer **Table 6**). More licensing agreements were seen in the organisation category, with 35% of the licensed patents compared to 2% of those in the individually owned category. This finding indicates that organisational owned patents could trade patents by attracting industry to invest and use new technology, which is not reflective in the individually owned patent category.

The study findings depict 18% of individually held patents being commercialised through start-ups or existing business operations. In comparison, 34% of organisation owned patents were used to further their business operations. This finding indicates that most patents in Sri Lanka are not traded but used to further the inventors owned business operations irrespective of ownership. This finding is similar to findings of previous studies (Svensson, 2007, 2012).

Based on the study hypothesis, which was to find a relationship between patent ownership and achieving commercial success, a Chi-square test of independence was conducted to examine the relationship between patent ownership and patent commercial success based on the data gathered from the 220 respondents of the survey. A Chi-square test is selected to verify the relationship between two nominal independent variables: the two ownership categories—independent individuals and organization. The nominal dependent variable is the patent commercial success achievement or the non-achievement (**Table 7**).

Table 6. Method of commercialization.

	Organisation		Individual	
	Frequency	%	Frequency	%
Licensing	40	35	2	2
Own/Start-up	38	33	19	18

Table 7. Two × Two variables.

	Organisation	Individual
Commercialised	60	21
Non-Commercialised	54	85

A chi-square test of independence was performed to examine the relation between patent ownership and patent commercial success. The study results show that the relationship between the two nominal variables was significant X^2 (1, N = 220) = 26.00, p < .001. The results give strong evidence that patents owned by individuals are less likely to achieve commercial success than patents owned by organisations. Thus, the findings confirm the research hypothesis which is: there is a relationship between patent ownership and its commercial success. Therefore, the ownership of patents matters for achieving patent commercial success, which policymakers need to note when driving the national innovation system. The findings also give direction to the country's innovation strategy and the need for a two-prong strategy addressing the different issues faced by the two ownership categories.

5. Conclusion and Contribution

The study was carried out with the objective of finding out if the large number of individually owned patents was a cause for the low patent commercial success especially as Sri Lanka is one of the few countries that have a high percentage of individually owned patents. In this endeavor the study has contributed to a more profound understanding of Sri Lankan patent holders across industries and ownership groups in a national setting. Theoretically the few studies in the past have empirically proven that ownership, complexity, and size are vital factors determining innovativeness and commercial success. This study confirms this in its finding. The study contributes significantly by revealing the demography profile of patent holders by ownership groups and the differences between the groups and benchmarking each profile with other global studies. The study also contributes to capturing the value of the patents based on patent proxies used to measure patent value. Finally, the study also captures the commercial success rate of the patented inventions on a national scale which is scarce, especially in a low inventive environment, thus addressing a research gap.

The demographic attributes of Sri Lankan Patent holders compared with global studies carried out in developed and high innovation climates. The high percentage of qualified tertiary inventors in both ownership categories and the high percentage of PhD holders in the organisation category augur well for Sri Lanka. In addition, the high maturity and experience of these inventors contend well for the country. This being so, what hampers the country to achieve success? Looking beyond the demographic profiling to the patent quality, it is seen that based on the innovation proxies of citation and family size and the success in commercialising, the patent value is low across the two patent ownership groups with a more significant disparity in the individually owned patents. The low patent value in the individual owned patent group could be attributed to the owner's financial constraints, market exposure and bargaining power which would require addressing.

The data gathered for the study reveals the disadvantage and low commercial

success for the independent individual patent holder who contributes mainly to the country in terms of radical innovation that is patented by representing 70% of the country's patents. The non-commercialisation of their inventions which is much lower than the global standards, signal a significant untapped economic opportunity that cannot be ignored and requires nurturing and fostering to harness its economic opportunity. The implications of this study lie in the reassessment of innovation policy and innovation infrastructure for addressing the challenges and issues faced by patent owners to harness the potential of the untapped radical inventions of patents for the country's economic development (Blit, Laureate, & Spenser, 2017).

To do so would require state support harnessing industry and other support agencies to strengthen the country's national innovation system (NIS) by linking them with patent holders. This could be done by setting up a support system geared to addressing the independent inventor's needs. However, the study reveals that independent inventors have less support, limited capabilities, and resources for commercialisation.

It is recommended that in order to spur the commercialisation of patents it would be necessary to set up an intermediary or intermediaries within the country's national innovation system that would enable inventors from the early stage of technology development to seek funding for furthering research and also commercial operation in terms of developing and bettering prototypes, testing them in market conditions, accessing expertise in aligned fields, seeking and linking with commercial partners both locally and internationally, registering of higher potential patents overseas to increase the scope of patent trading. This would then reduce the search time for commercial partners and increase the visibility and opportunity for the countries patents by increasing the patent value through greater exposure.

The proposed support system should be at each milestone in the innovation process from the inception of idea generation and patenting. Due to the limited time granted for a patent, provision is given in the patenting system to grant a patent at a very early stage of its development. This process necessitates further development after receiving a patent and would require funding that would be costly. This funding should be accessible in the form of state-funded grants. This fund would then help in risk-taking and failure that surrounds the introduction of new technology into markets. The fund would also open an avenue by which the majority of the country's inventors, who are independent inventors, add value to the country's economy through their patents commercialisation and upscaling that could contribute significantly more than is currently enables. It would also enable inventors, especially the independent inventor, to improve on the existing patents and build better and advanced versions of them, improving and creating more innovation traction than currently seen, with the majority of independent inventors owning only single patents. The current large proportion of non-commercialisation of independent inventor's patents and low innovation traction

within this group signals underdevelopment of patents which has serious consequences. Due to patents being underdeveloped, resulting in long gestation in development, the probability of the patent being commercialised becomes further remote due to the limited remaining time in patent protection before becoming public domain makes it unattractive to both the patent holder and commercial partner. This economic backing to patent holders or third-party patent developers will gradually enable the innovation community to become less risk-averse. It would also enable building a risk-taking culture through the entire innovation chain and network of players to include not only the patent holder but include patent developers such as commercial business partners, to the very end of the chain, of store and shelf who enable the link with consumers in the commercialisation of patented innovative products.

The current patent system in the country could also be better geared to prospecting. Since many individual patent holders struggle to obtain funds for patent development and commercialisation, the government, which is a crucial stakeholder in the country's innovation system, should set up a mechanism or another intermediary that would assist in the sourcing of prospective commercial partners seeking new innovative technology for products and processors to link with patent holders with suitable technology. The intermediary would also strengthen the negotiating power of individual patent holders and safeguard the patent holder's interest, which was stated as an obstacle by many surveyed respondents in the individual patent group. This intermediary could also be used as a platform for trading patents internationally and linking the research community with the commercial community. The linkages between the research community and the commercial community need strengthening to grow the country's innovativeness and add competitiveness and value to the country's economy. The gaps identified through this study, if addressed, would contribute to strong intellectual property rights and a practical operational framework fundamental for a thriving national innovation system in a country.

This study is limited to two patent ownership groups; ideally, four ownership groups, classified by individuals, research institutes, institutes of higher learning and commercial enterprise engaged in innovation and commercialising of research findings and applications. The study findings open up further discussion in gaining insight into each of these subgroups of the organisation ownership category by investigating the commercial success of IHL's, GRI's and commercial enterprises separately. A separate study of each ownership group will increase insight into each group's uniqueness in terms of demography, patent value, and commercial ability would differ owing to each category's prime objectives and core competencies. Therefore, it is recommended that future research be undertaken on these lines. Furthermore, this study is also limited to a cross-sectional analysis that limits the longevity of commercialised patents. Therefore, future research in terms of a longevity study too will enable a more robust and deeper understanding of the continued commercial success and the acceptance

of innovative technology in society.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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