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How the Innovation Take Place in Pharmaceutical Industry?: An Empirical Investigation from Thailand

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ABSTRACT
In pharma industry, innovation is claimed as key source for the competitive edge over the rivals in the market. However, in the drug market, innovation has not got enough attention from the literature both in theoretical and empirical perspective. Therefore, we have examined the innovative practices through five dimensions by the pharma sector of Thailand while selecting a set of factors under the title of firm position, structure, and characteristics, and strategic orientation as key determinants. For the analysis purpose, initially, data was collected from the targeted respondents of pharma industry with the help of questionnaire which also contained some demographic items too. A sample of 372 respondents was collected over a time span of 5 months from different local areas of Thailand. Our results have reflected the fact that there is a significant and positive influence on product innovation by PFD, OS, DECEN, RD and OS. For process innovation, positive impact is found from PFD, OS, RD, SPE, and SGDC. Additionally, service innovation is also positively influenced by the PFD, MC, DECEN, and RD. on the other hand, Revolutionary innovation and Incremental innovation, there is a significant and positive influence from PFS, MC, SPE, SGDC and economy of scale. our results have provided a meaningful practice insight which can further help the management in pharma industry. More specifically, a range of factors are discussed with their direct impact on the innovative practices which may increase the practical knowledge of the investors, owners and other parties in the local market of Thailand.

Keywords: Innovative practices, pharma industry, process efficiency, Thailand.

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INTRODUCTION AND RELEVANT LITERATURE REVIEW

The new and significantly better production methods which contain important changes in system, equipment , and software are entitled as process innovation in the field of business management [1]. The reason is that it is considered as a key source of strong-willed benefit for the business firms in the today's economy. In the product's life-cycle, the central form of innovation is accepted under the title of product design [2]. In manufacturing settings, the key quarrel hold up the procedure of innovation contains not only its rule in supporting product innovation, but it has more skill to improve operational performance of the production process even for non-innovation products [3]. In past studies, the firm's economic performance of innovation process is obtained less attention than product innovation. For example, the systematic review of the literature has provided the evidence that only 1% articles were devoted their efforts towards the process of innovation as compared to 20% related to product innovation [4]. Meanwhile, 44% of the item did not distinguish between different types of innovation [4]. As a result, much doubt have been found for the true impact of the process innovation on firm's performance. In this regard, our research study has aimed to analyze the trends and patterns for the innovation through adopting different dynamics as core determinants. In manufacturing process, the product innovation has changed the setting to produce the new drugs. The reason is that in pharmaceutical industry, there is a significant cost associated with the production of a product. However, for the pharma firms, It is not possible to continue without having a proven quality-improving techniques [5]. In this regard, the role of process innovation in ensuring a firm's competitiveness in the marketplace is further based on the business knowledge to acquire a good market repute. Researchers have provided their significant claim that the investment in process innovation is rather than product innovation has provided an attired productivity. It is important to ensure future growth for pharmaceutical firms in the contemporary business environment. The drugs in the pharma industry depends upon mainly on process improvements. Research studies have provided a good idea about range of factors affecting the different type of innovation. For example, it is found that ownership structure and funding [6], organizational size [7-9], market capitalization [10, 11], level of research [12], management type [13], organizational assets [14] are playing their major role in setting an innovative pattern for the business.

RESEARCH METHOD

A survey was conducted using the email approach for a period of 100 days where different respondents from the pharma industry were instructed to provide their valuable responses. Among various methods, online survey has many characteristics and one of the most efficient is time and cost saving with real time access to the users and unbiased information too. For this purpose, initially a questionnaire was developed and an online link was created where respondents were instructed to provide their valuable responses. Over the time of 100 days, overall 412 respondents have provided the feedback. An excel sheet was generated through collected responses and found that some of the respondents have not properly filled the questionnaire which were deliberately excluded from the valid sample. After this step, an overall 372 responses were found good for the statistical analysis of our research. For this reason, our study has finally analyzed the total responses of 372 which were collected and found appropriate for the analysis purpose. For the targeted responses, every statement was measured through a five point likert scale (as explained in discussion of the results below). For the demographic factors, age, working experience, and education level were under consideration. Our study has observed the descriptive analysis through mean, standard deviation, data range, percentile and kurtosis along with skewness. For

demographic factors, cross tabulation was provided and discussed through figures as well. lastly, the study results are discussed through five different regression models where each has provided separate regression coefficient, standard error with the overall explanatory power.

VARIABLES DESCRIPTION AND DISCUSSION OF THE RESULTS

In initial phase, our results have discussed the findings for the descriptive trends through total observations, mean score of each factor, its relative standard deviation, ranges, percentiles, and both skewness and kurtosis accordingly. our study has collected a data set from a sample of 372 respondents who are primarily those individuals which are engaged in pharmaceutical business in Thailand. For the better understanding of the nature of the respondents, some demographic details are also added in the third table of our research. A per the total observations, it is found that data was finally collected and found good from 372 respondents. For the likert scale, overall five points are selected covering the ranges as 1=unimportant, 2=slightly important,3= moderately important, 4=important, 5=very important. For analyzing the respondents view about the key factors and their significance in defining the innovative capabilities of pharmaceutical companies, the above stated scale was utilized. As per the findings through Mean score, most of the factors have shown their mean score of above 3 which means that on average, the respondent view about their significance is towards between the moderately important and important. However, standard deviation for these factors is between a range of 1 and 1.45 which defines the maximum and minimum dispersion in the mean value. For examining the ranges of the data, both minimum and maximum points are also expressed against each of the factor is presented under Table 2. However, we only presented two percentiles which are p1 and p99 as generated through detailed descriptive command in Stata-14. Meanwhile, skewness and kurtosis are showing the normality trends of our data where a mixed outcome for both positive and negative values are found.

TABLE 2. Descriptive Statistics

Variables	Obs	Mean	Std.Dev.	Min	Max	p1	p99	Skew.	Kurt.
PFD	372	3.97	1.413	1	5	1	5	.093	1.736
PFS	372	3.097	1.407	1	5	1	5	-.085	1.72
PR	372	3.917	1.46	1	5	1	5	.108	1.642
OS	372	3.03	1.421	1	5	1	5	-.024	1.699
MC	372	3.903	1.403	1	5	1	5	.096	1.689
AP	372	2.949	1.437	1	5	1	5	.068	1.675
BAS	372	3.597	1.434	1	5	1	5	.002	1.675
CEN	372	3.917	1.393	1	5	1	5	.047	1.738
DECEN	372	2.917	1.388	1	5	1	5	.016	1.747
UA	372	3.927	1.404	1	5	1	5	.082	1.731
RD	372	3.102	1.395	1	5	1	5	-.111	1.751
DSA	372	3.919	1.412	1	5	1	5	.062	1.756
IMIT	372	2.919	1.393	1	5	1	5	.138	1.763
SPE	372	3.046	1.456	1	5	1	5	-.074	1.654
DIV	372	3.013	1.436	1	5	1	5	-.007	1.669
EOS	372	2.839	1.405	1	5	1	5	.154	1.729
EOSCOP	372	3.005	1.422	1	5	1	5	-.021	1.703
VING	372	3.017	1.399	1	5	1	5	-.065	1.731
HING	372	3.005	1.414	1	5	1	5	.013	1.685
CIN	372	2.941	1.382	1	5	1	5	.075	1.781
ABOS	372	3.914	1.379	1	5	1	5	.037	1.727
SGDC	372	2.944	1.41	1	5	1	5	.042	1.732
LIDC	372	3.003	1.471	1	5	1	5	-.01	1.619
LODC	372	3.067	1.408	1	5	1	5	-.061	1.727
IN1	372	3.167	1.385	1	5	1	5	-.13	1.739
IN2	372	2.933	1.402	1	5	1	5	.102	1.734
IN3	372	2.984	1.403	1	5	1	5	.04	1.734
RI	372	2.927	1.457	1	5	1	5	.048	1.643
ICINO	372	3.024	1.445	1	5	1	5	-.058	1.665

NOTE: PFD: Public, federally-funded, Public, PFD: Funded by shareholders, PR: Private, OS: Organization Size, MC: Market Capitalization, APR: applied research, BASR: basic research, CEN: Cent. DECEN: Decent, UA: Upstream assets, RD: R&D,

DSA: Downstream Assets, IMIT: Imitation (me-too, generics),SPE: Specialized, DIV: Diversified, EOS: Economies of scale (supply side),EOSCOP: Economies of scope (demand side), VING: Vertically Integrated, HING: Horizontally Integrated, CIN: Conceived independently, ABOS: Aided by open science, SGDC: Self-generated drug candidates, LIDC: Licensed-in drug candidates, LODC: Licensing-out of drug candidates, IN1: innovation for products, IN2: innovation for process, IN3: innovation for service, RI: Revolutionary innovation (pioneer), INCINO: Incremental innovation, (follow-on).

TABLE 3. Cross Tabs for Education, Age and Experience Factors of the Respondents

		EDUCATION					Total
		14 Y	16 Y	18 Y	18 years + Diploma	other	
AGE	20-25	4	0	9	21	39	73
	26-30	4	8	7	24	12	55
	31-35	2	12	28	33	32	107
	36-40	1	2	6	44	3	56
	above 40	11	1	8	21	40	81
Total		22	23	58	143	126	372
EXPER * EDUCATION Crosstabulation							
		EDUCATION					Total
		14 years	16 years	18 years	18 years + Diploma	other	
EXPER	0-1	4	3	11	20	40	78
	>1 and Up to 3	6	3	16	37	20	82
	>3 and up to 5	2	7	12	24	10	55
	>5 and up to 7	10	6	15	29	11	71
	>7	0	4	4	33	45	86
Total		22	23	58	143	126	372

Table 3 has shown the cross tabulation for the three demographic factors of the respondents, while Figure 1 and Figure 2 has presented the core idea about three cross tabulation for better understanding. The categories of the age for the respondents covers the trends from 20 years to above 40 years where it is stated that total 73 respondents are those who are in age of 20-25 with all type of educational background. For the age distribution of 26-30 years, overall 55 respondents, for age category of 31-35 years 107 respondents, for age factor of 36-40 years, total 56 respondents and finally, above 40 years, 81 respondents were observed. Meanwhile in terms of experience 78 respondents are those who have the working experience of 0-1 years. 82 are with greater than 1 years and up to 3 years of working profile, 55 are those who are currently working with a working experience of greater than 3 years and up to 5 years. Meanwhile, 71 respondents are those who got the working expertise for greater than 5 years and up to 7 years. In the end, 86 respondents are working with a working profile of more than 7 years in the similar industry. Figures below are showing the overall trend for the demographic factors.

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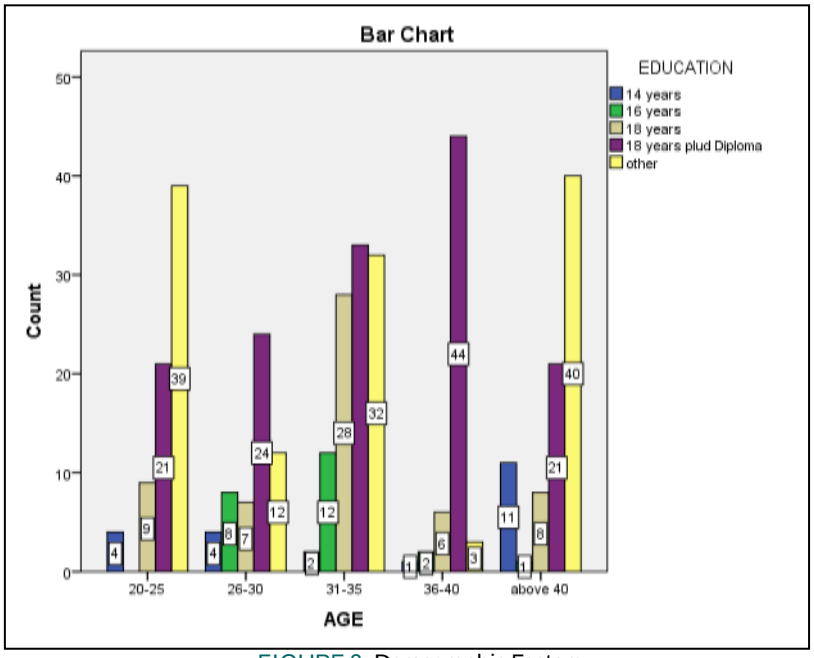

FIGURE 2. Demographic Factors

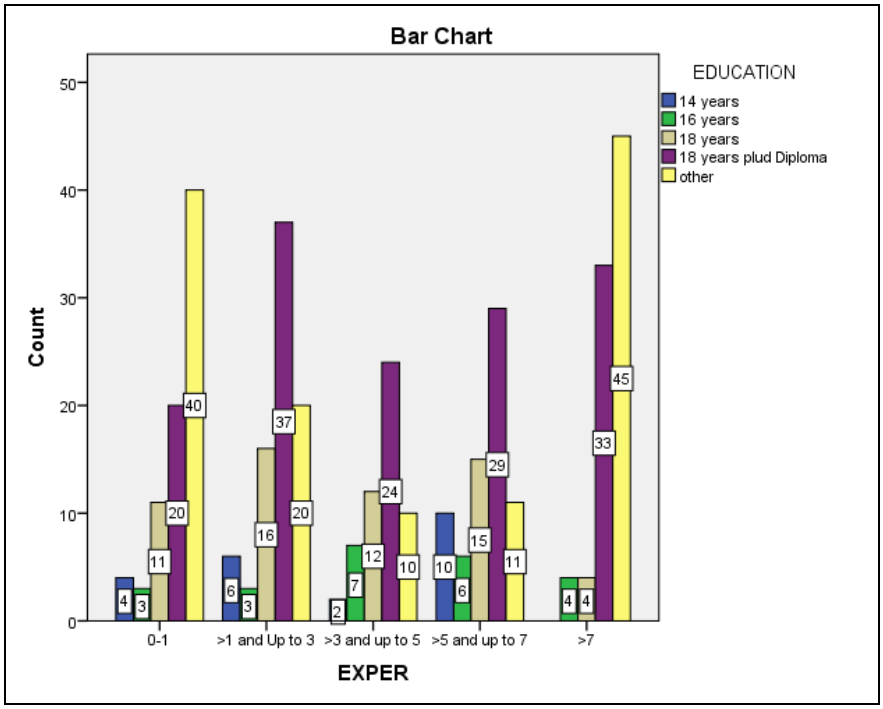

FIGURE 2. Demographic Factors

TABLE 4.

	IN1: Product	IN2: Process	IN3: Service
VARIABLES	Model 1	Model 2	Model 3
PFD	0.911***	0.569***	0.390***
	(0.0529)	(0.0521)	(0.0552)
PFS	-0.00657	-0.0628	-0.0446
	(0.0513)	(0.0505)	(0.0535)
PR	-0.0274	0.0982	-0.0416
	(0.0523)	(0.0515)	(0.0545)
OS	0.493***	0.875*	-0.0355
	(0.0145)	(0.460)	(0.0568)
MC	-0.0616	-0.0243	0.150***
	(0.0548)	(0.0540)	(0.0572)
APR	0.0465	0.0408	0.0397
	(0.0503)	(0.0495)	(0.0524)
BASR	-0.0906*	0.0153	-0.0382
	(0.0523)	(0.0515)	(0.0545)
CEN	0.0341	-0.00604	0.0336
	(0.0503)	(0.0495)	(0.0524)
DECEN	0.217***	-0.0881*	0.0973*
	(0.0532)	(0.0524)	(0.0555)
UA	-0.0179	-0.0239	0.0768
	(0.0518)	(0.0510)	(0.0540)
RD	0.278***	0.303***	0.0498*
	(0.0507)	(0.0499)	(0.025)
DSA	0.0350	0.0746	-0.0361
	(0.0528)	(0.0519)	(0.0550)
IMIT	-0.0578	-0.0401	-0.0192
	(0.0522)	(0.0513)	(0.0544)
SPE	0.0724	0.105**	-0.0511
	(0.0530)	(0.0522)	(0.0553)
DIV	-0.0162	-0.0719	0.00131
	(0.0516)	(0.0508)	(0.0538)

EOS	0.0955*	0.0272	-0.0363
	(0.0525)	(0.0517)	(0.0547)
EOSCOP	0.0263	-0.0109	-0.0144
	(0.0521)	(0.0512)	(0.0543)
VING	-0.0799	-0.0450	-0.0773
	(0.0513)	(0.0505)	(0.0534)
HING	-0.00519	-0.0377	-0.0111
	(0.0520)	(0.0511)	(0.0542)
CIN	0.0157	0.0380	-0.00935
	(0.0519)	(0.0511)	(0.0541)
ABOS	0.0139	0.0428	-0.00362
	(0.0524)	(0.0516)	(0.0546)
SGDC	-0.0456	0.0860*	0.0479
	(0.0521)	(0.0512)	(0.0543)
LIDC	0.0161	-0.0387	-0.0644
	(0.0516)	(0.0508)	(0.0538)
LODC	0.0100	-0.0290	-0.00297
	(0.0510)	(0.0502)	(0.0532)
Constant	0.454***	0.492***	0.718***
	(0.129)	(0.127)	(0.134)
Observations	372	372	372
R-squared	0.251	0.372	0.265

NOTE: NOTE: PFD: Public, federally-funded, Public, PFD: Funded by shareholders, PR: Private, OS: Organization Size, MC: Market Capitalization, APR: applied research, BASR: basic research, CEN: Cent. DECEN: Decent, UA: Upstream assets, RD: R&D, DSA: Downstream Assets, IMIT: Imitation (me-too, generics), SPE: Specialized, DIV: Diversified, EOS: Economies of scale (supply side),EOSCOP: Economies of scope (demand side), VING: Vertically Integrated, HING: Horizontally Integrated, CIN: Conceived independently, ABOS: Aided by open science, SGDC: Self-generated drug candidates, LIDC: Licensed-in drug candidates, LODC: Licensing-out of drug candidates, IN1: innovation for products, IN2: innovation for process, IN3: innovation for service, RI: Revolutionary innovation (pioneer, INCINO: Incremental innovation, (follow-on), Standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1

TABLE 5.

	RI	INCINO
VARIABLES	Model 1	Model 2
PFD	0.0336	-0.0779
	(0.0549)	(0.0529)
PFS	0.520***	0.396***
	(0.0532)	(0.0513)
PR	0.0532	0.0523
	(0.0542)	(0.0523)
OS	-0.0672	-0.0437
	(0.0565)	(0.0545)
MC	0.724***	0.108**
	(0.0569)	(0.0548)
AP	-0.0610	-0.0387
	(0.0521)	(0.0503)
BAS	-0.112**	-0.0496
	(0.0542)	(0.0523)
CEN	0.00209	-0.0409
	(0.0521)	(0.0503)
DECEN	0.0633	-0.0158
	(0.0552)	(0.0532)
UA	0.0191	0.0481
	(0.0537)	(0.0518)
RD	0.00205	-0.0511
	(0.0525)	(0.0507)
DSA	-0.0464	0.0580

	(0.0547)	(0.0528)
IMIT	0.0833	0.0390
	(0.0541)	(0.0522)
SPE	0.103*	0.450***
	(0.0550)	(0.0530)
DIV	-0.0150	0.0482
	(0.0535)	(0.0516)
EOS	0.133**	0.0934*
	(0.0545)	(0.0525)
EOSCOP	0.0216	-0.0450
	(0.0540)	(0.0520)
VING	0.0528	-0.0286
	(0.0531)	(0.0513)
HING	0.0739	0.0187
	(0.0539)	(0.0520)
CIN	-0.0738	0.0822
	(0.0538)	(0.0519)
ABOS	-0.0310	-0.00241
	(0.0543)	(0.0524)
SGDC	0.715***	0.0376*
	(0.0540)	(0.0221)
LIDC	0.0803	-0.0789
	(0.0535)	(0.0516)
LODC	0.0360	-0.0226
	(0.0529)	(0.0510)
Constant	0.416***	0.553***
	(0.134)	(0.129)
Observations	372	372
R-squared	0.188	0.169

NOTE: PFD: Public, federally-funded, Public, PFD: Funded by shareholders, PR: Private, OS: Organization Size, MC: Market Capitalization, APR: applied research, BASR: basic research, CEN: Cent. DECEN: Decent, UA: Upstream assets, RD: R&D, DSA: Downstream Assets, IMIT: Imitation (me-too, generics),SPE: Specialized, DIV: Diversified, EOS: Economies of scale (supply side),EOSCOP: Economies of scope (demand side), VING: Vertically Integrated, HING: Horizontally Integrated, CIN: Conceived independently, ABOS: Aided by open science, SGDC: Self-generated drug candidates, LIDC: Licensed-in drug candidates, LODC: Licensing-out of drug candidates, IN1: innovation for products, IN2: innovation for process, IN3: innovation for service, RI: Revolutionary innovation (pioneer, INCINO: Incremental innovation, (follow-on), Standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1.

Table 4 shows the individual effect of selected variables on first three dynamics of innovative practices named as product innovation, process innovation, and service innovation. As per the presented results, PFD is showing a highly positive and significant impact on product innovation or IN1. It means that higher the public, federally-funded grant for the pharmaceutical products, higher the innovative practices and vice versa. More specifically, this argument is justified through a coefficient of 0.911 which is presented under Model 1, Table 4. Meanwhile, the influence of PFD on service innovation or IN2 under Table 4 is also highly significant and positive where the coefficient is .569 and standard error of 0.0521. Meanwhile, the influence of PFD on IN2 is significant at 1 percent, hence proved that there is a significant and positive influence on IN2 by PFD. Additionally, similar impact by PFD on IN3 which shows the title for the service innovation in the pharmaceutical industry is also positively significant at 1 percent. It means that higher PFD is leading all three dynamics of innovation towards positive direction. However, our results have provided that there is no evidence for the impact of PFS on IN1-IN3. Similar effect is observed by the PR which shows a negative but insignificant impact as measured with the help of regression coefficients are their relative p-values.

Additionally, previous research studies have provided some good evidences for the organizational size and its relationship with the innovative practices in different organizations. Some of the relevant literature sources are provided by [15-19]. As per our results, it is observed that there is a significant and positive influence from OS on IN1 and IN2 where the coefficients are .493, and .875 and their significant level is 1 percent. It means that whenever there is an expansion of the business in terms of size, there is a significant and positive impact on product innovation and process innovation in the pharmaceutical industry of Thailand economy. However, for the service innovation, our study has found no significant evidence. For MC, both IN1 and IN2 have shown their insignificant relationship, but the service innovation is positively and significantly associated to it. Various earlier studies have proved their contribution

for analyzing the relationship between the market capitalization and innovation practices [20-22].

Contrary to the above discussion, our research has found a negative and significant influence of basic research factor on the product innovation which specifies that pharmaceutical business firms need to change their research profile from basic to other. However, its influence on service innovation and process innovation is insignificant. additionally, management structure like centralized has also shown no influence on first three dimensions of innovative practices by pharmaceutical industry of Thailand. on the other hand, decentralization of the management structure has shown its positively significant impact on IN1 and IN3 while IN2 is negatively affected. It shows that when the management structure of pharmaceutical industry turns more towards decentralization product innovation and service innovation are positively while process innovation is adversely affected. In addition, as per the research findings in various existing studies, there is a good association between research and development and innovation among the business firms [23-26]. Our study has provided the evidence that innovation like product, process and service are positively and significantly determined by the research and development factor where the highest impact is recorded on IN2, followed by IN1 and IN3 accordingly. The impact of more specialized research focus on IN2 is showing its positively significant impact with the coefficient of .105 and standard error of 0.0522. It proves that with SPE there is a good indication for the process innovation in pharma industry of Thailand. For the process efficiency, our research has added the factor of economies of scale or EOS which shows a significant and positive impact on product innovation in pharma sector. However, IN2 and IN3 are showing no significant determination by EOS. Project Sourcing and Outsourcing is reflected through SGDC, showing a positive and significant impact on process innovation. Whereas, the rest of the factors are found to be insignificant indicator of product, process and service innovation in the pharmaceutical industry of Thailand.

Table 5 has reflected the impact of stated explanatory factors on last two innovative dynamics; Revolutionary innovation (pioneer, INCINO: Incremental innovation. Through PFS, there is a significant and positive impact on RI and INCINO where the coefficients are 0.520 and 0.396, significant at 1 percent. Meanwhile, the influence of market capitalization in both Revolutionary innovation and Incremental innovation is .724 and .108, significant at 1 percent. It is accepted that PFS and MC are directly creating a positive trends for these innovation dynamics in pharma industry of Thai economy. However, basic research is again showing a negative influence for the R1 and same trend is observed for IN1-IN3 as explained earlier. Meanwhile, with the more specialized research focus both Revolutionary innovation and Incremental innovation are directly determined under full sample results. Through process efficiency, economies of scales EOS is showing a positive trend for both Revolutionary innovation and Incremental innovation. Similar was found for the first dynamic of innovative practices as observed through product innovation. Lastly our results have provided the evidence for a positive and significant impact of SGDC on Revolutionary innovation and Incremental innovation where the coefficients are .715 and 0.036, significant at 1 percent and 10 percent respectively.

CONCLUSIONARY REMARKS

Innovation practices are the need of time for the business firms who want to sustain over the long run in the market. For the pharma industry, it is believed that more focus on product development, service development and process innovation may provide some significant results to business growth and success. However, variety of factors are observed in the literature, covering the title of key determinants in the drug discovery, product innovation, process innovation and service innovation respectively. under present study, we have tried to investigate the influence of set of factors as observed under the title of firm position, structure, characteristics, and strategies orientation to analyze the trends in product, process and service innovation in pharmaceutical industry of Thailand. A structural questionnaire was developed with the help of stated factors as measured through likert scale and demographic factors too. The study results are in favor of the assumption that PFD, OS are positive and significant determinant for IN1-IN3 and IN1-IN2. On the other hand, OS is positively influencing on both product and process innovation in pharma sector. But the factor of market capitalization is only beneficial for the service innovation. Meanwhile, BASR is negatively impacting on Product innovation. For the management trend, decentralization is a good indication for the first three innovation dynamics and similar trend is found through research and development in pharmaceutical sector. Additionally, economies of scales as a process efficiency dynamic is positively related to product innovation. Through PFS both RI and INCINO are positively determined and this trend is observed through market capitalization too. Meanwhile, our results depicts that SPE is a positive sign for RI and INCINO and similar is reflected by EOS.

Based on the above results, our study has concluded the following points

1. product, process, and service innovation in pharma industry is significantly determined by variety of factors
2. These factors might be from the firm's position, structure and characteristics, and strategic orientation.
3. Management of pharma industry and other stakeholders need to evaluate the significance of stated factors are presented under this research.
4. Pharma industry in Thailand can avail a good growth if the conceptual model of this study is theoretically and conceptually observed.

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