

Conceptualization of the Absorptive Capability Paradox in Technology Transfer Projects: A Study of the Ghanaian Construction Industry

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Abstract

Technology transfer projects within the construction industry transcends cross-national, -industrial sector and/ or business-to-business interfaces to transfer knowledge and technical capacity to enhance a recipient's capabilities. These capabilities encapsulate both new forms of knowledge (soft technology), and/ or skills and tools (hard technology) which drive business efficiency gains and concomitant productivity/ profitability enhancements. In the developing world, technologically advanced construction organizations from developed nations often initiate and steer the technology transfer process when working with developing world partners. Maximizing the opportunity presented depends upon the recipient's 'absorptive capacity' and hitherto scant research has been conducted in this novel area of construction science. This paper therefore seeks to clarify the enablers of absorptive capability in Ghanaian construction technology transfer projects. Using a quantitative analytical approach, theoretical hypotheses generated were tested on empirical data gathered from technology transfer projects. Results reveal that a significant relationship exists between the dependent variable (absorptive capacity) and independent variables (employee capability; knowledge sharing; working culture; research and development (R&D) capability; and communication capability). The findings will provide guidance for construction contractors in developing countries who seek to improve their technical knowledge and capability.

Keywords: absorptive capability; concepts; enablers; Ghana; technology transfer

1. Introduction

Technology transfer is the movement of knowledge and technology from one individual or firm to another and presents an important opportunity for contractors within developing countries to grow their intellectual and technological capability (Inkpen and Dinur, 1998; Gibson and Smilor, 1991; Devine *et al.*, 1987). This knowledge transfer can transform and complement current technologies to create and sustain higher levels of performance and profitability - essential to both infrastructure and consequently, national development (Sexton *et al.*, 1999; Nonaka and Takeuchi, 1995; Kogut and Zander, 1992). Importing innovative knowledge and technology is vital for augmenting indigenous technology but maximizing upon the opportunity presented depends upon the recipient's *absorptive capacity* (Sanusi, 2008). Absorptive capacity can be defined as a measurement of an organization's cognitive ability to learn external knowledge, identify new technological opportunities and integrate new information/ knowledge into the firms' processes and routines (Lane *et al.*, 2001; Lichtenthaler, 2009; Yeoh, 2009; Easterby-Smith *et al.*, 2008; Todorova and Durisin, 2007). Absorptive capacity is also dependent upon the recipient firm's level of prior related knowledge which includes: basic skills; a shared language; a positive attitude towards learning; relevant prior experience; and contemporary knowledge of the external economic climate (cited in Sazali, 2009; Cohen and Levinthal, 1990; Szulanski, 1996; 2003). According to Fransman (1984, pp. 10) these capabilities involve:

"... the search for available alternative technologies and the selection of the most appropriate technology; the mastering of technology, that is, its successful use in the transforming of inputs into outputs; the adaptation of the technology in order to specific production condition; the further development of the technology as the result of minor innovations; the institutionalized search for more important innovations with the development of R&D facilities; the conducting of basic research."

Theoretically, the concept of absorptive capacity is located between the fields of organizational learning (Huber, 1991; Kim, 1998), knowledge management (Chiva and Joaquin, 2005; Oshri *et al.*, 2006) and dynamic capabilities (Mowery *et al.*, 1996). Although absorptive capacity can relate to the ability of individuals or countries, past research suggests that it is an organizational construct (Minbaeva *et al.*, 2003; Mowery and Oxley, 1995). Weakness in the capacity and capability of construction contractors within the developing world have been widely reported (Kirmani, 1988; Serpell and

Ferrada, 2007). For example, many developing and newly industrialized countries lack the technical and management capabilities to undertake large or complex infrastructure projects (Waroonkun and Steward, 2008). To overcome these problems, technology transfer programs in public sector projects have been adopted through the contract's contractual terms and conditions with foreign contractors (Abbott, 1985). Many indigenous construction enterprises adopt technology from abroad and make little use of regional technology (Van Egmond *et al.*, 2003; Waroonkun *et al.*, 2005). Hence, contractors become dependent upon developed world interventions. Upon contract completion, it is anticipated that a substantial degree of technology will have been imparted by foreign to regional contractors who then assume a principal role in undertaking similar 'future' projects (Ming and Xing, 1999; Wie, 2005). However, each project (and participants within the project team) is bespoke and so *success* varies dependent upon *employee capability; knowledge sharing; working culture; research and development (R&D) capability; and communication capability* (Gorschek *et al.*, 2006). In addition to these specific issues, contractors within developing countries also experience similar issues found in developed countries (Abu-Hassan *et al.*, 2011). For example, a small number of large companies, often foreign-owned, predominate the market share and control price (Kirmani, 1988; Van Egmond *et al.*, 2008; Kumaraswamy, 2006; Sexton and Barrett, 2004; Ling *et al.*, 2009). Although research has been undertaken to identify important factors that impact upon an organization's absorptive capability (Rezaei-Zadeh and Darwish, 2016), consensus has not been reached on what the most critical factors that affect technology transfer performance are (Kumar *et al.*, 2015). Therefore, to address this knowledge gap, this research aims to understand the relationship that exists between the various factors of absorptive capability and the development of absorptive capacity of the indigenous Ghanaian construction companies. Objectives of the research are to provide clear guidance and instruction for contractors within developing countries who seek to improve their technology transfer rate and concomitant performance and profitability.

1.1 Technological Capabilities and Absorptive Capacity

Technological capability encapsulates the degree with which an organization can transfer skills, technical knowledge, machinery and other capital equipment from one business/ organizational entity to another (Wei, 2005; Cohen, 2004). Within developing countries, virtually all advanced technologies are imported from developed industrial nations via international

technology transfer projects which enable local firms to absorb these technologies within their own businesses (Driffield *et al.*, 2016). However, several researchers believe that these projects are complex phenomena that require time to develop (Rosenberg and Frischtak, 1985; Perlmutter and Sagafi-Nejad, 1981; Contractor and Sagafi-Nejad, 1981; Simon, 1991; Stobaugh and Wells, 1984; Agmon and Von Glinow, 1991). For example, Rosenkopf and Nerkar, 2001 argue that prior experiences facilitate knowledge absorption by defining the locus of knowledge search yet, earlier experiences restrict a firm's search activities to familiar and proximate areas (Helfat, 1994; Stuart and Podolny, 1996). Firms tend to recognize external knowledge that is close to their existing knowledge base and ignore other important knowledge sources (Cohen and Levinthal, 1990). Therefore, organizations must not only recognize the value of new knowledge but also have the organizational capability to integrate and utilize such (Pennings and Harianto, 1992; Eisenhardt and Martin, 2000; Grant, 1996).

The ability to absorb new technology is known as *absorptive capacity* and this concept has been defined, used and enhanced in various studies. For example, Zahra and George (2002) conceptualized absorptive capacity as “...a set of organizational routines and processes by which firms acquire, assimilate, transform, and exploit knowledge to produce a dynamic organizational capability.” The authors argue that “...firms can acquire and assimilate knowledge but might not have the capability to transform and exploit the knowledge for profit generation” and label the first two dimensions as absorptive capacity and the latter two dimensions as realized absorptive capacity. Todorova and Durisin (2007) added that absorptive capacity must also have the flexibility to operate within rapidly changing environments. Whilst Barney (1991) proffered that absorptive capacity requires a higher-order competence that consists of different individual capabilities building on each other to yield maximum competitive advantage (*ibid*). Daghfous (2004) stated that the knowledge acquisition process consists of transmission and absorption, culminating in a behavioral change by the recipient. They considered lack of absorptive capacity in the recipient as friction, which slows or prevents technology transfer.

In contrast to nonspecific input units (i.e. absorptive capacity), *organizational capabilities* represent productive and explicitly firm-specific skills to use resources (Grant, 1991). Amit and Schoemaker (1993) state that organizational capabilities “refer to a firm's capacity to deploy resources, usually in combination, using organizational processes, to effect a desired

end.” Whilst Grant (1991) argues that: “*A capability is, in essence, a routine, or a number of interacting routines.*” Traditionally, these routines are seen as the outcome of intentional design such as *performance programs* (March and Simon, 1958) and/ or *standard operating procedures* (Cyert and March, 1963). Contrary to this traditional view, other researchers such as Nelson and Winter (1982) see routines as socially constructed and collective recurrent programs of action that are the outcome of complex evolutionary processes. Accordingly, they are viewed as distinct behavioral patterns, which are complex in nature and involve both formal and informal processes (Dosi *et al.*, (2000). This perspective has been modified by more recent research which postulates that routines are complex social practices (Nicolini *et al.*, 2003; Schultze and Orlikowski, 2004; Gherardi, 2006). This recent paradigm shift provides interesting insights into the concept of absorptive capacity and especially into the understanding of absorption practices within organizations (Bourdieu, 1990; Schatzki *et al.*, 2001; Whittington, 2006). Following this perspective, firms can be seen as entities that possess heterogeneous absorptive capabilities as a function of their absorption practices.

1.2 Attributes for Absorptive Capabilities

Previous studies reveal that a low degree of a recipient’s absorptive capacity impedes both intra and inter-firm knowledge transfer (Cohen and Levinthal, 1990; Gupta and Govindarajan, 2000; Lane *et al.*, 2001). This capacity in turn is dependent upon a variety of attributes or factors that determine the performance of technology transfer activity. For example, research carried out by United Nations (2005) found that a major impediment to technology transfer was a lack of sufficiently skilled labour to assimilate and adapt new knowledge to local conditions. Others, such as Mohamed *et al.* (2009) indicate that knowledge sharing, working culture, R&D capability and communication capability all had an effect on technology transfer performance within an organization. Each of these attributes are now discussed in some further detail.

- *Employee capability* - According to Monappa (2005), employees are the key to building a world-class organization while Hong (1994) adds that employees are a front-line resource in acquiring and integrating new technology during the technology transfer. Therefore, an employee’s ability, educational background and acquired job related skills represent

critical prior knowledge needed within organizations (Cohen and Levinthal, 1990).

- *Knowledge sharing* - Knowledge is the lifeblood of an organization and must be effectively shared and communicated (Nonaka and Takeuchi, 1995). Van den Hooff and Van Weenen (2004) state that knowledge sharing is a process whereby individuals exchange their intellectual capital and collectively create new knowledge. Kim and Lee (2006) defined knowledge sharing capability as the ability of employees to share their work-related experience, expertise, know-how and contextual information with other employees within or across teams or work units. According to Sung and Gibson (2000) and Li-Hua (2004), technology transfer successfully occurs when knowledge and technology are shared and transferred across personal, department or organizational linkages; however, the knowledge must also be well accepted and understood by users.
- *Working culture* - Working culture plays a significant role in influencing members of an organization in terms of their commitment, loyalty and development of absorption capability traits and attributes (Ungku *et al.*, 2005). Working culture includes the practice, beliefs, assumptions, principles, legends and norms that affect how a person thinks, makes decisions and carry out tasks within an organization (Zuliana and Khalil, 2008). Culture represents a core set of values governing the attitudes that employees adopt towards change and their approaches to the introduction of something new (Ang and Massingham, 2007). It dominates how employees interact and how decisions are made (Simonin, 2004). Extant literature reveals that a high degree of organization performance is related to an organization, which has a strong working culture (Kotter and Heskett, 1992; Denison and Mishra, 1995).
- *R&D capability* Research and development involves the creative work undertaken on a systematic basis and seeks to increase an organization's stock of knowledge as a first step towards devising new innovative applications (OECD, 2008). Research into the impact of R&D capability upon organizational performance has been extensively documented. For example, Johansson and Loof (2008) found that investment in R&D capability is associated with the firm's economic performance (both productivity and profitability). Similarly, Chinho *et al.* (2011) concluded

that different levels of an organization's R&D capability enables decision makers greater flexibility to choose an appropriate commercialization strategy.

- *Communication Capability* - Communication capability is the foundation for successful human interaction regardless of the setting in which it occurs (Marques, 2010). Communication is defined by Narimah and Saodah (2002) as the sharing of information between two or more individuals or groups to achieve mutual understanding. Whilst Abdullah and Ainon (2002) proffer that communication transfers or delivers messages either by speech, actions, writings or images from the sender to the receiver. Staples (2001) reports that many managers have taken several initiatives to increase communication capability amongst their employees such as encouraging their employees to participate in courses and workshops that will increase and improve their interaction capability.

From the literature, it is appropriate to hypothesize that: Hypothesis 1; there exists a significant key relationship between absorptive capability in the Ghanaian construction industry and: (H1a) employee capability; (H1b) knowledge sharing; (H1c) working culture; (H1d); research and development (R&D) capability; and (H1e) communication capability.

2. Methodology

This research is motivated by a positivist paradigm, which suggests that knowledge can be discovered in measurable terms (Saunders *et al.*, 2012). This requires that all attributes are well-defined and measured using established statistical measurements in order to gain empirical knowledge about the relationship between the constructs. A population of 120 key respondents within the Ghanaian construction sector who were identified as participating in technology transfer programs. The selection criteria adopted was as follows: local firm involvement; technology acquisition objective explicitly or implicitly expressed by clients; and projects completed recently or currently under construction. The data set for this study was collated through self-designed and administered questionnaire that was posted and emailed to the population respondents.

Out of the 120 questionnaires distributed, 94 were completed and returned representing a response a high rate of 78%; this high response rate was attributed to follow up telephone calls made to participants within the selected population. The questionnaire contained closed ended questions which address the hypotheses formulated in the study and was divided into two parts to collect information on: demographic profile; and the relationship between absorptive capability and the attributes of technology absorption capability. A five-point Likert item scale was used to measure variables for the research constructs (Klaus, 2014). The scale ranged from ‘strongly disagree’ to ‘strongly agree’ and was coded 1 to 5 respectively. Quantitative data analysis was carried out by using SPSS for Windows and statistical techniques, such as, descriptive analysis, mean score ranking and chi-square test of significance were employed. To supplement the empirical results, several additional interviews were conducted with local professionals to verify the issues identified in the literature and explore new areas emerging from the research.

3. Results and Discussion

The results of the study are divided into two dichotomous groupings. First, the demographic profile of the Ghanaian construction sector and its associated professionals participating in technology transfer programs are defined. Second, the aforementioned hypothesis was thoroughly tested and the results discussed. The types of construction organization considered in this study were enterprises/ sole proprietorship, private limited liability, and partnerships/joint venture. As presented in Table 1, the majority of respondents (57.4 percent) were operating as private limited liability firms (PLF), whilst 28.7 percent were enterprises/ sole proprietorship and 13.8 percent were partnerships/ joint venture.

Table 1. Firm Status

Firms Status		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Enterprise/Sole proprietorship	27	28.7	28.7	28.7
	Private Limited Company	54	57.4	57.4	86.2
	Partnership/Joint Venture	13	13.8	13.8	100.0
Total		94	100.0	100.0	

Source: Researcher's Survey (2015)

These statistics reveal that the construction industry in Ghana is largely private owned and emphasizes the perceived advantage of being a PLF (for example, financially separate from personal equity liabilities) (Cassar, 2004). However, Storey (1994) and Cassar (2004) argue that the limited liability gain is fictional in reality because the government is the largest employer and operates with public procurement regulations that do not recognize limited liability business entities. The relatively high proportion of sole proprietorships reflects Ghana's localised market in which personal attention is valued by customers and business entrepreneurs relish the prestige of owning their business(es) and maximizing profitability.

Table 2. Years of Firm Existence

Years of Existence		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Under 10 years	31	33.0	33.0	33.0
	10-20 years	14	14.9	14.9	47.9
	21-30 years	35	37.2	37.2	85.1
	Over 30 years	14	14.9	14.9	100.0
Total		94	100.0	100.0	

Source: Researcher's Survey (2015)

With regards to the age of the firm, Table 2 reveals that: 33.0 percent of the firms have been established for ≤ 10 years; 14.9 percent $>10 - \leq 20$ years; 37.2 percent $>21 - \leq 30$ years, and 14.9 percent > 30 years. These results provide assurances that the sample of firm have acquired good experience of the acquisition of knowledge in the technology transfer process. This assumption is supported by Stinchcombe (1965) who suggested that: older firms are more experienced and have learned more over time; are not susceptible to the liabilities of newness; and have the benefits of better performance. However, experience of employees within the organization is also an important attribute of absorptive capacity (refer to Table 3).

Table 3. Experience of Professional

Years of Experience	Frequency	Percent	Valid Percent	Cumulative Percent
Valid				
Less than 5 years	21	22.3	22.3	22.3
5-10 years	41	43.6	43.6	66.0
11-15 years	11	11.7	11.7	77.7
16-20 years	21	22.3	22.3	100.0
Total	94	100.0	100.0	

Source: Researcher's Survey (2015)

The analysis revealed that 22.3 percent of respondents have: < 5 years working experience; 43.6 percent >5- ≤10 years; 11.7 percent >11- ≤15 years; and 22.3 percent >16- ≤20 years. These results indicate that survey respondents have reasonable experience and a plausible conclusion therefore, is that respondents are engaged in the technology transfer process and should provide a balanced view of such activity in the Ghanaian construction sector.

Table 4 reveals that because all the factors affecting technology absorption capability of technology transfer projects have their mean values above the accepted population mean of 3.5, it can be concluded that they all necessary to the performance of Ghanaian construction firm as well as the economy as whole. The standard error associated with all the mean were relatively closer to zero suggesting that the sample chosen is an accurate reflection of the population. Finally, from the results, the analysis revealed that the standard deviations of a large majority of questions posed are less than 1.0 signaling that there is little variability in the data collected and consistency in agreement amongst respondents. However, it is important to draw attention to the variable *Research and Development (R&D) capability*, which had a standard deviation > 1.001 suggesting that there might be differences to how this variable was interpreted by respondents. Thus, based on the descriptive statistics alone and using the mean score ranking, it could be confidently concluded that the independent variable (technology absorption factors) identified through literature and the interview reflects the views and perspective of the target respondents

Table 4. Descriptive Statistics of Technology Absorption in TT Projects

Technology Absorptive Capability	N	Mean	Standard Deviation	Standard Error
Attribute Factors				
Employee Capability	94	4.11	0.956	0.099
Knowledge Sharing	94	4.36	0.701	0.072
Working Culture	94	3.66	0.712	0.073
Research and Development(R&D) Capability	94	3.71	1.001	0.103
Communication Capability	94	4.36	0.620	0.064

Source: Researcher's Survey (2015)

The Chi-Square test conducted with regards to the hypothesis testing is presented in Table 5. Results reveal that a significant relationship exists between absorptive capability and employee capability ($X^2 = 71.745^d$, $X^2\alpha = 9.488$, $df = 4$, $p < 0.05$); knowledge sharing ($X^2 = 19.489^b$, $X^2\alpha = 5.991$, $df = 2$, $p < 0.05$); working culture ($X^2 = 51.957^a$, $X^2\alpha = 7.815$, $df = 3$, $p < 0.05$); research and development (R&D) capability ($X^2 = 9.574^a$, $X^2\alpha = 7.815$, $df = 3$, $p > 0.05$); and communication capability ($X^2 = 28.745^b$, $X^2\alpha = 5.991$, $df = 2$, $p < 0.05$). Since, $X^2_{cal} > X^2\alpha$ (5.991; 7.815; 9.488) at $p < 0.05$ in the cases of all the group independent variables (*employee capability; knowledge sharing; working culture; research and development (R&D) capability; and communication capability*), we reject the null hypothesis H_0 1 at a significance level of 0.05. Therefore, there exist a significance relationship between absorptive capability and employee capability; knowledge sharing; working culture; and communication capability.

Table 5. Test Statistics

Independent Variables	Chi-Square (X^2)	df	Asymp. Sig.	Decision
1. Employee Capability	71.745 ^d	4	0.000	Reject
2. Knowledge Sharing	19.489 ^b	2	0.000	Reject
3. Working Culture	51.957 ^a	3	0.000	Reject
4. Research and Development (R&D) Capability	9.574 ^a	3	0.023	Reject
5. Communication Capability	28.745 ^b	2	0.000	Reject

Source: Researcher's Survey (2015)

- a. 0 cells (.0%) have expected frequencies less than 5. The minimum expected cell frequency is 23.5.
- b. 0 cells (.0%) have expected frequencies less than 5. The minimum expected cell frequency is 31.3.
- c. 0 cells (.0%) have expected frequencies less than 5. The minimum expected cell frequency is 18.8.

Drawing on the above, the results confirm the existence of a significant relationship between absorptive capability and employee capability; knowledge sharing; working culture; research and development (R&D) capability; and communication capability. This finding concurs with the work of Ashekele and Matengu (2008) who found that relatively high levels of skill among employees provided impetus for a desire to be more competent. They also found that the willingness of employees to learn and adopt new technologies is an asset to firm's success. As articulated by Lall (2002) "*developing countries obtain industrial technologies mainly from the industrialized world, and their main technology problem is to master, adapt, and improve on the imported knowledge and equipment.*" In conclusion, knowledge sharing is a learning process where construction organizations continually interact with others in order to enhance the process of firm's technology development. Using such knowledge, a conceptual framework for technology absorptive capability attributes can be derived.

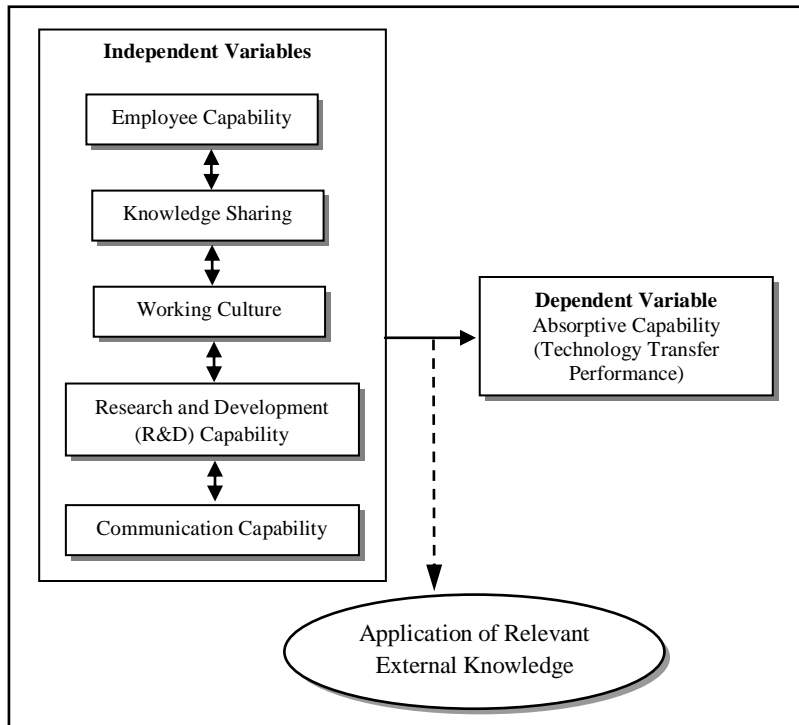


Figure 1. Conceptual Framework for Technology Absorptive Capability Attributes

The needs and dynamics of the construction industry within developing countries are different from that of developed countries. Due to on-going development of basic infrastructure stock, lessons may be learnt in the future planning and designing for more sustainable infrastructure achieved through commercially healthy and knowledgeable construction organizations and practitioners (Kumaraswamy, 2006). The model presented does shed some light upon mechanisms to improve absorptive capability and capacity but case study research is urgently needed to substantiate and quantify the level of organizations gains that could be made under various economic and operational circumstances.

The review of previous theoretical and empirical studies of absorptive capacity illustrates the necessity of advancing research in this study area. This paper contributes to the existing body of knowledge in terms of narrowing the research gap by examining the relationship between firms'

absorptive capability and technology transfer performance in the Ghanaian construction industry. The novelty of this paper is that it provides an holistic view of the critical factors of firms' absorptive capability that influence technology transfer. The conceptual framework developed is in line with existing theories in that it considers the factors of technology absorptive attributes and defines organizational dimensions in developing the competency of local professionals. Firms are required to pay high attention to absorptive capacity of technology transfer via construction projects from the initial stage of project implementation. Firms with high absorptive capacity of technology transfer at the early project stage produce a better technological capabilities among employees.

4. Conclusions

The survey results of this study revealed that employee capability, knowledge sharing, working culture, R&D capability and communication capability are significant ($p < 0.05$) and therefore have impact upon technology transfer performance. Thus, with proper attention to these vital factors, the rate of success in transferring the required technology can be increased demonstrably. The role and contribution of technology transfer in the development and upgrading the capability and capacity of local firms and professionals are shown in this study to be vital to national economic prosperity. The technology transfer program involving cooperation between transferor (foreign) and transferee (local) firms has greatly contributed to the development of local professionals. These specific variables identified under the attributes of absorptive capability contribute to successful knowledge absorption.

This study provides some limited but vital information on the process of technology transfer within Ghana and will prove useful to researchers and practitioners in other developing countries. However, the work has limitations and therefore, future studies of knowledge absorption practices particularly in different types of firms and industries could make important contributions to understanding concept of absorptive capability and indicate how to capture the complex construct empirically. The variables presented in this paper are first proxies that can be used for subsequent work. It can also offer valuable implications for practitioners, especially with regard to the implementation of innovative initiatives and the successful management of absorptive capacity. Perhaps the optimum means of achieving future

proposed work would be for higher educational institutions to collaborate more effectively with each other and with industry.

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