

BUILDING SOCIAL SUSTAINABILITY OF PHARMACEUTICAL INDUSTRY THROUGH INDUSTRY 4.0 IMPLEMENTATION

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Abstract: The aim of this study was to check out the impact that is casted by information intensive services on social sustainability performance and the impact of supply chain integration on social sustainability performance as well. The study took industry 4.0 implementation as a mediator to know the enhancement of that it causes with the impacts of information intensive services and supply chain integration on social sustainability performance. The study took a sample from Thailand's Pharmaceutical Industry and 306 individuals were selected in total. Moreover, the study analyzed the data and found out that the impact of information intensive services on social sustainability performance is significant and the impact of supply chain integration on social sustainability performance is significant as well. The study validated that industry 4.0 implementation is a significant mediator. The study has significance for the theoretical, practical and policy making sector as to practically implement information intensive services and supply chain integration in industries around the globe to enhance social sustainability performance. The study is however, short in its sector and sample selection.

Key words: social sustainability, pharmaceutical industry, industry 4.0 implementation, information intensive services, supply chain integration drivers, Thailand

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Introduction

Industry 4.0, the 4th revolution in the industrial sector that was initiated in Germany has gained popularity in the business world (Lu, 2017). The use of Information and Communications Technology (ICT), making use of the internet, introducing Cyber Physical Systems (CPS) in the Enterprise Architecture (EA) and upgrading of the already present infrastructure are the things involved in the Industry 4.0. Business management strategies are moving towards the technological platforms and digital innovations to promote internationalization of the industrial sector. Because of the increasing interest of industries in the industry 4.0 and the progressive increase in benefits from such changes and the unavailability of scientific research in this sector, the focus of research work in business sector is increasing in this particular area. Research studies focused on the examples of particular industries that have succeeded in internationalization by upgrading their capabilities (Cuervo-Cazurra, 2016). Scholars of the business literature have explained the reasons of business

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expansion of the globally emerging economies. The factors that make the economies successful are explained by different theories like the international theory of production (Cantwell, 2000), the economic theory to explain the business expansion of multi-national companies (Buckley and Casson, 2016) and the theory to explain the eclectic paradigm of production at international level (Dunning, 2015). The factors that are responsible for the international emergence of economies in context to these theories are the usage of digital platforms and the mentality of the workers and managers to accept change in the working methods and techniques.

Industries have to look for their resources, the quality leadership that have the capability to cope up with the new advancements and to bring the needed changes in the corporate and the knowledge portfolio of its employees. These factors will help them in adopting the Industry 4.0 revolution. Corporates will have advantage of this revolution and will move towards the sustainable manufacturing practices (Stock and Seliger, 2016). The use of Industry 4.0 in pharmaceutical sector has allow the pharmacy industries to enjoy competitive advantages (Ding, 2018). This revolution has also introduced a sustainable pharmaceutical supply chain that will allow the proper management of the products throughout the complete life cycle. It will also improve the patient centric drug supply flexibility and the use of technology will improve the communication between the different areas and develop coordination among the different teams. The use of Information technology and computer science during the different operations of production, management and supplying of products, will benefit the industries and decrease their cost of labor along with the decreased chances of mistakes and errors. For the proper implementation of Industry 4.0 initiative in the pharmaceutical companies of Thailand, there is a need to make proper use of digital technology and innovative advancements in science and the use of artificial intelligence and robotics. This will allow them to get benefit from the medical technologies and meet with the international standards. These technological advancements will not only benefit the pharmaceutical industries but also play their role in stabilizing the economy of Thailand and the internationalization of its industrial sector.

Literature Review

Researchers have argued (Scuotto et al., 2017) about the impact of social networking sites and digital platforms on the innovation performance of the enterprises. In today's world, the use of knowledge and innovation is necessary for the better performance of enterprises. The use of social networking sites enables the firms to get information about the consumer preferences. This information can be used efficiently to promote businesses and manufacture the products that are according to the needs of customers. Corporate sector uses these platforms very effectively and make online communities where they directly interact with the customers and get external knowledge. It also enables them to learn about different companies and firms and the services they provide, so that they can face the market

competitiveness in an efficient way. The use of technology for management and efficient marketing is very vital, because the world is moving towards the digitalization. To succeed in the digital world, companies have to move towards internationalization and the use of Industry 4.0 innovations make them able to learn about the trends in the global market. This also makes the corporate sector aware of the efficient marketing strategies and increase social sustainability in the firms. Literature study provided efficient information to support the following hypothesis:

H1: Information intensive services has a significant impact on the social sustainability performance.

A similar research work was carried out by (Abdul-Rashid Salwa, 2017) in context to Malaysia. To practice sustainable manufacturing is helpful for the industrial sector to make products that are not harmful for the environment and also not in the social context that is, it does not negatively affect the human life quality. The products should be favorable for the humans and must provide easiness to them by considering the environmental factors. Companies are moving towards the sustainable manufacturing to get identified in the international market. For the internationalization of the companies, the factors like sustainable practices and social concerns are noticed. The companies that work on these are considered favorite by the stakeholders and the consumers. Questionnaire based study was carried out for the estimation of benefits provided by the sustainable practices. The research findings indicated that Malaysian corporate sector takes care of the sustainable practices in the manufacturing process. This study provided useful information about the practices been performed in the Malaysian corporate sector but still there were limitations because only some limited factors were identified and studied. The research work supported the following hypothesis:

H2: Supply chain integration has a significant impact on the social sustainability performance.

Research study by (Sanders et al., (2016) and Gonos et al., (2016) focused on the improvement of productivity by decreasing the cost in the lean manufacturing by the implementation of industry 4.0. Lean manufacturing strategy has been practiced to get efficient productivity with the less cost. Industry 4.0 initiative works for the conversion of industries into smart industries with the use of information and communication systems and other digital innovations. The aim of Industry 4.0 is also the same that is, increased productivity with the decreased cost by the use of smart machinery and knowledge intensive workforce. Manufacturers get benefit by implementing Industry 4.0, but a lot of manufacturers are reluctant in using this approach because of the deficiency of scientific research work on this particular area. The benefits provided by Industry 4.0 are not listed and this makes the manufacturer's to think before its implementation. There are theoretical barriers in the way of implementation of industry 4.0 that needs to be deal with. Similar research work was performed by (Jones and Pimdee, 2017) in perspective of

Thailand. The empirically novel model was used in this study to learn about the maturity of Industry 4.0 and the dimensions, customers, products, operations and manufacturers that get affected by the implementation of the 4th industrial revolution. The practical implementation of the model was also observed by practicing it in some industries. So that the information can be useful for the manufacturing sector. The information obtained by the literature review supported the following hypothesis:

H3: Information intensive services has a significant impact on the implementation of Industry 4.0 revolution.

H4: Supply chain integration has a significant impact on the implementation of Industry 4.0 revolution.

Research Methodology

In order to fulfill objective of research study, researcher observes impact of information intensive service and supply chain integration on social sustainability performance, in mediating role of industry 4.0 implementation. Coming towards data collection process, researcher distributes 400 questionnaires among respondents, out of which only 321 respondents filled questionnaire or provide responses. At the end of data cleaning process, few responses have been discarded on the bases of invalidity and incomplete responses and researcher receives only 306 valid responses. In the proposed research study, researcher takes into account work of those authors from previous literature, which has already been conducted research study on impact of concerned variables of proposed study. Moreover, researcher considers these variables more reliable and authentic because validity and reliability has already been verified by previous authors. Information intensive service (independent variable) has been measured through 17 measurement items, which have been adapted from (Roy and Satpathy, 2019) and for supply chain integration (independent variable) measurement, 13 survey items have been adapted from (Roy and Satpathy, 2019). Further, researcher accompany for adapting 3 survey items, for the measurement of industry 4.0 implementation. Dependent variable of study such as social sustainability performance has been measured through 3 measurement items, which have been taken from. For the measurement of responses of all these survey items, researcher takes into account 5- point Likert scale in which 1 stands for strongly disagree and 5 stands for strongly agree.

Results and Analysis

Before estimating the empirical model, post estimation analysis is conducted. The frequency distribution is estimated to analysis the share of respondents based on gender, age and education. The data comprised on 316 respondents of Thailand, among which the share of male and female respondents are almost equally divided. The male and females constitute about 52.2 and 47.8 percent share in data, respectively. As far as ages of respondents are concerned, the respondents older

than 50 year constitute about 16 percent of total data set. The respondents fall under the age range of 41-50 is highest constituting 31.7 percent in data. Besides, the high educated respondents have considerable high share in total respondents and they easily understand the nature of questionnaire. The respondents having of master and post graduate degree constitute about 34 and 43.5 percent share, respectively.

Table 1: Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation	Skewness	
						Statistic	Std. Error
IS	306	1.00	4.88	3.5046	1.04275	-.849	.139
SC	306	1.00	5.00	3.4399	1.10050	-.609	.139
II	306	1.00	5.00	3.6024	1.08402	-.835	.139
SP	306	1.00	6.33	3.4183	1.10077	-.264	.139
Valid (listwise)	N306						

Table 1 presents the descriptive statistics of variables' data for conducting detail analysis of each variable's data. Summary statistics of variables include average, minimum, maximum and standard deviation, and skewness of data. The minimum and maximum values of all the variables are 1 and 5, respective. The values denote that variables response is noted on five point Likert scale. The means values of all the variables hovering around 3.6 which means that high proportion of respondents are slightly agree with the statement. Furthermore, the skewness test endorses the normal distribution in all variables' data as threshold value of skewness lies in the range of -1 and 1 for normal distribution.

Table 2: Factor Loading and Convergent Validity

	IS	SC	II	SP	CR	AVE
IS4	.835				0.940	0.660
IS5	.826					
IS3	.823					
IS15	.818					
IS6	.816					
IS16	.813					
IS13	.808					
IS14	.807					
IS7	.801					
SI17	.795					
IS8	.789					
IS9	.784					
IS2	.777					
IS10	.777					
IS12	.768					
IS1	.725					

IS11	.712			
SC4	.887		0.917	0.768
SC6	.884			
SC5	.883			
SC3	.870			
SC2	.863			
SC7	.859			
SC1	.841			
SC13	.832			
SC8	.829			
SC9	.824			
SC12	.822			
SC10	.815			
SC11	.778			
II2		.834	0.900	0.750
II1		.823		
II3		.807		
SP3			.730	0.873
SP2			.684	0.695
SP1			.661	

The findings of component factor analysis (CFA) and rotated component matrix of variables is presented in table 3. The values of CFA test affirm that all measures have valid construct as the load factors are higher than threshold value of 0.7 for validity of variable. Besides, the problem of cross loading is also not observed. In addition, the “convergent and discriminant” test also authorize the validity of measures.

Table 3: Discriminant Validity

	II	IS	SC	SP
II	0.866			
IS	0.551	0.812		
SC	0.478	0.515	0.876	
SP	0.446	0.570	0.735	0.834

Table 4 shows the findings of Kaiser-Meyer-Olkin and Bartlett’s Test. The KMO test is a measure to ascertain how suited data is for Factor Analysis, whereas Bartlett’s test is a measure of assessing the equality of variance in different samples. The KMO test estimates sampling adequacy for each indicator in the model and for the complete model. The results of KMO also confirms adequacy in sample data. The threshold range is lies between 0.6 - 1.0 for Confirmatory Factors Analysis, whereas the observed value of KMO of all the variables are 0.90.

Table 5 shows the results of Structural Equation Model which is measured by employing AMOS.

Table 4: Confirmatory Factors Analysis and KMO

CFA Indicators	CMIN/DF	GFI	IFI	CFI	RMSEA	KMO
Threshold Value	≤ 3	≥ 0.80	≥ 0.90	≥ 0.90	≤ 0.08	0.6 – 1.0
Observed Value	2.308	0.810	0.947	0.947	0.065	0.938

The model explores the relationships of Information Intensive services and supply chain integration with social sustainability in Thailand's Pharmaceutical Industry. The results indicate that direct impact of information intensive services on social sustainability in Thailand's Pharmaceutical is insignificant, as p-value of coefficients are higher than 0.05. Whereas, the direct impact of Supply Chain Integration on Social Sustainability of Thailand's Pharmaceutical is significant, as p-value of coefficients are less than 0.05. The coefficient of Supply Chain Integration shows that one unit increase in Supply Chain Integration will improve Social Sustainability of pharmaceuticals by 31.2 percent. Moreover, the indirect impact of information intensive services and supply chain integration on social sustainability of Thailand's Pharmaceutical is significant through industry 4.0 implementation. The mediating coefficients indicate that one unit increase in industry 4.0 implementation will improve the social sustainability about 14.6 and 10.7 percent through information intensive services and supply chain integration, respectively. Therefore, it can be inferred that mediating impact of industry 4.0 implementation strengthens the relationships of supply chain integration with social sustainability performance of pharmaceutical in Thailand.

Table 5: Structural Equation Modeling

Hypothesis	B-Value	SE	P-Value	Decision
IS→SP	.090	.056	.108	Accepted
SC→SP	.312	.052	.000	Accepted
IS→I4I→SP	.146	.041	.010	Accepted
SC→I4I→SP	.107	.032	.010	Accepted

Discussion

The aim of this study was to check out the impact that is casted by information intensive services on social sustainability performance and the impact of supply chain integration on social sustainability performance as well. The study took industry 4.0 implementation as a mediator to know the enhancement of that it causes with the impacts of information intensive services and supply chain integration on social sustainability performance. The first hypothesis that the study proposed was that, "The impact of information intensive services on social sustainability performance is significant." This hypothesis has been accepted by the study and by the research work of (Chalongsuk & Sribundit, 2013) which says that information intensive services enhance the social sustainability performance in a positive and significant way. The second hypothesis proposed by the study was

that, “*The impact of supply chain integration on social sustainability performance is significant.*” The hypothesis has been accepted according to the study of (Kuek et al., 2011), supply chain integration eases the supply chain activities and result in efficient work performance which can create social sustainability and will actually sustain it as well. The study proposed the third hypothesis stated as, “*The mediation of industry 4.0 implementation between information intensive services and social sustainability performance is significant.*” This hypothesis has been accepted by the study. While, the fourth hypothesis proposed by the study was that, “*The mediation of industry 4.0 implementation between supply chain integration and social sustainability performance is significant.*” This hypothesis is accepted by the results of the study showing a significant and positive mediation as well. Because (Pongcharoensuk and Prakongpan, 2012), implementation of industry 4.0 practices makes the work practices efficient and sustainable for both society and environment (Pothitong and Charoensiriwath, 2011).

Conclusion

The aim of this study was to check out the impact that is casted by information intensive services on social sustainability performance and the impact of supply chain integration on social sustainability performance as well. The study took industry 4.0 implementation as a mediator to know the enhancement of that it causes with the impacts of information intensive services and supply chain integration on social sustainability performance. The study took a sample from Thailand's Pharmaceutical Industry and 306 individuals were selected in total. Moreover, the study analyzed the data and found out that the impact of information intensive services on social sustainability performance is significant and the impact of supply chain integration on social sustainability performance is significant as well. The study validated that industry 4.0 implementation is a significant mediator.

The study has very interesting and significant contributions in the theoretical section as it has contributed in increasing the theoretical evidence about the significance of presence of information intensive services for the positive enhancement of social sustainability performance. The study also has practical implications to practically implement information intensive services and supply chain integration in industries around the globe to enhance social sustainability performance.

The study has a very limited scope. The study is only focusing on the pharmaceutical industry of Thailand, whereas, industries like the automotive industry and heavy engineering industry are the ones, looking forward to information intensive services so that their issues can be minimized and social sustainability performance can be maximized. Moreover, the study has also taken a very small sample which could be increased by the researchers in the near future.

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BUDOWANIE SPOŁECZNIE ZRÓWNOWAŻONEGO PRZEMYSŁU FARMACEUTYCZNEGO POPRZEZ WDRAŻANIE PRZEMYSŁU 4.0

Streszczenie: Celem tego badania było sprawdzenie wpływu usług intensywnie korzystających z informacji na wyniki w zakresie zrównoważonego rozwoju społecznego oraz wpływ integracji łańcucha dostaw na wyniki w zakresie zrównoważonego rozwoju społecznego. W badaniu wykorzystano implementację Przemysłu 4.0 jako mediatora, aby dowiedzieć się, jakie ulepszenie to powoduje wraz z wpływem usług intensywnie wykorzystujących informacje i integracji łańcucha dostaw na wyniki w zakresie zrównoważonego rozwoju społecznego. W badaniu pobrano próbkę z tajlandzkiego przemysłu farmaceutycznego i w sumie wybrano 306 osób. Ponadto w badaniu przeanalizowano dane i stwierdzono, że wpływ usług intensywnie wykorzystujących informacje na wyniki w zakresie zrównoważonego rozwoju społecznego jest znaczący, a wpływ integracji łańcucha dostaw na wyniki w zakresie zrównoważonego rozwoju społecznego jest również znaczący. Badanie potwierdziło, że wdrożenie przemysłu 4.0 jest znaczącym mediatorem. Badanie ma znaczenie dla sektora teoretycznego, praktycznego i kształtowania polityki w celu praktycznego wdrożenia usług wymagających dużej ilości informacji i integracji łańcucha dostaw w branżach na całym świecie w celu poprawy wyników w zakresie zrównoważonego rozwoju społecznego. Badanie jest jednak krótkie w swoim sektorze i doborze próby.

Słowa kluczowe: zrównoważony rozwój społeczny, przemysł farmaceutyczny, wdrożenie przemysłu 4.0, usługi wymagające dużej ilości informacji, czynniki integracji łańcucha dostaw, Tajlandia

通过工业4.0实现医药行业社会可持续发展。

摘要: 本研究的目的是检验信息密集型服务对社会可持续性绩效的影响以及供应链整合对社会可持续性绩效的影响。这项研究以工业4.0的实施为中介,以了解由于信息密集型服务和供应链整合对社会可持续发展绩效的影响而导致的增强。该研究从泰国的制药工业中抽取了样本,总共选择了306个人。此外,该研究对数据进行了分析,发现信息密集型服务对社会可持续性绩效的影响显著,而供应链整合对社会可持续性绩效的影响也显著。该研究证实,工业4.0的实施是重要的中介。该研究对于理论,实践和政策制定部门具有重要意义,对于在全球范围内的行业中实际实施信息密集型服务和供应链整合以提高社会可持续发展绩效具有重要意义。然而,该研究在其领域和样本选择方面很短。

关键词: 社会可持续性, 制药业, 工业4.0实施, 信息密集型服务, 供应链整合驱动力, 泰国