

IMPACT OF INSTITUTION FACTORS TO UNIVERSITY-INDUSTRY KNOWLEDGE EXCHANGE: A STUDY BASED ON SRI LANKAN UNIVERSITY SYSTEM

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Article History: Received on 25th October, Revised on 25th November, Published on 24th December 2019

Abstract

Purpose: The study explored the impact of institutional factors have on the university-industry knowledge exchange based on the Sri Lankan university system.

Methodology: The study is quantitative and explanatory by nature and it applied the deductive method and questionnaire survey strategy. The study conducted with minimum interference of researcher and individual academics is the unit of analysis. The types of knowledge interaction, university-industry knowledge exchange, and institutional factors were the independent, dependent and moderating variables respectively. A Structural Equation Model is deployed on collected data to explore the moderating impact of the institutional factor on the university-industry knowledge exchange.

Implications: It implies that the level of joint, contract research activities, human resource mobility, and training of academic staff are largely wider on the conducive environment and sophisticated facilities of the university.

Main Findings: First, study evidence that there are statistically significant impacts of type of interactions and institutional factors on university-industry knowledge exchange. Further, the study confirmed the moderating power of institutional factors over the knowledge exchange process.

Novelty: There is a lack of research literature discussing the moderating effect of institutional factors on the university-industry knowledge exchange process.

Keywords: *University-Industry, Knowledge Exchange, Institutional Factors, Sri Lanka, University System, Knowledge Interactions.*

INTRODUCTION

University-industry knowledge exchange refers to the interaction between university and industry aiming to promote knowledge, technology and information exchange between two institutions to the betterment of the society ([Ankrah and Al-tabbaa, 2017](#)). The knowledge exchange between university-industry had a long history. However, the commercial exchange of knowledge by the university with industry was not evident in past ([Lee, Hwang, and Choi, 2012](#)), but plenty of interactions had been between them around the world later. University itself has an open environment by nature ([Poyago-Theotoky et al, 2002](#)) in which university makes its scientific outputs freely available with the aim that it would be picked up by researchers for further development or industry for application ([Striukova and Rayna, 2015](#)). At the inception, the collaboration between university-industry aimed to build organizations' knowledge stock ([Cricelli, L., Grimaldi, 2010](#)), but in later the interactions became mandatory in the open innovation paradigm which encourages the intended application of knowledge inflows and outflows to quicken the innovation process([Chesbrough, 2012](#)). The open innovation changed everything in which former leading industries also confronted remarkably strong competition from many new companies and star-ups ([Chesbrough, 2012](#)), due to the transfer of knowledge and technology across boundaries of organizations.

Under the open innovation perspective, the university is believed as a strategic source of knowledge to the industry, and another hand industry is believed as a commercial partner to the university. With this, the commercial exchange of knowledge starts between university and industry. This interdependency has been attributed to a combination of pressures on both industry and universities ([Giuliani, E.; Arza, 2009](#)). For university, pressure has included sapping government annual allocation for education, rising research costs, updating advanced technology and infrastructure, limited access to actual industrial data which exerted gigantic burden on knowledge creation of the university. Moreover, not like in the past, now many have been criticizing the university's role in the process of economic development emphasizing that the role university plays has been significantly distracting from the role university should play, and the gap is continuing to wider year on year([Philbin, 2008](#)). For the industry, pressure has included shorter product life cycles, environment volatility, technology change, intense global competition, political instability, competitor quick swerve for strategy. Consequently, now, business firms extensively rely on external sources of knowledge especially on universities when directing business to success([Howells, Ramlogan and Cheng, 2012](#); [Siegel, Waldman and Link, 2003](#)). On the other

hand university also has taken tremendous effort to develop a “third mission” ([Autio et al., 2012](#); [Razak and Murray, 2017](#)) for a collaborative journey with the industry. Accordingly, there has been active university-industry knowledge exchange but the level of interaction and nature of the relationship is significantly diverse across universities ([D’Este, P., Patel, 2007](#)). Therefore, the study focused to explore the impact of institutional factors on the university-industry knowledge exchange.

There have been several studies on the university-industry collaboration ([Perkmann and Walsh, 2007](#); [Bekkers, Maria and Freitas, 2008](#); [Kondo, 2011](#); [Ankrah and Al-Tabbaa, 2017](#); [Degl, Matousek and Tzeremes, 2019](#)) and university-industry knowledge exchange ([Striukova and Rayna, 2015](#); [Jonsson et al., 2015](#); [Secundo et al., 2018](#)). However, only a few studies have focused on the effects of faculty quality on university engagement with industry ([Siegel, Waldman, and Link, 2003](#); [Perkmann, King and Pavelin, 2010](#)) but no one has explored the effect institutional factors to the university-industry knowledge exchange.

SIGNIFICANCE AND OBJECTIVES OF THE STUDY

As no universities are equal in terms of available facilities, administrative setup, rules and regulation, procedures, the exploration of how the university-industry knowledge exchange vary on institutional factors is timely imperative as it addresses to the existing literature gap. Hence, the study aims to explore the impact of institutional factors on the university-industry knowledge exchange in Sri Lanka.

This study significance in many ways. First, the study addressed an area that had been given a little attention by researchers in the area of literature in university-industry knowledge exchange. This is the first systematic study that describes the impact of institutional factors on university-industry knowledge exchange in Sri Lanka hence, study would be a great support and be a platform for policymakers to decide institutional setup if they wish to promote knowledge exchange between university and industry. Second, the study synthesizes existing theoretical and empirical results into a novel framework on university-industry knowledge exchange. Third, the study explores the impact of institutional factors on university-industry knowledge exchange.

LITERATURE REVIEW

Recent studies on university-industry collaboration have indicated that there has been a growing trend of university-industry collaboration at present competitive business environment, however, the study is filtered to knowledge exchange relationship between the university and the industry. University-industry knowledge exchange refers to the interaction between university and industry aiming to promote knowledge, technology and information exchange between two institutions to the betterment of the society ([Ankrah and Al-tabbaa, 2017](#)). Knowledge transfer is one of the main activities by which universities achieve its knowledge dissemination objective ([Rossi, F., Rosli, 2013](#)), and it is not a single homogenous concept ([Sengupta and Ray, 2017](#)), but can occur through a number of ways, both formal and informal, between two or more partners. Before the open innovation, universities enjoyed knowledge exchange and technology transfer with the industry through ([Striukova and Rayna, 2015](#); [UIDP, 2014](#)), however, after the open innovation, the procedure was formalized and validated ([Chesbrough, 2012](#)).

University-industry knowledge exchange brings many advantages to both entities. For the industry, it provides access to technology, fresh knowledge, qualified graduates, specialized talents and networks ([Lee, 2000](#)), facilitates research and development, human resource mobility, innovative solutions, collaborative publications ([Lee, 2000](#); [Perkmann and Walsh, 2007](#)). In return university will benefit from attracting funds for research, accessing real data and modern equipment, familiarizing with industrial science and technology, supplementary income ([Blackman, C., Segal, 1993](#)). Further, it reinforces academic entrepreneurship, university spin-offs, and application of academic researches ([Lee, 2000](#); [Perkmann and Walsh, 2007](#)). Instead of the aforementioned advantages, there are several demerits have been discussing at many academic forums. For the industry, there is a big risk if any sensitive information leaks to competitors, if outsource core business activities through the collaborations ([Dahlander, L., Gann, 2010](#)), and it is a challenge to capture the benefit from external knowledge and maintain long-term relationships with several parties simultaneously. Moreover, innovating with partners not only share risk but benefit too. To university, external engagement significantly deteriorates the research agenda of scholars.

The university-industry knowledge exchange exists in different ways. According to [Ahrweiler, Pyka and Gilbert, \(2011\)](#); [Feldman and Baba, \(2015\)](#), the relationship can be either formal or informal or both. The formal relationships include licensing of patents, academic spin-offs, contract research, collaborative research, counseling ([Autio et al., 2012](#)), co-publications, mutual secondments and employment of graduates, that based on a legal agreement between the entities ([Padilla-Melendez and Garrido-Moreno, 2012](#)). In contrast, activities such as informal meetings, consultancies, lectures and conference participation, and ad-hoc advice can be identified as informal relationships ([Ahrweiler, Pyka and Gilbert, 2011](#)). This informal interaction may purely be based on personal connections and interpersonal relations of each party ([Melese et al., 2009](#); [Perkmann and Walsh, 2007](#)). The university-industry knowledge exchange spans a much broader range of

interactions beyond formal and informal, it includes focus and non-focused and general support interaction. Moreover, these interactions can be segregated as industry-full (contract research) connection and university-push (university spin-off) interaction ([Poyago-Theotoky, J., Beath, J. and Siegel, 2002](#)). The typology of university-industry interactions based on depth, intensity and importance for the parties, [Baraldi, E., Ingemansson, M., Launberg, \(2014\)](#), classified as shallow contacts, participation (meeting and discussion), actual corporation (exchange knowledge and joint activities), deeper collaboration (closer combination of resources towards a common goals) and full-blown relationship (long term solid relationships and interdependencies). [Schartinger, et al \(2002\)](#) grouped university-industry interactions into four: Joint research; includes co-publication and research activities, Contract research; takes place on a legal agreement, Mobility; staff movement between university and firms, and Training; staff or undergraduates. These interactions could be seen both at individual and institutional levels. All in all, the types of knowledge interactions between university and firm could be arranged on the basis of the degree of formalization, suitability to transfer tacit knowledge and personal contact.

Table 1: Types of knowledge interactions between university and firms

Types of knowledge interaction	Formal interaction	Transfer of tacit knowledge	Personal contact
Employment of graduates by firms	+/-	+	-
Conferences or other events with firm and university participation	-	+/-	-
New firm formation by university members	+	+	+/-
Joint publications	-	+	+
Informal meetings, talks, communications	-	+	+
Joint supervision of Ph.D. and Masters theses	+/-	+/-	+/-
Training of firm members	+/-	+/-	+
Mobility of researchers between universities and firms	+	+	+
Sabbatical periods for university members	+	+	+
Collaborative research, joint research programmes	+	+	+
Lectures at universities, held by firm members	+	+/-	+
Contract research and consulting	+	+/-	+
Use of university facilities by firms	+	-	-
Licensing of university patents by firms	+	-	-
Purchase of prototypes developed at universities	+	-	-
Reading of publications, patents, etc.	-	-	-

+: interaction typically involves formal agreements, transfer of tacit knowledge, personal contacts;
+/-: varying degree of formal agreements, transfer of tacit knowledge, personal contacts;
-: interaction typically involves no formal agreements, no transfer of tacit knowledge, no personal contacts.

Source: [Schartinger, D., Rammer, C., Fischer, M.M., Fröhlich, J. Research policy 31 \(2002\), p-302](#)

Joint research projects are defined as research projects that involve two or more parties, institutions or individuals who have a distinct attribution but work together on one objective, represented by a set of activities that allow the corporation to take place ([Aronson, Z.H., Lechler, T., Reilly, R.R., Shenhar, 2001](#)). Joint works include a wide range of activities such as information exchanges, joint research grant, co-publication, co-locational arrangement ([Ankrah and Al-tabbaa, 2017](#)), and often exists at three levels. The level one represents the joint work between one university and one company whereas the secondary level covers the joint works between one university and multiple companies. [The third and final level explains the joint interactions between multiple universities and multiple companies ([Kondo, 2011](#))]. This collaboration often ranges from temporary small and medium to more permanent large scale long term relationships ([Perkmann and Walsh, 2007](#)) with private or public organizations either form of formal or informal. Here, the responsibility lies equally among both parties as the work is funded partially and output is equally important. Contract research involves multiple interactions between university and industry under a legal agreement and this interaction is very systematic by nature in which firms determine unilaterally what type of expertise or service they require or what sort of research work should be carried out against the payment ([Perkmann and Walsh, 2007](#)). All the contract researches are carried out to explore specific industry or firm based problem rather than generating new research insights to the field, and therefore is totally funded by the industry ([Perkmann and Walsh, 2007](#)) and output of this research is less academic-oriented.

Human resource mobility is the movement of human resources between the university and the industry to better transfer of knowledge across the organizations ([Perkmann and Walsh, 2007](#)), and it guarantees a continuous flow of knowledge, skills, and expertise between organizations. The mobility is a reciprocal process. From the university side, staff/students could join the firm as an employee or intern, another hand firm sends the employee to university as students or research assistants. This

movement can either be permanent or temporary ([Perkmann and Walsh, 2007](#)). In terms of training, employees themselves often develop skills through on the job training however majority of them fails to upsurge important job skills such as creative thinking, innovative thinking, analytical thinking, breakthrough thinking, reflective skills that have been considered as indispensable in contemporary business world ([Garrick, Chan and Lai, 2003](#)), training, therefore, is considered as effective mechanism that touches strategic competencies of employees. Training is a bilateral process from which knowledge is transferred to the both institutes, from the side of university, many training programs are organized or conducted either invitation of a firm, by university staff for industry to uplift specific knowledge and skills that govern competitive advantage of industry. Very frequently university invites industry to share experiences and practical aspects of theories with undergraduates time to time. By considering all the study hypothesis that

H1: Type of knowledge exchange has a significant impact on the knowledge exchange process between the university and the industry.

In an open environment, the university is essential to have a suitable mechanism to exchange knowledge to external entities, therefore system and structures reflected within the universities should be principally investigated to assess that by nature they are prone to be open or not ([Striukova and Rayna, 2015](#)). Successful knowledge exchange is influenced by many factors that exist in both institutions. University culture, reputation, internal policies, financial support and attitudes towards knowledge transferring significantly influence the university-industry interaction ([Lipinski, J., Minutolo, M., Crothers, 2008](#)). When a leader is active, members will be more active ([Bercovitz, J., Feldmann, 2006](#)). Moreover, university culture, reputation, internal policies and attitudes towards knowledge transferring significantly influence the university-industry interaction ([Lipinski, J., Minutolo, M., Crothers, 2008](#)). Further, experienced well-known universities with formal management generally show an efficient knowledge transferring process than that of less experienced ([Siegel, Waldman and Link, 2003](#)). Institutional factors are likely to moderate the impact of individual characteristics on knowledge engagement ([Autio et al., 2012](#)). Accordingly, study develop a hypothesis as;

H2: Institutional factor significantly moderate the impact of types of knowledge exchange to the university-industry knowledge exchange process

This study focus to explore the impact of institutional factors on the university-industry knowledge exchange. Accordingly, the study identified four main types of knowledge exchange which well describe all types of direct, indirect, codified, non-codified, personal, official, formal, informal engagement in order to transfer knowledge and science from university to the industry. Generally, knowledge exchange can be measured on two sides: on the side of the firm or the side of the university ([Schartinger et al., 2002](#)). This study, the university side is chosen as a study area. Having considered the nature and types of relationships universities had with industry, the current study focused its investigation along key dimensions of joint research, contract research, staff mobility, and training.

METHODOLOGY

This study aimed to explore the impact of institutional factors on university-industry knowledge exchange, therefore by nature study was quantitative and explanatory. The study applied the deductive method and questionnaire survey strategy. The study was conducted with minimum interference of researcher and individual academics was the unit of analysis. The study developed two hypotheses to address the research questions and one out of which, tested moderating impacts institutional factors. Joint research, contract research, human resource mobility, and training were key dimensions of independent variables and knowledge exchange was the dependent variable. The moderating variables of the study were the institutional factor. The dependent variable was measured through the standard questionnaire developed by [Kitson, M., Hughes, \(2010\)](#), albeit, few questions altered to the Sri Lankan context. The questions related to types of interactions (joint research, contract research, staff mobility, and training) and institutional factors were able to manage through previous studies. Here, studies of [Kitson, M., Hughes, 2010](#); [Scandura, 2016](#); [Ankrah and Al-Tabbaa, 2017](#); [Bekkers et al., 2008](#); [Schartinger et al., 2002](#); [Padilla-Melendez and Garrido-Moreno, 2012](#); assisted a lot.

All academic staff attached to state universities where the population of the study. A structured questionnaire was used to reach the sample randomly. The structured questionnaire had three sections. Section one contained short answer questions related to respondents' demographic information. Section two included five-point Likert questions to measure the independent variable and the last section was used for moderating and the dependent variable. The questionnaire was sent two experienced researchers to improve the clearness of questions and structure of the questionnaire. This process debugged weak questions and changed a few questions to maintain the validity and reliability of the study. This cross-sectional study collected data from 15th May 2019 to 31st July 2019. A study distributed 200 printed questionnaires among academic staff of state universities randomly, but only 29 completed questionnaires received on the agreed date though the researcher himself involved in the data collection process. As the response rate of the physical survey was 14.5%, an e-mail survey was launched on 1st June 2019, to all academic staff. After 4 weeks, 112 had responded to the survey and 1st and 2nd reminder was given a week later. Resulting 178 responses received on 31st July 2019 including physically collected questionnaires. To

avoid repetitions, a notice that “Ignore this mail if you have already contributed to the physical survey form” displayed in the e-mail. To verify that the sample obtained was indeed representative of the population, the non-response bias was analyzed. Thus, beginning responding compared with those responding at the end, however, no significant differences found. Collected data were examined from different perspectives for its accuracy. Missing values analysis detected few cases with missing information, and it's were filled by the mean value of respective questions for a minimum implication (Josephs Hair, Jf., William, C. Black., Barry, J Babin., 2009). Face and content validities of the questionnaire were ensured. Finally, for an accurate result, a structural equation modeling technique was applied to detect moderating impacts. Therefore, AMOS was used to analyze the data.

PROCEDURE

The sample had distributed fairly among the universities. The University of Sri Jayewardenepura represented around 25% of the sample and Rajarata University, Sabaragamuwa University, University of Peradeniya and Moratuwa contributed to the sample 18%, 14%, 14%, and 9.6% respectively. However, the participation from the university of Vavuniya, Wayamba, South Eastern, were very low compared to other state universities. The majority of the respondents were specialized management discipline and followed by medicine and sciences. The lowest contribution recorded by the technology faculties. As per the table 02, around 45.5% of respondents in the survey were male and 54.5% were female, and these both groups contained all grades of staff; 2.2% were senior professors, 7.9% were professors, 59.6% were senior lecturers and 30.3% were lecturers. Further, 43.8% of respondents had Ph.D. qualification and 14.6%, 36% qualified M.Phil and Master Degrees respectively.

Table 2: Gender, Qualification and Job title of the respondents

Category	Percentage
Gender	
Male	45.5 %
Female	54.5 %
Job title	
Senior Professors	2.2 %
Professors	7.9 %
Senior Lecturers	59.6 %
Lecturers	30.3 %
Qualifications	
PhDs	43.8 %
M. Phill	14.6 %
M.Sc/ MBA/ MA	36 %
BA/B.Sc	5.6 %

Descriptive statistics further revealed that about 55% of respondents have been bearing teaching, research and administrative responsibilities simultaneously and 15% engaged only in teaching and research activities. Further, only 27.5% respondent believed that their researches are relevance for commercial application. Moreover, the study found that about 40% of respondents have joined university just after graduation without sufficient industry exposure and however, only 34.8% of them had working experiences at either small & medium or large-scale organization.

DATA ANALYSIS AND DISCUSSION

The study developed a Structural Equation Model exhibits in figure 01, to explore the impact of institutional factors on university-industry knowledge exchange. As per figure 01, types of interactions are measured through joint research, contract research, human resource mobility, and training. The moderating variable was created combining institutional factors and types of interactions.

According to the test statistics table 02, SMIN/DF is 4.214. It is at an appropriate range where the value below five is reasonable for calculation. The sample data fit distribution from the population was ensured through the GIF value; it is 0.901 and is very close to 1. The comparative fit index (CIF) is very close to its ideal value one (0.919) which is also under acceptable range. The error term: RMSEA is 0.135 which exceeded the threshold level 0.05.

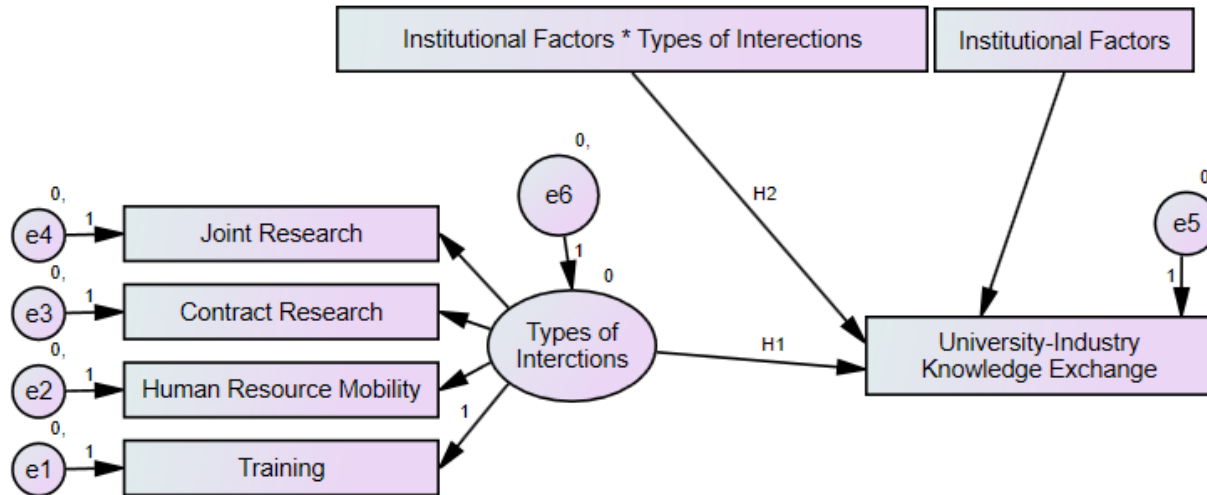


Figure 1: Structural Equation Model to measure the moderating effect of institutional factors

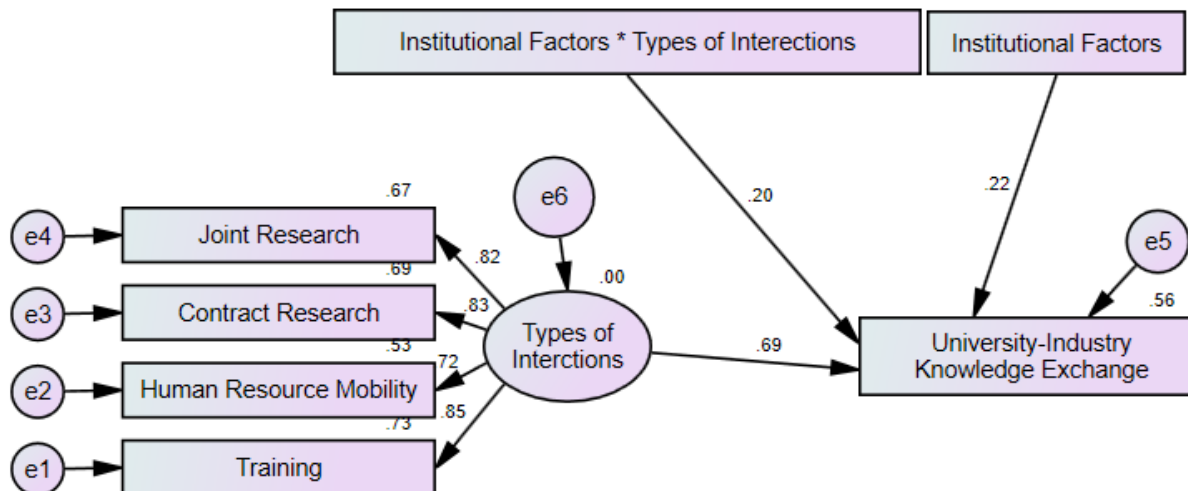


Figure 2: Test Statistics and coefficients

Table 3: Regression statistics

Variables		Estimate	C.R.	P
Knowledge Exchange	<--- Types of Interactions	.686	9.168	***
Knowledge Exchange	<--- Institutional Factors	.218	2.967	***
Knowledge Exchange	<--- Types of Interactions * Institutional Factors	.205	2.961	***
Training	<--- Types of Interactions	.855	13.981	***
Human Resource Mobility	<--- Types of Interactions	.725	10.869	***
Contract Research	<--- Types of Interactions	.829	13.180	***
Joint Research	<--- Types of Interactions	.821	12.995	***
Model Accuracy: CMIN/DF: 4.214 GIF: 0.901 CIF: 0.919 RMSEA is 0.135				

As indicates in table 03, the standard regression coefficient of types of infection to the knowledge exchange is 0.690 and respective sig. value is 0.000. It is less than 0.05, hence the study accepted hypothesis 01, accordingly, it can be concluded that types of interactions have a statistically significant impact on the knowledge exchange process in Sri Lanka. The findings of the study aligned with many previous studies. [Howells, Ramlogan and Cheng, \(2012\)](#) stated that collaborations between firms and universities are having positive and significant effects on knowledge exchange and firms' innovation.

Further, contract research activities have been significant in many previous studies as a knowledge transfer channels([Schartinger, D., Rammer, C., Fischer, M.M., Frohlich, 2002](#); [Ankrah and Al-tabbaa, 2017](#)). Human resource mobility between university and industry is presently considered as the most productive way of transferring non-codified knowledge among organizations([Bekkers, R., Bodas Freitas, 2008](#)). Here, academic spin-offs and labor mobility were found particularly useful for effective knowledge exchange and specially commercializing breakthrough knowledge ([Bekkers, R., Bodas Freitas, 2008](#)). Further, personnel mobility and training courses for firms are considered as the most important types of knowledge interaction channels([Schartinger et al., 2002](#)).

As per table 03, the regression coefficient of institutional factors to knowledge exchange is 0.218 and its respective sig value is 0.000. Accordingly, it can be concluded that institutional factors have a significant impact on the university-industry knowledge exchange process in Sri Lanka. The further study tested the moderating power of institutional factors in the knowledge exchange relationship. As per, the test statistics, the regression coefficient of moderating variable, is 0.205 and its respective sig value is 0.000. It was less than 0.05, therefore, the study accepted hypothesis two. It demonstrates that institutional factors significantly alter the university-industry knowledge exchange process. Accordingly, the level of joint, contract research, human resource mobility, and training of academic staff may largely wider due to internal factors of the university. Consequently, the academics who are at a more supportive internal environment are likely to engage more joint, contract, training and mobility works than the academic who is not. Moreover, the university which has a high reputation, more physical resources, favorable internal mechanism to knowledge exchange, enjoy more industry collaboration than other university does. Resulting, the academic who attached to rural and developing university has no as equal chance as academics who works for well-reputed universities in the country. This is not good for a country. Many previous studies had confirmed this moderating power of the institution factors to the knowledge exchange process. [Degl, Matousek and Tzeremes, \(2019\)](#) stated that university efficiency is likely to have a positive effect on research quality. The movement of technology between university and industry is also largely influenced by the quality of the faculty ([Perkmann and Walsh, 2007](#)). The collaboration brings a lot of advantageous to the industry when connecting with the university which maintains the quality of their academic works ([Szucs, 2018](#)). Generally, it is believed that prestigious universities may produce quality researches so that they are able to connect with more external institutions and raise more funds from the private sector([Degl, Matousek and Tzeremes, 2019](#)). However, many contradictions have also been found. Not all but few studies had noticed the negative effect of institutional factors on the university-industry knowledge exchange process ([D'Este and Patel, 2007](#)).

CONCLUSION AND RECOMMENDATION

The objective of this paper has been to explore the impact of institutional factors on the knowledge exchange process between the university and industry. In particular, this paper investigated the relationship between types of interactions to the knowledge exchange process and moderating power of institutional factors to university-industry knowledge exchange. For the purpose, the study developed a structural equation model and collected fresh data from university academics through a standardized questionnaire. First, study evidence that there are statistically significant impacts of type of interactions and institutional factors on university-industry knowledge exchange. Further, the study confirmed the moderating power of institutional factors over the knowledge exchange process. It implies that the level of joint, contract research activities, human resource mobility, and training of academic staff are largely wider on the conducive environment and sophisticated facilities of the university. Consequently, the academic who attached to rural and developing universities have a lower chance to connect with industry than academics who does at well-reputed one. This inequality should be address by policymakers through sophisticated policy decisions in resource allocation, therefore it is fundamental to create or strengthen the mechanism if exists, that support university-industry collaboration as a means for connecting regionally-based industries at least which are likely to be more useful than mechanism promoting just academic researches.

LIMITATIONS AND SUGGESTIONS FOR FURTHER STUDIES

Given the nature of the study, some limitations have to be taken into account. First, the study considered only the university side of the knowledge exchange process though it has two main parties as university and industry. Resulting in a room is still vacant for future researchers to consider both sides in the future. Though the study touched one side of the bridge, I firmly believe that some of our findings could spark debate knowledge exchange and be informative for future research activities. Secondly, the study takes only joint, contract, human resource mobility, and training into consideration when measuring academic contribution through a large pool of knowledge exchange types, therefore someone who wishes to consider more in future studies has a room for that.

ACKNOWLEDGMENTS

We hereby acknowledge the assistance gave by the Faculty of Management Studies, Rajarata University of Sri Lanka when conducting the research releasing me from other administrative works. Further, all Deans of the Faculties who supported us collecting data are highly appreciated.

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