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Technology Transformation in Pharmaceutical Industries of Pakistan through joint efforts of R&D and Manufacturing Departments-A Process Centered Approach

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Abstract: Pharmaceutical industries being knowledge intensive in nature undergo intense technology acquisitions due to advancement in pharmaceutical products. The active ingredients, acquired from outside or developed through own R&D, are passed through different transformation processes related to both technology and human. The technology transformation in pharmaceutical industries is dependent on R&D and manufacturing segments as both are closely linked with each other. The mismatch between them may lead to low quality products. However, competence level to deal with new technology (Absorptive Capacity) plays a pivotal role in transformation process. This study evaluates the technology transformation in pharmaceutical industries in context to processing of active ingredients to form an end pharmaceutical product. The study results show that the transformation of active ingredient is dependent on employees with specific background experience in addition to competence level (Absorptive Capacity) of R&D and manufacturing departments in pharmaceutical industries in Pakistan.

Keywords: Pharmaceutical industries, technology transformation, manufacturing, Absorptive Capacity and R&D.

1. INTRODUCTION

There is growth in pharmaceutical industry in Pakistan since last few decades and meets more than 90% of the demands of finished products. However, this industry has limitation in producing active ingredients and bulks of the active ingredients are imported to meet the needs. The new technology acquisition is, therefore, a permanent feature of pharmaceutical industries of Pakistan. The acquired technology in the form of active ingredients is transformed into the final product through Transformation process. The transformation of the acquired technology by combining the new and the old is one of the component of absorptive capacity which is defined as the ability of the industry to deal with the new technology and use for the commercial ends (Cohen and Levinthal, 1990) (Nonaka, *et al.,* 1994). (Teece, *et al.,* 1997) (Foss, 998) (Lane and Lubatkin, 1998). The transformation process is dependent on many factors both hard ware technologies and human behavior as concluded by studies (Cohen and Levinthal, 1990). (Mukherji and Silberman, 2013) (Lane, , *et al.,* 2001) and most employees have been identified as the key actors in technology transformation (Minbaeva, *et al.,* 1998) Moreover, the transformation is not a unidirectional process rather a close loop process that depends on all related departments (Cohen and Levinthal, 1990). (Mukherji and Silberman, 2013) (Lane, *et al.,* 2001)

Transformation process is interdependent on different departments of the pharmaceutical companies as the knowledge used by one department is an input to the process of the other department, thus making the transformation process interdependent (Wang, *et al.,* 1998). This study evaluates the transformation process in pharmaceutical companies specific to R& D and manufacturing departments. Keeping in view the background experience (Automated system and Manual system) of employees belonging to R& D and manufacturing departments, effectiveness of transformation process of technology was explored. The transformation process was also evaluated in the perspective of competence level of employees of both departments.

Transformation process in pharmaceutical companies

Pharmaceutical companies of Pakistan are dependent on foreign technologies regarding active ingredients and related products. Pharmaceutical companies process the active ingredients through collaboration of manufacturing and local R& D efforts on getting the feedback from the user either related to side effects or improvements in the process and the change in the existing process based on any requirements related to the new active ingredients (Popaitoon and Siengthai, 1998) (Jeon, *et al.,* 1998). The active ingredients are analyzed against the specifications under the predefined conditions. The exceptients are then mixed with the active ingredients to process for the use in the form of suitable taste and color. Mixing process leads to the granulation and sieving process. The product is then compressed and packed for the marketing and end user. The feedback of

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the user and identified side effects about product are probed into the process for improvements in the process and procurement of active ingredients. **(Fig.1)** shows the flow chart of transformation process of active ingredients with the outcome of final product in pharmaceutical companies in Pakistan.

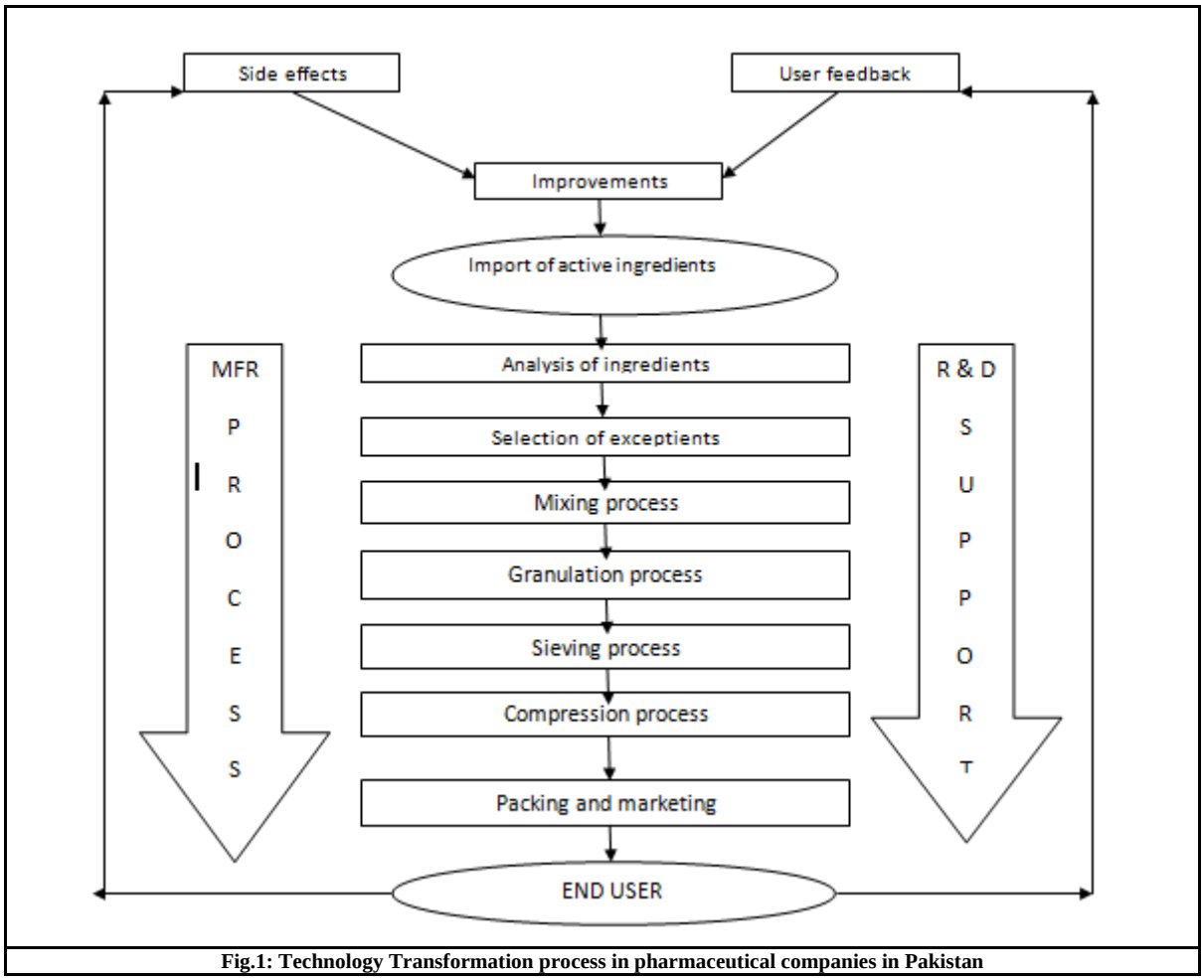

Fig.1: Technology Transformation process in pharmaceutical companies in Pakistan

Transformation (Absorptive capacity)

The construct "absorptive capacity" (ACAP) was introduced by (Cohen and Levinthal, 1990) with the argument that recognition of new external knowledge, its assimilation and application has positive impact on organizational capabilities. The dimensions of the construct have been developed and operationalized in extensive publications (Zahra and George, 2002). The authors (Zahra and George, 2002). proposed four components of absorptive capacity grouped into two interlinked subgroups: Potential absorptive capacity, consisting on acquisition (ACQ) and assimilation (ASM) and Realized absorptive capacity, consisting on transformation (TFMN) and exploitation (EXPL) and were empirically tested and validated by (Jansen, *et al.*, 2005). The transformation component of absorptive capacity was defined as the process in which new and old technologies are combined in the light of requirements of the organization and resultantly the new technology is transformed through this combination (Rothaermel and Alexandre, 2009). The Transformation process has been argued in different hard and soft aspects of the organization in the form of interaction patterns of human and technology (Nonaka, *et al.*, 1994) but the employees keep the central role in the transformation process (Cohen and Levinthal, 1990)

Transformation Process of technology in employees' perspective

The pharmaceutical companies of Pakistan process the active ingredients through exchange of technological knowledge and process activities between the manufacturing and R & D departments. The main process is handled by the manufacturing department and is supported by R & D in every step and especially the point where the improvements are required. The transformation process is considered as an interdependent with rigorous to and fro activities

between R&D and manufacturing departments in a close loop as suggested by Popaitoon and Siengthai, 1998. The active ingredients are processed in a sequence and with inputs from different departments such as marketing, production units and user feedbacks (Cohen and Levinthal, 1990).

In this turbulent environment, the acquisition of new technology is vital for organizations especially pharmaceutical companies in which extensive R& D efforts focus on medicines against different emerging diseases. Although there are advancements in the pharmaceutical technology yet the manufacturing processes are employee centered and their role is considered vital. The employment of manpower as per their potential is therefore important for pharmaceutical companies. Advancement in technology has led firms to follow new directions. Hence, employees are the key entities responsible for the transformation of the this technology into a useful product (Parra-Requena, *et al.,* 2013) (Tzokas, *et al.,* 1998).

The manufacturing process in pharmaceutical companies demands continuous assimilation of new technologies in order to transform into routine activities, however, old employees enriched in tacit domain in existing technologies often resist to adapt to new ones and desire, either to maintain status quo or advance in their specific domain. Therefore, they want to work in preview of their background experience. Employees maintain these desires whether they are employed in the field of their interest or not.

Behavioral theorists argue that employees' performance increases if they are allowed to opt their domain to work in (Parra-Requena, *et al.,* 2013). Researchers (Hart, *et al.,* 1998) argue the industrial approach about the success in the motto 'right person in the right job'. At the same time, it is recognized that employees feel comfortable if they are working in their favored domain (Hart, *et al.,* 1998), employees' actions are determined by their perceptions. In general, employees are tuned to work in routine activities and stick to these routine activities (Rafique, *et al.,* 1998) Therefore, employees with a predefined scope of work in knowledge processing activities behave accordingly.

Technologies in the industries have become an asset in this revolutionary environment and with continuous new advancements in technologies and firms expect from their employees to adapt to these changes. Employees with polished skills cope with these changes and upgrade their technological base with the new requirements; however, their desire to work in the opposite domains cannot be ruled out. The employees with good automated system experience may like to work in manual system and vice versa due to many reasons. Skilled employees may exert to go uphill to learn new techniques and work in the environment opposite to their domains. Thus, it is employer-employee equation that determines the new technologies to be transformed and processed effectively. The new technology is acquired through systematic approaches either through interaction patterns (Stock, *et al.,* 2001idiosyncratic learning or through a transformation process (Cohen and Levinthal, 1990).

The transformation process in pharmaceutical companies is not a unidirectional process rather a closed loop system and manufacturing and R&D departments as key actors in this transformation process. The active ingredients are processed through initial selection by R & D and manufacturing departments and information is shared in the transformation process at each incremental step till finished product. This is inferred that both these departments work in collaboration with each other and effective transformation is dependent on the competence level of each department. This means, they give inputs and use inputs as donors and recipients for each other and resultantly, competence level of these departments (manufacturing and R&D) has direct impact in the transformation process of active ingredients in pharmaceutical companies of Pakistan.

Conduct of study

This study aimed to explore two aspects in the technology transformation process in pharmaceutical industries in Pakistan. First, how the employees perceive and willingly adopt the systems irrespective in which system they are employed at the moment. Automated systems and manual systems were considered as their option to adopt as well as their background experience. Second, the competence level of the employees of two departments, manufacturing and R& D was evaluated in the transformation process. Data for this study was collected from employees of pharmaceutical companies of Pakistan. Specifically, the companies having manufacturing and R&D departments were focused for this study. Data was collected through questionnaire which was circulated using mail, e-mail, drop and pick by the authors. The questionnaire consisted of questions relating to the background experience of automated and manual systems employees and their willingness to work in these systems. Data was collected from about 35 pharmaceutical companies in Pakistan in manufacturing sectors with their local R&D.

Characteristics of Respondents

Data was collected from both genders with different age groups and type of qualifications. The respondents with different service lengths were included in the study. The data was collected form 586 respondents in this study. 384 males and 202 females participated in

this study. With regard to the age groups, maximum participation (173) came from age group of 26-30 years followed by the participation by the age group of 20-25 (165). 20 and 136 respondents from the age groups of 31-35 years and 36-40 years respectively participated in the study. 59 respondents came from the age group of 41-45 years and 13 respondents came from the age above 45 years.

Data was collected from respondents with different qualification levels. Graduates and subject specialist respondents consisted on majority of the representation with 130 and 257 respondents respectively. 50, 53 and 96 respondents came from respondents' with an education level of metric, undergraduate and master level respectively. Respondents with different service length of service participated in the study and majority came from middle bracket of service. 136, 140 and 125 responses came from 5-10, 11-15 and 16-20 years of service bracket. 99 and 56 respondents belonged to the service bracket of 21-25 and 26-30 years respectively. 30 respondents participated with over the service of 30 years. Characteristics of the sample are shown in **(Table 1).**

Table1: characteristics of sample		
Characteristic	Data	Total
Gender	Male	384
	Female	202
Age	20-25	165
	26-30	173
	31-35	20
	36-40	136
	40-45	59
	Above 45	13
Qualification	Matric	50
	Undergraduate	53
	Graduate	130
	Masters	96
	Subject Specialists	257
Length of Service	5-10 Years	136
	11-15 Years	140
	16-20 Years	125
	21-25 Years	99
	26-30 Years	56
	Above 30 Years	30

2. RESULTS

236 of the total employees (586) came with the Auto system experience and 350 employees belonged to Manual systems as their background experience. 260 employees opted to work in Auto systems environment and 326 employees showed willingness to work in Manual system environment.

About 44% of the total respondents (N=586) showed willingness to adopt auto systems and about 55% showed willingness to adopt manual systems. Regarding willingness to adopt auto systems, 44.2% belonged to category of employees having auto systems as their background experience, while 55.7% of the employees showed willingness to adopt auto systems with manual systems as their background experience.

Regarding willingness to adopt Manual systems, 37.1% belonged to category of employees having auto systems as their background experience, while 62.9% of the employees showed willingness to adopt Manual systems with manual systems as their background experience.

Table 2: Adoption of System * Back ground experience Cross Tabulation

		Background experience		Total
		AUTO	MANUAL	
Willingness To Adopt System	AUTO	115 44.2%	145 55.7%	260 44.4%
	MANUAL	121 37.1.%	205 62.9%	326 55.6%
Total		236	350	586

(Table. 3) shows the Odds values in different cases of auto and manual systems as their option to adopt and their existing background experience. The highest odds value (1.69) was observed for the adoption of manual system with manual system as their background experience. The odds value (1.26) was observed for the adoption of Auto system with manual system as their background experience. The odds values (.79) for the employees with adoption of auto systems with the auto systems as their background experience were observed. However, odds value (.59) with manual adoption with auto background experience was observed in employees in manufacturing and R&D departments of pharmaceutical companies of Pakistan. **(Table.3)** and **(Fig. 2)** show the odds of the employees with different combinations.

Table 3 : Odds of employees with Auto / Manual system Adoption		
Odds(for Auto adoption with Auto system as background experience)	.442/.557	.79
Odds(for Auto Adoption with Manual system as background experience)	.557/.442	1.26
Odds(for Manual Adoption with Auto system as background experience)	.371/.629	.59
Odds(for Manual Adoption with Manual system as background experience)	.629/.371	1.69

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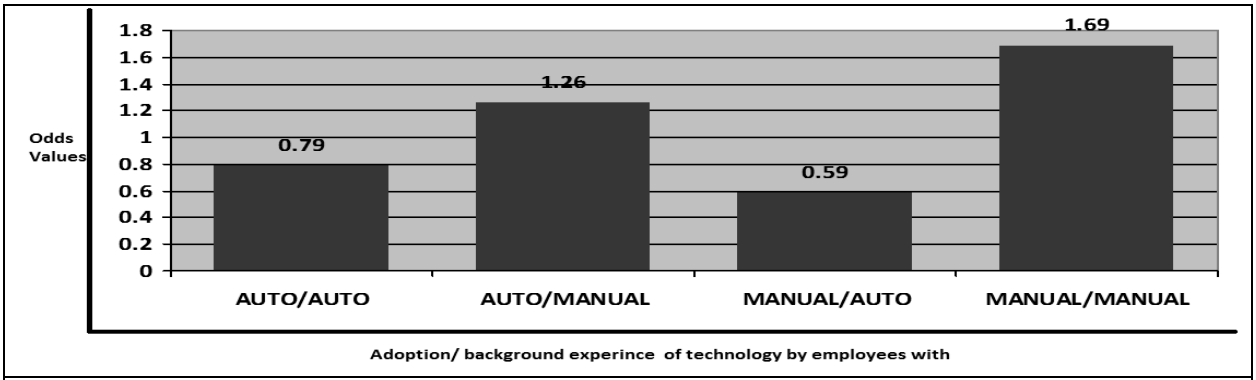

Fig. 2: Odds values of adoption of technology by employees

Highest odds ratio (2.14) was observed for the adoption of auto system with manual background as compared to the manual adoption with auto background experience. This means that for the employees with manual background experience and adopting auto system, the odds for them were about the 2.14 times the odds from the group with auto background and adopting manual systems.

Odds ratio (.47) was observed for the adoption of auto system with auto background as compared to the manual adoption with manual background experience. Odds ratio (.47) was observed for the adoption of manual system with auto background as compared to the auto adoption with manual background experience. Odds ratio (2.1) was observed for the adoption of manual system with manual background as compared to the auto adoption with auto background experience. Odds ratios are shown in Table 4 and Fig. 3.

Table 4 : Odds ratios of employees with Auto and Manual systems' adoption

Odds ratio(Auto adoption with Auto system as background experience/ Manual adoption, Manual background)	.79/1.69	.47
Odds ratio (Manual adoption, Manual background/ Auto adoption, Auto background)	1.69/.79	2.1
Odds ratio (Auto adoption, Manual background /Manual adoption, Auto background)	1.26/.59	2.14
Odds ratio (Manual adoption, Auto background/ Auto adoption, Manual background)	.59/1.26	.47

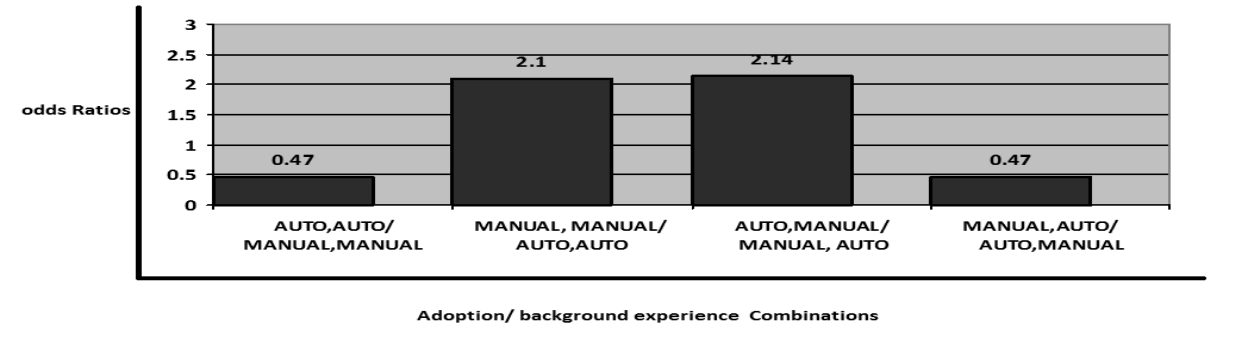

Fig. 3: Odds ratios of Adoption/ background experience

The process of transformation of the technology to the end product was analyzed based on the competence level of employees from both the departments (R&D and manufacturing). It was revealed that with high competence of recipients and donors, the high level of transformation was also observed. High transformation was also observed even with moderate competence level of donor but with high competence level of recipients. However, moderate level of transformation was observed in case of medium competence level of recipients with high and medium level of donors. Moderate level of transformation was observed in case of low competence level of donors but with high competence level of recipients. Low transformation was observed in case of low competence level in donors and moderate competence level in recipients. Confusion in transformation was observed in case the competence level of recipients is low and donors' competence level is either medium or high. No transformation is carried out incase both donors and recipients are at low level of the competence. **(Table 4)** shows the donor -recipient transformation process based on their competence level

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Table 4: Transformation of technology based on competence level of recipients and donors

	COMPETENCE LEVEL OF RECIPIENTS		
COMPETENCE LEVEL OF DONORS	HIGH	MODERATE	LOW
HIGH	Very High transformation	Moderate transformation	Low transformation
MODERATE	Very High transformation	Moderate transformation	Low transformation
LOW	Moderate transformation	Low transformation	Very Low transformation

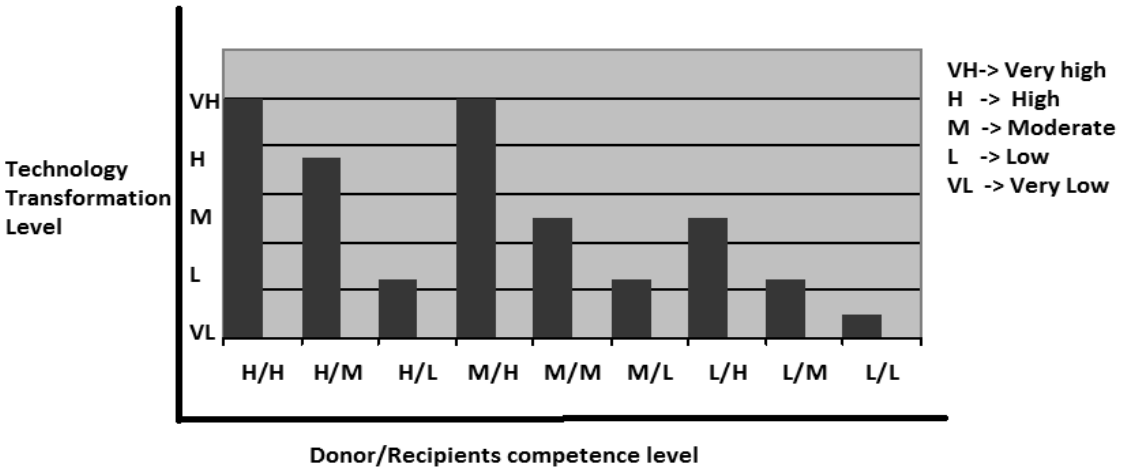

Fig. 4: Technology transformation level based on competence level of donors/recipients

3. DISCUSSION AND ANALYSIS OF RESULTS

Though the Pharmaceutical companies of Pakistan are fulfilling national needs through the local resources, these are dependent on foreign countries regarding active ingredients. The transformation of this acquired technology is dependent on the hard and soft infrastructure in the form of employees. Most of the human capital has the experience on manual systems and results reveal that they want to maintain their status quo, however, there is tremendous increment in the technological aspects and technology transformation becomes a complicated phenomenon. In this scenario, the willingness of employees to work in the automated system even becomes more important. The employees working in manual systems and automated systems with background experience in either system directly impacts the transformation process. The results of this study reveal that employees having experience in one domain are working in the opposite domain. The employees with background experience in manual system are working in the automated systems but have the willingness to adopt manual systems and vice versa. Results show that majority of the employees are willing to adopt the automated systems irrespective of their past experience (background experience). Employees need to be given opportunities to adopt the systems as their own choice for effective transformation of new technologies. Transformation of new technologies is heavily dependent on the employees and their active involvement in the knowledge process activities in pharmaceutical companies is vital.

Transformation of process is close loop process where the knowledge about the technology flows to and fro between departments and takes a final shape in the form of end product. In pharmaceutical companies of Pakistan, the knowledge about the new active ingredients is processed extensively between manufacturing and R&D departments. The new active ingredients need equally good knowledge on both sides to convert into the final product. The results reveal that the competence level of both departments is equally important in processing the new ingredients into final product. However, the recipients' competence level is more important as compared to the donors' competence level. In pharmaceutical companies of Pakistan, the R&D and manufacturing departments overlap in their role as donors and recipients. The results of this study about the competence level of both donor and recipient are aligned with the study on transformation of new technological knowledge into routine activities.

Overall, there is a mismatch between the employment of the human capital and their strong professional knowledge domain, whereas, the results reveal that competence level of donors and recipients must be high for effective transformation of technology. There is another aspect highlighted in the study that the employees are willing to adopt the systems contrast to

the existing employment. This may lead to less effective transformation and wastage of resources and time and employees may leave the companies thus, losing very valuable employees by the company. The suitable employment of employees as per their potential may foster the transformation process.

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