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Influence of Demographic and Technical Profile on Success of Independent Inventors in Sri Lanka

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The remarkable growth of patent applications in Asia has been the central focus of the recent studies on technological knowledge creation. However, all the Asian countries have not shown similar growth and hence, have not gained similar academic attention. Especially, the lower and middle-income countries in South Asia are stagnating in technological knowledge creation. Sri Lanka is one such country that has high proportion of independent inventors in their innovation system. Owing to small number of inventors, there is hardly any attention given to conduct empirical studies on inventors in these countries. Therefore, inherent characteristics of inventors and innovation systems in these countries are underexplored in published academic literature. This pioneering study attempted to explore the inherent characteristics of the independent inventors in Sri Lanka as the representatives of inventors in middle-income South Asian developing countries. The findings of the study suggest that most of the sociodemographic and technical characteristics of Sri Lankan inventors are similar to the independent inventors in industrial countries. It also indicates that demographic factors such as age, income, job mobility, marital status and technical factors such as engagement in inventions, prototype development and commercialization method have significant influence on the overall innovation success of independent inventors in Sri Lanka.

Keywords Southern Asia; patents; technology transfer

Asia is a region that has shown significant development in technological knowledge creation in recent years; however, every country in Asia has not achieved equal-level improvement (Urata, 2007). The number of patents, patent applications and patent citations has been the widely accepted criteria to compare the technological knowledge creation among the nations in recent literature (Hu, 2009). According to the recent patent application data in Asia, there is a noticeable disparity in patent applications among the Asian countries (WIPO, 2007). According to the statistics, Japan, Korea, China and India are moving neck and neck with the western industrial countries (Palangkaraya, 2010). Further, China, Korea and India have influenced the neighboring southeast Asian countries to emerge as technologically enabled countries (Stuart-Fox, 2004; Urata, 2011). With this emerging trend, countries such as Singapore, Malaysia, Taiwan and Hong Kong also have grown rapidly as newly industrial countries with relatively higher number of patent applications. However, except for India, countries in South Asia have not shown significant growth in technological knowledge creation. This has created a significant disparity in technological knowledge creation among the nations in Asia (Kim *et al.*, 2011).

The majority of published literature explains the nature of innovation systems in emerging countries. Even though the literature evidence are readily available on the dynamism of technological knowledge creation in emerging countries in Asia, so far no proper attention was given to learn about the innovation systems in less-inventive nations in South Asia that have not achieved higher

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numbers in local inventions (Chen and Puttitanun, 2005). Hence, it is important to get to know about who are the local inventors, what are their characteristics and behaviors in less-innovative developing countries in Asia to help them to be enabled in technological knowledge creation in coming years (Intarakumnerd *et al.*, 2002; Nam and Barnett, 2011). However, the existing empirical knowledge about the inventive community in developing countries is insufficient to explain the true nature of the inventive communities in developing countries (Diyamett and Mabala, 2007; Weick and Eakin, 2005).

This paper aims to explore the inherent characteristics of the independent inventive community of Sri Lanka as the representatives of inventors in middle-income South Asian developing countries that are not technologically developed as China, Korea, India or other southeast Asian counterparts. First, this paper explains the composition of Sri Lankan innovation system based on the number of patent applications in last decade. Second, based on the findings of first ever survey conducted on inventors in Sri Lanka, this paper explores the significant demographic and technical characteristics of Sri Lankan independent inventors. Finally, authors compare the demographic and technical characteristics of Sri Lankan independent inventors with their Overall Innovation Success to explore the impact of demographic and technical factors on the success of inventors.

Context of the Study

Sri Lanka is a multiethnic, lower middle-income island nation in South Asia with 21 million mid-year populations. Sri Lanka has comparatively higher human development index than rest of the South Asian countries, but she has fallen behind the technological development compared to the neighboring countries in Asia (Dissanayake, 2003). Exports of garments and textiles, worker remittance, tea and tourism have been the major sources of export income and 81% of the import expenses have been spent on intermediate and investment imports (Central bank of Sri Lanka, 2008). During the last decade, the import dependency on industrial and technological products of Sri Lanka has been drastically shifted from western countries to Asian countries. In the year 2008, 73% of total imports of Sri Lanka originated from India (24%), Singapore (9%), China (8%), Hong Kong (5%) and other Asian and Middle Eastern countries (51%) (Central Bank of Sri Lanka, 2008). The number of resident patent applications in Sri Lanka is not very high; however, there is a steady increase of patent applications in recent years. Further, the number of independent inventors in Sri Lanka has drastically increased since the last decade (Wickramasinghe *et al.*, 2011).

Recent patent statistics have shown a significant percentage of independent inventions in the national patent system of Sri Lanka (Table 1). From the total resident patent applications, 77% of the applications have been forwarded by the independent inventors. It has increased up to 80% and 85% in years 2007 and 2008, respectively. Albeit, the business environment in Sri Lanka has not encouraged the local inventors, independent inventors have not discouraged. They have been the driving force of the Sri Lankan innovation system.

Apart from the significant proportion of independent inventors, independent inventions in Sri Lanka have shown high technical merits as well. Some of the inventions were recognized among the best inventions in the world. In the 37th International Exhibition of Inventions of Geneva 2009, Sri Lankan independent inventors have won the prestigious World Intellectual Property Organization (WIPO) award and the International Press Award. Sri Lankan invention of "safety kerosene lamp" also won the BBC World Challenge 2009 award as the best invention of the competition. Further, all the best inventor's awards at the annual presidential awards for Sri Lankan inventors in 2006 and 2007 were won by the independent inventors. Unfortunately, the majority of the award-winning inventors were unable to achieve high level of commercial success for their inventions (Wickramasinghe, panel discussions with Sri Lankan grassroots-level inventors, 2010).

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Table 1: Resident Patent Applications in Sri Lanka—2000–08

Year	Research institutes	University affiliated	Business affiliated	Nonresident affiliated	Independent inventors	Total	Percentage of independent inventions (%)
2000	5	2	9	1	52	69	75
2001	7	1	12	1	92	113	81
2002	11	6	12	1	69	99	70
2003	13	5	11	1	50	80	62.5
2004	4	6	14	0	82	106	77
2005	10	6	16	0	113	145	78
2006	13	12	14	0	121	160	76
2007	7	7	15	1	123	153	80
2008	9	6	14	2	170	201	85
Total	79	51	117	7	872	1126	77
Percentage	7.0	4.5	10.4	0.6	77	100.0	

Source: Sri Lanka National Intellectual Property Office.

Methodology

Theoretical Framework of the Study

There are a number of studies that have explained the nature of the influences on individual characteristics of success (Carbonell *et al.*, 2011; Nga and Shamuganathan, 2010; Wang *et al.*, 2011). Among the individual characteristics, demographic and work-related technical factors are recognized as the most general influential factors of career success. Past studies on independent inventors in industrial countries also have investigated the influences of demographic and technical factors on commercial success of independent inventors (Amesse and Desranleau, 1991; Georgia Tech Enterprise Innovation Institute, 2008; Weick and Eakin, 2005). The present study is the preliminary investigation of the inventors in Sri Lanka. Therefore, the authors focused on exploring demographic and technical factors of inventors in the first place. Second, these factors were considered as the exogenous factors that might have influence on the success of independent inventors in Sri Lanka.

Innovation is a long process, which has a number of milestones to be achieved to attain success. Therefore, in order to measure the overall success of inventors, achievements in different stages of innovation process need to be considered (Hauschildt, 1991). The commercial success is only a high-end outcome of innovation process. It has not been able to measure the success in different stages of innovation process. Existing standalone measurements of innovation success such as the number of patents, scientific awards/grants, patent citations, commercialized inventions and return on investments have never considered all stages of the innovation process. Therefore, influence of demographic and technical factors on overall inventive success has never been studied thoroughly.

Theoretical framework of the present study designed to address the knowledge gap by introducing new cumulative innovation success index as the measurement of the inventive success of the independent inventors in Sri Lanka. Based on the existing findings of the individual factors and success, the researchers hypothesized that the demographic and technical profile factors of the independent inventors in Sri Lanka might also contribute to their overall success of innovation process activities (Figure 1).

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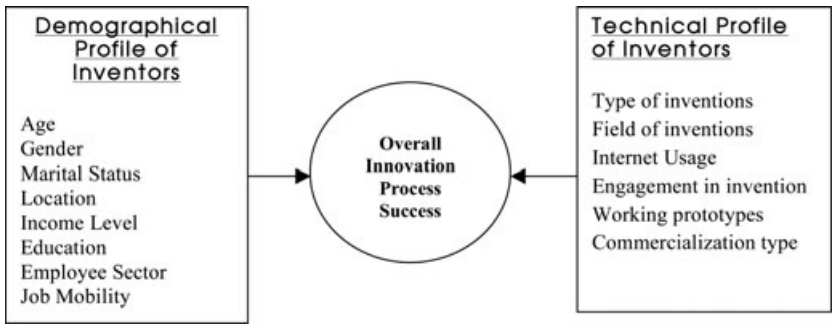

Figure 1: Theoretical Framework of the Study

Operationalization

The present study adopted the Hauschildt (1991) innovation process approach to measure the Overall Innovation Success of the inventors. Overall Innovation Success defined as the measurable and observable monetary and nonmonitory achievements of the innovation process, which includes the patent received, awards and rewards, commercialization, commercial survival and profit earnings. The researcher initially developed the Overall Innovation Success measurement as ten-item Likert-like scale and asked the selected panel of experts to validate the scale. When the researcher consulted Professor Chinta Weick, she advised the researcher to use limited number of items with dichotomous response because that is straightforward to measure and avoid complex comparisons (Weick C, Personal Communication, 12 August 2008). Weick and Eakin (2005) also measured the commercial success of inventors using multi-item dichotomous (0, 1) scale. To eliminate the influence of the number of inventions, researchers adopted a dichotomous scale by asking the questions on whether the inventors have at least single invention achieved success at each stage. Overall Innovation Success was calculated as the summation of five items measured through the dichotomous scale (0, 1) on the patent grants, award and rewards, commercial startup, commercial continuation and profitable inventions. When the inventors had at least one invention that satisfies the criteria of each question, they were considered successful at the respective stage of the innovation process. In the questionnaire, the researcher asked the respondents to state how many patents they received, how many inventions have won either awards or rewards, how many inventions started to commercialized, how many inventions still been commercialized and how many inventions earned profits at the time of survey. Respondents who reported values 1 or more were considered as successful (1) and others considered as unsuccessful (0) at the respective innovation process stage. By calculating the summation of dichotomous responses, the researcher generated the continuous Overall Innovation Success index ranging from 0 to 5. These five values were categorized as very low, low, moderate, high and very high success (Hair *et al.*, 2009).

Research Design and Data Analysis

Owing to the relatively small number of independent inventors, empirical studies on independent inventors in developing Asian countries are rare (Mahmood and Singh, 2003). Likewise, there are hardly any published empirical studies on the inventors in Sri Lanka (Wickramasinghe *et al.*, 2010). Hence, the researchers had to design the present study as an exploratory research. In order to achieve the first objective of the study, researchers collected secondary data from the patent database of Sri Lanka National Intellectual Property Office and Central Bank of Sri Lanka. To achieve the

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subsequent objectives, researchers collected the primary data from the randomly selected respondents from the Sri Lankan Inventive community.

In the year 2010, the researchers conducted the first independent inventors survey in Sri Lanka. The aim of the survey was to understand the demographic and technical profiles of Sri Lankan inventors to assess their inherent strengths (and weaknesses) to be successful inventors. Two hundred inventors were randomly selected as the sample of the study from population of 640 patent-applied inventors. Sample size represented the 31% of the target population.

Selected inventors were asked to come for data-collection panels conducted in selected districts in Sri Lanka. Respondents were given self-administrative questionnaire to provide required information about them and their inventive activities. Demographic and technical profiles of the respondents were analyzed using descriptive statistics. According to the inherent nature of the phenomena, the majority of the demographic and technical factor variables of the study are collected as nominal or ordinal data. The measurement of the overall innovation success is a continuous variable. Hence, the analysis of variance (ANOVA) was selected as the appropriate statistical analysis tool to achieve the final objective of the study. The researchers conducted the exploratory data analysis to test whether the data met the normality assumption in ANOVA. The absolute skew index and kurtosis index of the overall innovation success were .265 and 1.011, respectively. Both the indices satisfied the recommend cut off criteria of skewness (<3) and kurtosis (<7) values to satisfy the normality assumption of dependent variable in ANOVA (Kline, 2011).

Findings

Who Are the Independent Inventors in Sri Lanka

Demographic Profile of Inventors

According to the data collected from the respondents, the researchers were able to determine the major demographic characteristics of Sri Lankan independent inventors (Table 2).

1. The majority of independent inventors are middle-aged inventors with average age of 42 years.
2. Independent inventors in Sri Lanka are predominantly the males, with only 5% of females.
3. Most of the independent inventors in Sri Lanka are married, where two-thirds of the inventors were married.
4. According to the political administrative definition, the majority of the independent inventors reside in rural areas; however population density wise, majority of inventors are living in metropolitan districts.
5. Generally, the independent inventors in Sri Lanka are a well-educated group where majority had completed at least formal upper secondary level school education.
6. Independent inventors in Sri Lanka are largely the part-time inventors, where 65% inventors employed in formal employments.
7. Independent inventors in Sri Lanka largely represent the middle-income group of the country.

The findings of demographic factors revealed that the average independent inventor in Sri Lanka is an educated, married, middle-aged male who lived in rural areas of an urban district. Then again, three of five inventors were part-time inventors and majority has received medium-level income. These findings are similar to the findings of the previous studies that were conducted on independent inventors in western industrial countries. Winston (1937) in the United States, Macdonalds (1986) in Australia, Sirilli (1987) in Italy, Amesse *et al.* (1991) in Canada, Whalley (1992) in the United States, Wieck and Eakin (2005) again in the United States, Giuri *et al.* (2007) in Europe and Georgia

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Table 2: Demographic Profile of the Respondents

	Frequency	Percentage		Frequency	Percentage
Age			Education		
10–18	10	5.0	School	80	40
19–30	43	21.5	Vocational	34	17
31–40	45	22.5	Lower tertiary	65	32.5
41–55	60	30.0	Postgraduate	21	10.5
56–65	36	18.0	Employment sector		
65+	6	3.0	Government	34	17
Gender			Private	77	38.5
Male	190	95	Nongovernment	01	0.5
Female	10	5	Freelance	88	44
Marital status			Location		
Married	135	67	Rural	128	64
Unmarried	65	33	Urban	72	36
Income (SLR 000′)					
Less than 10	17	8.5			
11–20	23	11.5			
21–30	39	19.5			
31–40	39	19.5			
41–50	36	18.0			
51–60	20	10.0			
61–70	15	7.5			
71–80	9	4.5			
81 and above	2	1.0			

Tech Enterprise Innovation Institute (2007) in Georgia have revealed that an average independent inventor is middle-aged, educated, employed, married male who has middle-level income. Further, inventors in Asian industrial countries also have shown identical demographic profile (Walsh and Nagaoka, 2009). Hence, findings of the present study suggest that the demographic profiles of the independent inventors in Sri Lanka also parallel with the demographic profile of independent inventors in industrial world.

Technical Profile of Inventors

In the present study, independent inventors' technical profile was examined by the type of invention, field of invention, inventive lifespan, engagement in invention, internet usage, number of working prototypes and commercialization efforts. Based on the responses of the respondents, researchers were able to explain the technical profile of the Sri Lankan independent inventors (Table 3), which is as follows:

1. The independent inventors in Sri Lanka are mostly the radical product inventors.
2. Most of the independent inventors in Sri Lanka have mainly involved in agriculture, environment or energy and household equipments inventions.
3. The majority of the independent inventors in Sri Lanka is generally the immature inventors with 3 years or less experience in inventing.

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Table 3: Technical Profile of the Respondents

	Frequency	Percentage		Frequency	Percentage
Type of inventions			Inventive lifespan		
New products	89	44.5	Immature inventors	106	53.0
New process	37	18.5	Growing inventors	51	25.5
Product development	37	18.5	Matured inventors	43	21.5
Process development	37	18.5	Daily inventive hours		
Field of inventions			Less than 3	88	44.0
Environmental and energy			4–7	108	54.0
Automotive	32	16.0	8 or more	4	2.0
Sports and entertainment	18	9.0	Working prototypes		
Agriculture related	5	2.5	Less than 2	102	51.0
Medical equipments	34	17.0	3–4	62	31.0
Tools	20	10.0	5 or more	36	18.0
Household equipments	5	2.5	Commercialization effort	93	46.5
High-tech products	31	15.5	Produce and sell by inventor	16	8.0
Security and safety	19	9.5	Licensing to others	16	8.0
Industrial equipments	11	5.5	Outright sales of patent	7	3.5
Educational instruments	24	12.0	Teaching and consultation	68	34.5
	1	.5	Not try to sell		
Internet usage					
Low	46	23.0			
Moderate	90	45.0			
High	64	32.0			

4. The majority of the independent inventors in Sri Lanka generally develop at least one working prototype of their inventions.
5. Independent inventors in Sri Lanka generally prefer to commercialize their inventions by their own.
6. Independent inventors in Sri Lanka are generally moderate-level internet users.

The study found that average Sri Lankan independent inventor is an immature radical product inventor who mainly invents in fields of agricultural, environmental, medical, industrial equipment and household equipment. The majority of the inventors have only one or two significant inventions and most of them tried to commercialize their invention on their own. However, one-third of the inventors have not even tried to commercialize their inventions. The internet is a promising medium of gaining knowledge and sharing information; however one-fourth of the inventors have shown low-level internet usage. The majority has shown moderate-level internet usage. According to the results, more than one-half of the respondents had only less than 3 years of postpatent application experience as inventors. It clearly indicates the immaturity and the growing nature of the independent inventive community in recent years. Further, the findings indicated that a significant number of independent inventors have engaged in inventing activities as part-time inventors and in expanded fields of inventions. This indicates the tendency of the continuous expansions of both the depth and breadth of independent inventive community in Sri Lanka.

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Table 4: Overall Innovation Success and Its Sub-Indicators of the Respondents

	Expected score range	Mean	Standard deviation	Very low	Low	Average	High	Very high
Patent success	0–1	.795	.405				*	
Award-winning success	0–1	.395	.490		*			
Commercial success	0–1	.590	.493			*		
Market-survival success	0–1	.370	.484		*			
Profit-earning Success	0–1	.370	.484		*			
Overall innovation success	0–5	2.520	1.490			*		

Overall Innovation Success of Inventors

Overall Innovation Success and its sub-indicators of the respondent inventors are shown in Table 4. According to sub-indicators presented in Table 4, respondent independent inventors have achieved high-level patent success ($M = .795$, SD $= .405$). Further, they have achieved average-level commercial success ($M = .590$, SD $= .493$) by taking at least one of their inventions to the market. However, award-winning success ($M = .395$, SD $= .490$), market-survival success ($M = .370$, SD $= .484$) and profit-earning success ($M = .370$, SD $= .484$) indicate that the majority of the inventors has only achieved low-level success in back-end innovation activities. Therefore, independent inventors have faced problems in back-end inventive process activities that are related to commercialization and marketing stages of the inventive products and processes. Owing to lower success level especially in back-end inventive activities, overall innovation success index of the respondent inventors have shown average-level success ($M = 2.52$, SD $= 1.49$). Hence, in general, independent inventors in Sri Lanka are moderately successful inventors in their inventive life.

Influence of Demographic and Technical Factors on Success

According to the ANOVA results presented in Table 5, demographic factors such as income ($F = 3.852$, $p = .000$), age ($F = 2.562$, $p = .029$), job mobility ($F = 3.505$, $p = .032$) and marital status ($F = 4.086$, $p = .045$) have shown significant effect on overall innovation success of the respondent inventors. According to the mean comparison of the overall innovation success, the researchers found that the high-income group gains high success than the low-income group. Then again middle-aged inventors achieved higher success than the young and older inventors. Inventors who had low job mobility have achieved high success than the inventors with high job mobility. Furthermore, married inventors achieved higher success than the unmarried inventors. According to the results, employment sector had somewhat significant influence on the success, but it only statistically significant at .1 levels. Meanwhile, demographic factors such as living location ($F = 2.083$, $p = .151$) and education level ($F = 0.549$, $p = .650$) have not shown significant influence on the success even at .1 level.

Second part of Table 5 indicates the influence of technical factors on the overall innovation success of the inventors. According to the results, engagement in inventions ($F = 10.835$, $p = .000$), Prototype development ($F = 11.175$, $p = .000$) and commercialization method ($F = 18.900$, $p = .000$) have significant influence on the Overall Innovation Success. According to the detailed mean comparison, inventors who spend more time in inventive activities achieved higher success than inventors who spend less time in inventions. Further, inventors who develop more working prototypes of their inventions achieved higher success than the inventors those who did not develop

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Table 5: Analysis of Variance of Overall Innovation Success With Inventors' Profile Variables

Factors	Variables	Sum of square	df	Mean square	*F*	*p*-Value
Demographic	Age	27.376	5	5.475	2.562	.029**
	Marital status	8.935	1	8.935	4.086	.045**
	Income	61.394	8	7.674	3.852	.000*
	Education level	3.681	3	1.227	0.549	.650
	Employment sector	14.287	3	4.762	2.183	.091***
	Location	4.601	1	4.601	2.083	.151
	Job mobility	15.185	2	7.592	3.505	.032**
Technical	Type of invention	2.356	1	2.356	1.061	.304
	Field of invention	15.577	10	1.558	0.691	.733
	Internet usage	11.072	2	5.536	2.531	.082***
	Inventive lifespan	2.444	2	1.222	0.548	.579
	Engagement in inventions	43.795	2	21.898	10.835	.000*
	Prototype development	45.029	2	22.515	11.175	.000*
	Commercialization type	123.462	4	30.865	18.900	.000*

*$p < .001$; **$p < .05$; ***$p < .1$.

more prototypes. Then again, inventors who tried to commercialize their inventions by their own have achieved higher success than the inventors who tried licensing, outright sales and knowledge dissemination of their inventions.

There is significant argument in the world to increase technological innovation in developing countries through the knowledge transfer through the internet. However, the results of the study only indicate mediocre influence of internet usage on the innovation success of independent inventors in Sri Lanka ($F = 2.532$, $p = .082$). Further, type of invention ($F = 1.061$, $p = .304$), field of inventions ($F = 0.691$, $p = .733$) and inventive lifespan ($F = 0.548$, $p = .579$) of the inventors have not significantly influenced their overall innovation success.

Discussion

The consistency of the results of the present study and past studies in industrial countries has indicated the universally similar demographic profiles among the independent inventors. It suggests there are common demographic characteristics among the inventors that would stimulate the creative and inventive skills in any favorable or unfavorable conditions. Therefore, in general, the independent inventors belong to common demographic profile, no matter where they reside, either in developed or developing countries. Hence, the independent inventors in developing countries such as Sri Lanka should also be treated as the equal members of the global independent inventive community.

The major difference between the demographic profiles of the past studies and present study was the geographical locations of the inventors. According to past studies, average inventors are living in metropolitan areas in the industrial countries. Most of the western countries defined the urban and rural areas based on the population density, but Sri Lanka has defined the rural and urban areas based on the nature of the governing council than the population density (United Nations, 2007). Therefore, in political sense, the majority of the grassroots inventors in Sri Lanka are rural-based inventors. However, the results of the present study indicate that the majority of the independent inventors have pooled in districts that have high population density. Therefore, in principle, finding

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on geographical location of independent inventors in Sri Lanka aligns with the western studies that had indicated higher number of independent inventions in metropolitan areas (Carlino *et al.*, 2007; Sonn and Storper, 2008). This finding also indicates that the urbanization and urban issues might have higher influence on people to be involved in the inventions than in the rural problems in rural areas. This might be owing to the higher level of access to the information and availability of other basic ingredients for technological inventions in urban areas of the country.

Several past studies on the demographic profiles of inventors also give attention to the technical profiles of the inventors in industrial countries. However, none has examined all the aspects of technical profile of inventors in a single study. Meyer (2004) and Dahlin *et al.* (2004) found that majority of the independent inventors were radical inventors. Studies of Astebro (2003), Georgia Tech Enterprise Innovation Institute (2008) and Weick and Eakin (2005) examined the field of invention and found that household and consumer equipments, environment and energy, automotive and medical devices were among the top inventive fields among independent inventors. However, agricultural inventions had not among the most popular fields. This may be a result of the influence of the industrial development of those countries. Historically, Sri Lanka has been an agriculture-based economy. Hence, the independent inventors have natural tendency toward finding solutions to the technical issues in agro-industry.

The findings of inventive lifespan of the independent inventors in Sri Lanka align with the argument of Wieck and Eakin (2005) on full-time and part-time independent inventors. They found that majority of the independent inventors are having less than 5 years of inventive life. Meanwhile, Whalley (1992) and Weick and Eakin (2005) have examined the number of working prototypes developed by the independent inventors. Whalley (1992) had found that there were very limited numbers of inventors, who had developed final-level prototypes of their inventions. However, Weick and Eakin (2005) have revealed that more than one-half of the inventors have at least one working prototypes. Compared to earlier studies, Sri Lankan independent inventors have a higher number of working prototypes.

Commercialization methods among the Sri Lankan independent inventors have the similar trend as the industrial country inventors. Studies of Whalley (1992), Parker *et al.* (1996) and Wieck and Eakin (2005) revealed that nearly one-third of the inventors have never tried to take any of their inventions to the market. Then again, according to their studies, the majority of the inventors wanted to commercialize their inventions by their own. Present study also revealed the similar pattern, where the 34% of the inventors never tried any of the commercialization methods, and the majority who wanted to commercialize their inventions has tried to do it on their own. A substantial number of intentional noncommercialized inventions indicate that unlike employed inventors, independent inventors might not go after the commercialization whole heartedly.

Past studies have mentioned that internet is one of the major sources from which inventors can get inventive ideas (Ibrahim and Fallah, 2005). Georgia Tech (2007) identified that internet is one of the top three resources among the Georgian inventors. However, compared to those studies, internet usage among Sri Lankan inventors was lower than the expected level. According to the explanation of the inventors, even though they use public internet access to communicate with others through e-mails, more than one-half was not using internet for patent search, information or knowledge search in their inventive activities. This might have happened due to the lack of awareness and limited internet access available to the inventors. Owing to the low usage of internet, their awareness and knowledge about existing inventions and commercialized innovations were substantially lower. This might be a reason for their high involvement in radical inventions than the incremental inventions. Further, most of the inventors mentioned that they do not have internet connection at their home, but are very keen to have and learn how to use it in their inventive activities (Wickramasinghe, 2010).

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According to the internet penetration data, Sri Lanka has very low rating compared to industrial countries. Only 8.3% of the population has the internet access (Miniwatts Marketing Group, 2010). Therefore, limited internet access of the general population also reflected within the independent inventors in Sri Lanka.

Findings of the overall innovation success of the independent inventors in Sri Lanka indicate that they have only achieved low-level success due to their lower success in back-end inventive activities. Previous studies on independent inventors in industrial countries also indicated that independent inventors are not successful entrepreneurs (Astebro, 1998; Weick and Eakin, 2005). Even though the invention and entrepreneurship are at the two ends of the innovation process, each end required unique and specialized knowledge. Inventors might be good at inventing new product or process, but they are not necessarily capable to convert the invention into successful product (Kevin, 2009). Self-commercialization provides the best opportunity for the inventors to market their inventions as they wish. However, when the inventors lack knowledge in technological product market mechanism, self-commercialization becomes counterproductive.

Conclusion and Recommendations

Along with the influential demographic factors such as age, marital status, income and job mobility, results have shown that high engagement in inventive activities, prototype development and commercialization type influenced the overall innovation success of the inventors. When considering these factors, age, marital status and engagement in invention influence the inventors' strengths, time and commitment on inventive activities. Further, income and job mobility provide the finances and technical knowledge for inventive activities, respectively. Despite of these factors largely influence the successful invention, prototype development and commercialization type are the necessary back-end activities that bridge gap between independent inventors' bold inventive idea and marketable product.

Business organizations, governments and universities have been recognized as the key players in national innovation systems in less successful developing countries (Intarakumnerd *et al.*, 2002). There is no encouragement for independent inventors in modern business environment. Hence, the growth of independent inventions in Sri Lanka is not a generally expected scenario in the modern society. This controversial growth of the independent inventors in Sri Lanka has raised the questions on who are the independent inventors and what are the explicit factors of these inventors that motivate them to be involved in inventive activities in the environment that consider their independent nature, survival and growth as the indications of primitive innovation system. According to Lundvall (2008), most successful economies in the world are those where the ordinary people are involved in progresses of creative thinking (Lundvall, 2008). Further, according to the Diyamett and Mabala (2007) poor attention given to the informal inventors in developing countries is one of the reasons for their lower technological development (Diyamett and Mabala, 2007). Wieck and Eaken (2005) have mentioned that owing to the significance of the independent inventions in developing countries, they need to be identified as a major element of the technological development efforts in developing countries. The present study provides pioneering explanations and framework of the independent inventors in developing country such as Sri Lanka to make them think beyond the narrow definitions of inventors as the novel utilization of indigenous knowledge and grassroots inventors in rural communities. Therefore, the present study has ended the long-standing drought of empirical studies on overview of the patent-applied independent inventors in developing countries in South Asia.

Most of the Overall Innovation Success measures, demographic and technical characteristics of the independent inventors in Sri Lanka are identical with the characteristics of independent inventors explained in the western industrial countries. Owing to the inherent demographic, and technical factor

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anatomy that is similar to independent inventors identified by other countries, the finding suggests that the independent inventors are typically look-alike wherever they reside. Hence, the majority of the demographic, technical and success factors explained in the present study might be the common universal anatomy of the independent inventors. This common anatomy of the inventors suggests that the inherent characteristics within the Sri Lankan independent inventors might have driven them to be continually involved in inventive activities. Even though the social and environmental factors are not identical and supporting as the industrial countries, the independent inventors will not stop their inventive activities even in the unfavorable and unsupportive environments such as Sri Lanka.

Unavailability of acceptable mechanism to identify the independent inventors in developing countries has been a serious problem for their local innovation development efforts (Wettansinha *et al.*, 2008). Hence, the demographic and technical profile of the independent inventors explained by the present study would be one of the most comprehensive bottom-up frameworks to explain the independent inventors in low- and middle-income countries. Even though the findings of the study explain the size, structure and nature of the independent inventive community in Sri Lanka, in broader sense, the demographic and technical profile found in the present study would be useful to identify and explain the structures and behaviors of inventive communities in other developing countries. It would allow them to develop asset-based technological development by overcoming needs and problems in their innovation systems.

The present study mainly focused on providing the bird's eye view of the independent inventors and their success level in Sri Lanka. Therefore, it is not possible to answer all the pertinent questions of the innovation system in Sri Lanka. Therefore, future researchers are expected to conduct more relational studies to understand the influences of demographic, technical, psychological and social factors on the innovation process activities of the local innovation systems in Sri Lanka and other Asian developing countries to get more in-depth empirical knowledge about their innovation systems.

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