

An Evaluation of Enabling Factors for Technology Transfer in Tanzania Construction Industry

Justine Mselle

Property and Facilities Management, Ardhi University, Dar es Salaam, Tanzania

Abstract The purpose of this paper is to present findings of a study related to enabling factors for technology transfer in the Tanzania construction industry. A semi-structured interview was used to collect data from stakeholders who were contractors, consultancies, regulatory bodies and a research center. Interview questions were designed to collect data in the area of the level of technology in the construction industry and enabling factors for technology transfer in the construction industry. Findings from the study indicate that the level of technology in the Tanzania construction industry is very low and transfer of technology has not been successful due to lack of enabling factors for TT. Lack of these enabling factors has created impediments to TT process. The study was mainly affected by low rates of interviewee. The key enabling factors for TT obtained from interview with selected firms can be used for the entire construction industry.

Keywords Technology Transfer (TT), Construction Industry, Tanzania

1. Introduction

Traditionally, construction industry lags behind in terms of technology and skills compared to other industries, although the extent to which the industry lags behind differs considerably between developed and less developed countries [1]. Thus, due to the technological gap between developed and Less Developed Countries (LDC's) there has been a practice of transferring knowledge and skills from developed countries to less developed countries. The transfer usually takes different forms such as forming joint ventures between local and foreign firms, training experts in developed countries, creating policies for foreign firms to subcontract to local firms and any other forms of skills and technology transfer [2, 3]. Several studies by [4-6, 2] have argued on the importance of technology transfer and ways in which it can be transferred to the local construction industry. The above ways for transferring technology to the local construction industry have been used and showed success in Asian countries such as Singapore, Hong Kong, Malaysia and Sri-Lanka. These successes have been achieved due to collaborative efforts between government and other construction stakeholders in making sure that there are environment/infrastructures to facilitate the transfer, absorption and diffusion of new technology in these countries. Also, there are well established

infrastructures, policies and legal framework to ensure that there is effective transfer, absorption and diffusion of technology. This is evidenced by studies [5, 2] who reported that some Asian countries such as Singapore, South Korea, Malaysia and Sri Lanka have succeeded in TT to their construction industry due to well established TT infrastructures, policies and legal framework that have facilitated TT in these countries.

Tanzania, like many other developing countries lags behind in terms of construction technology and skills. Both [7, 8] acknowledged the low level in terms of technological capacity of Tanzania local firms. Findings from a study on knowledge creation and transfer in the Tanzania construction industry conducted by [9] indicated that many local construction firms had failed to compete with international firms during tendering for complex projects due to lack of technology and managerial skills. The findings by [7] indicated low absorption capacity as an impediment to technology transfer. Some researches by [7, 8] have been carried out on technology transfer to local firms but none has tried to address precisely what would be the enabling factors for technology transfer in Tanzania. Therefore, this research is intended to fill that gap in the existing literature on technology transfer in Tanzania. Also [7, 8] researches had focused generally on technology transfer to local firms, while this research focuses specifically to the construction industry. Specifically, this research is trying to address one research question on what are the enabling factors for technology transfer in the Tanzania construction industry.

* Corresponding author:

mselle@aru.ac.tz (Justine Mselle)

Published online at <http://journal.sapub.org/ijcem>

Copyright © 2014 Scientific & Academic Publishing. All Rights Reserved

2. Brief Literature of Existing Situation

2.1. Technological Development and TT in Construction Industry

Generally, technological development in the construction industry is low, however the situation in LDC's is worse compared to developed countries [6]. As a result, many of these countries depend on developed countries in terms of materials, technology, plants, equipment and human skills. It was reported by [4, 3, 6] that many of these LDC's rely on foreign contractors and consultants to execute complex projects that require complex technology, skills, equipment and management. Several studies by [5, 2, 4] indicate that countries which have established effective infrastructures, policies and framework for TT have benefited in transferring technology to their local construction industry. In the past couple of years, construction industry has been operating as a labor intensive industry with little application of technology. Studies by [10-12] established that construction industry lags behind other industries in application of technology. However, the ever increasing complexity of buildings and other infrastructures coupled with competition in the industry in past few decades has stimulated the industry to seek and adopt new technology to overcome the challenges associated with these buildings and other infrastructures. Firms are increasingly focusing on the area of design like application of BIM technology, an area of construction such as prefabrication which has hugely increased efficiency. Studies by [11,12] pointed out that a transfer of technological knowledge such as RFID, ICT, barcode and lean construction which traditionally were applied in other industries such as aerospace and car making industries continue to advance at an increasingly rapid rate.

2.2. Absorption and Diffusion of Technology

There is a general consensus that there is no true transfer of technology unless the technology is absorbed and diffuses to the recipient organization or nation. Studies conducted by [13-15] indicate that the degree of absorption and diffusion of technology depends largely on the level of knowledge and other supporting infrastructures available to a recipient. Similar findings by [16-18] indicated that absorption capacity differs from one organization to another and from one country to another. Thus, it is important for organizations or countries to interact one another to exchange technological knowledge. Nevertheless, the transfer or exchange of technological knowledge between organizations or countries will become effective only if there are skilled labors and other supportive infrastructures to absorb a transferred technology.

Furthermore, studies by [13, 16] specify that the size or capacity of a firm affects its ability to transfer and apply new technology. They hinted that many small firms work on survival base and technology transfer is not their priority and therefore they recommended the establishment of motivation policy that could facilitate absorption of technology by small

firms. Many of these small firms suffer shortage of skills and infrastructures that support absorption of new technology. Thus, it calls for efforts from stakeholders, including government to put policies and infrastructures that can help to build capacity of small firms so that they can improve their skills and capacity to absorb new technological knowledge.

3. Research Methods

Qualitative data were gathered from a semi-structured interview due to its flexibility. Interview questions comprised of broad questions that allowed respondents to provide an in-depth description of the situation and were constructed by the researcher after a detailed literature review around the subject area. They covered a number of issues such as the level of construction technology, barriers to technology transfer and optimum conditions for technology transfer. They were administered by a researcher and each took between 50 to 75 minutes. A purposive sampling of experienced Architects, Quantity Surveyors and Engineers was used to represent other stakeholders in a construction industry. Experienced professionals were selected due to the fact that they have witnessed a huge transformation of the industry compared to less experienced professionals. The number of respondents interviewed was thirteen (13) consisting of professionals from consulting firms, contractors, CRB and Building Research Unit (BRU).

Analysis of collected data was through a qualitative technique by coding together the similar themes from different respondents who were interviewed.

4. Research Findings and Discussion

4.1. Levels of Technology in Tanzania Construction Industry

The findings collected from all respondents reveal that, there is a uniform consensus among all interviewees that the level of technology in the Tanzania construction industry is low and very low as shown in Table 1.

Table 1 indicates a transcribed interview coded after themes, issues and concepts were identified. The transcripts generated from the respondents were coded with (QS01 – QS07, ENG01 – ENG04 and ARCH01 – ARCH02 to indicate Quantity Surveyors, Engineers and Architects interviewed respectively). The main concepts and themes were identified and indicated by line number where the idea was drawn. For example 23 in a column “very low” indicates that the number was drawn from QS07 code.

Basing on analysis, none of respondent pointed out that the level of technology in the Tanzania construction industry is average. This reflects the low capacity and capability of local construction firms in competing with foreign contractors and consultants. Low competitive capacity of local construction firms is evidenced by their share in a market as reported by [19] that market share for local firms is

only 20 percent leaving 80 percent of market share value to foreign construction firms.

Table 1. Summary of general information on level of technology in construction industry

Code Reference	Need for TT		Level of Technology in the construction industry	
	Yes	NO	Very Low	Low
QS01	2		19	
QS02	2			18
QS03	2		17	
QS04	2		15	
QS05	2			21
QS06	2			15
QS07	2		23	
ENG01	2		16	
ENG02	2			10
ENG03	2			22
ENG04	2		9	
ARCH01	2		26	
ARCH02	2			13
Total	13	0	7	6

Low technological capacity is contributed by erratic and a small volume of work in a market. Erratic work in the industry makes it difficult for firms to invest in technology due to lack of funds as well as fearing technology to be idle. As a result, these firms rotate in a vicious circle of “*no technology, no work opportunity and no work opportunity no investment in technology*”. For example, the amount of spending in Tanzania construction recorded by [19] in 2009 was around USD 2 billion; this is small for the whole industry, although some data may have not been recorded due to the informal nature of the industry.

4.2. Optimal Conditions Required for Effective TT in Tanzania Construction Industry

Findings from the interview indicated that very little or no technology transfer has been done due to lack of formal arrangement of TT in the construction industry. Whenever little transfer happened, it was accidental because no formal arrangement had been put in place whether in government or private funded projects. These results contrast with [5] and [2] views that, countries such as Singapore, Malaysia and Sri Lanka have established formal arrangement for technology transfer in the construction industry, hence succeeded in TT to their construction industry. Their success was possible due to the fact that there was a requirement for all foreign firms to partner with local firms when executing projects in these countries. Also, they established preferential arrangements for foreign firms which entered into a joint venture (JV) with local firms or those which sub-contracted part of the work to local firms. For Tanzania, mandatory joint venture and sub-contracting may face challenges due to prevailing low capacity and capability of Tanzania local firms in terms of finance, technology and managerial skills.

Furthermore, findings from the interview indicated that, there are barriers for TT in Tanzania construction, including lack of formal arrangement, lack or poor infrastructures, lack of funds, poor capacity of local firms and low absorption capacity. These barriers need to be addressed so that effective technology transfer can be realized. In order to address the barriers, establishment of enabling factors for effective technology transfer is required. Analysis of the findings indicates that there are six enabling factors required for effective TT in Tanzania construction industry. Table 2 below summarize 6 main enabling factors required to facilitate TT in the construction industry. Data were coded from the interview transcripts with CR in a table indicating the coding reference.

Table 2. Summary of Enabling Factors for Technology Transfer

CR	Coding category					
	FATT	CBLF	PBIRC	EITT	ERC	ETTF
QS01	33/36/57/74	-	128	121/129	56/87	100
QS02	77/86/126	49	141			52
QS03	24/42/44	125	83	41/126	57	87
QS04	42/49	118	96/137	103/123/139	86-87	101
QS05	53/132-133	57	82		74-75	50
QS06	28/46/150	129	98	151	68/86	103
QS07	40	48/83	107/152-153	49-50/151	93	-
ENG01	28/35/37/39	60/72	84/86	50/117-118	57	-
ENG02	19/28/124	81	43/76		68	12-13/126
ENG03	39/42/50	51/58	65/110	87/109	72	
ENG04	13-14/25	65/78	98	31/76/97	47	32/96-97
ARCH01	187	-	-	89/133/182	94-95/121	-
ARCH02	10/49-50	03	96/149	25-26/155	62/84	-
Total	13	11	12	10	12	8

The coding categories indicated in the table above are FATT = Formal Arrangement for Technology Transfer, CBLF = Capacity Building for Local Firms, PBIRC= Partnership between Construction Industry and Research Centers, EITT=Establish or improvement of TT infrastructures, ERC=Establishment of Research Culture and ETTF=Establishment of Technology Transfer Fund.

4.3. Establishment of Formal Arrangement for TT

According to the interview, it was revealed by all 13 respondents that TT in the construction industry has not been successful due to the fact that there is no any formal arrangement for technology transfer (Table 2). Although [20] insisted on improvement of construction technology through enhanced research activities in construction industry by establishing research centers and TT, none has been established.

Respondents argued that the construction industry has not benefited from foreign firms working in Tanzania because there is no any requirement for foreign firms to transfer technology to local firms. They proposed that it is high time for a country to put a policy that would require foreign firms to partner or sub-contract part of their work to local firms and make sure they provide training to locals. The same was supported by [5] who reported that Indonesia had established a policy that requires foreign firms to work alongside with local firms that in turn have improved the technological capacity of Indonesia local firms.

4.4. Partnership between Industry and Research Centers or Universities

Of all 13 respondents interviewed, 12 respondents (i.e. 92%) pointed out that for effective TT, the linkage between the construction industry and research centers or universities need to be strengthened and there should be a direct linkage for exchange of knowledge (Table 2). Research centers and universities researching in a construction field are very important infrastructures for TT. In stressing a point, a respondent mentioned that;

..... *"I could say if the linkage is there it is very weak. We need to strengthen it to become very vibrant. When you have a strong link, the industry for example, may fund PhD research and parties may share the owning of the patent of the research"*.

With a similar view, [21] insisted a linkage between the industry and research centers or universities. In a country like Tanzania with small firms, the cost should be shared because firms cannot fund in-house research.

4.5. Capacity Building of Local Firms

Capacity of local firms in terms of skills, management and finance remain low, thus making it difficult for them to transfer new technology. Out of 13 people interviewed 11 (i.e.85 %) admitted that low technological base of local firms is mainly due to low capacity in skills, management and

finance (Table 2). The majority of firms are facing these problems due to erratic job in the industry, thus lack the resource to invest in human skills and technology as the assets of a firm. Due to poor investment in technology, many firms end up carrying out small jobs which are normally labor based owing to the fact that labor is much cheaper compared to technology. As a result, many firms end up in a vicious circle of poverty due to the fact that they cannot win large projects due to lack of technology and they cannot invest in technology due to lack of funds. To show how capacity building is important for TT, One respondent insisted that;

" Big projects, for example, need large investment in plant and equipment. If we address the problem of capacity, we will be able to address the problem of TT both soft and hard technologies".

The statement indicates that the capacity of local firms has great contribution to the level of technology in the Tanzania construction industry. The respondent also insisted on capacity building of local firms so as to ensure local firms are in a position to absorb a transferred technology thus improve their skills.

4.6. Establishment of Research Culture in Construction Industry

Globally, the construction industry lags behind in the application of new technology as reported by ([10, 22]. It is also universally agreed that construction industry lags behind in research and application of research findings compared to other industries such as pharmaceutical and aerospace. According to [23] the situation in Tanzania is even worse due to the fact that, research and application of research findings are low across all sectors, construction industry inclusive. The report by [23] also indicates that Tanzania spent about 0.35 percent of her GDP in research in 2005 and large proportion was spent on agriculture.

Out of the 13 people interviewed, 12 people (i.e. 92%) clearly pointed out that, construction industry lags behind in terms of research (Table 2). They insisted that very little research is done in the industry and it is done ad hoc without practical orientation, thus it becomes difficult for the research findings to disseminate technology in a construction industry. Respondents argued that, little research which is done is neither demand driven nor practically oriented, thus adds very little or nothing at all in terms of new technology. As a result, the morale for both researcher's and funders has declined. The finding is strongly supported by the following statement which was put forward by one respondent.

"The level of research is very low and is done blindly. The themes which we are doing are not palatable for the industry, thus no one is willing to fund such themes".

Several reasons were put forward by respondents on why there has been poor research culture in the Tanzania construction industry. The reasons include the fact that firms

cannot fund their own research because they are working to survive due to poor financial and skills capability. Another reason is that many firms are facing shortage of skills needed for research, thus not able to carry out research.

4.7. Establishment and Improvement of TT Infrastructures in the Construction Industry

As it was reported in section 2.2 of this paper, TT cannot be achieved unless a transferred technology is absorbed and diffused in a particular industry. However, absorption and diffusion of technology will only be achieved where there are established infrastructure that supports absorption and diffusion of technology. According to [13, 15] absorption capacity is influenced by the ability of a firm or a country to acquire, learn, absorb and make use of new resource or information, and this ability depends on available infrastructure to facilitate acquisition, learning or exchange of information among people and make the use of such information.

According to interview with respondents, 10 out of 13 respondents (i.e. 77%) argued that; there are very few infrastructures such as research centers and universities that can support TT in the construction industry (Table 2). Furthermore, they insisted that the few research centers available are poorly resourced in terms of research staff, laboratory equipment and funding for research. One respondent gave an example of the only research center available (Building Research Unit) and that the funding it receives is only enough for running the center and not for carrying out research. The finding from research shows that, while there are about twenty eight (28) agricultural centers, there is only one (1) research center for construction industry and about five (5) higher learning institutions in a field of construction. The importance of the construction technology transfer center was reported by [24] who argued that South Korea succeeded in TT due to the establishment of many of these centers, they have played important role in coordinating technology transfer.

4.8. Establish a Special Fund for TT Activities

Based on data collected from interviews, respondents suggested the establishment of a special fund for TT in the construction industry which will fund TT activities. Funds can be raised through mandatory contributions from stakeholders in form of TT development levy. Raised funds will be used for TT from inside and outside the country as well as funding researches which can be commercialized into construction technology, training of people, establishing construction Industry technology transfer center and establishing construction industry research centers.

Additionally, another respondent reported that there is an equivalent mandatory fund for developing vocational training in Tanzania. The fund is managed by the Vocational

Educational Training Authority (VETA) and it has trained many artisans including those working in the construction industry. Establishment of this fund is highly significant due to the fact that very little funding for research is provided by the government. According to [23], funding for research provided by Tanzania government was only 0.35 percent of the GDP and most of the fund was used for researches in agricultural sector. The fund may address the problem of shortage of researchers in a construction industry by providing scholarship to those interested in carrying out researches in a construction industry. In the long run, the fund will address the shortage of skills for research in the industry thus building technological capacity. However, large investment in research will only benefit individual firms if they build their absorption capacity which is currently weak as it was reported by several respondents.

5. Conclusions and Recommendations

Like any other LDC, Tanzania construction industry technological development is low. Empirical evidence collected from this research indicates that the level of technology in Tanzania construction industry is low and little efforts are made to transfer technology locally or internationally. Findings also identified poor infrastructures to support TT thus making technology transfer efforts not effective. Six enabling factors for TT in construction industry were identified. These factors include establishment of formal arrangement to transfer technology, improving partnership between construction industry and research centers, capacity building of local firms, building a research culture among professionals and establishment of a TT and research fund for construction industry.

Indeed, some of enabling factors identified such as establishment of research culture and partnerships between construction industry and research centers are within the control of firms and stakeholders while other factors such as improvement of infrastructures for TT, establishment of fund for TT and formal arrangement for TT need government policies and the establishment of a legal framework. Factors such as a formal arrangement for TT and capacity building of local construction firms may need some modification in Public procurement Act (PPA) of 2010 so that it can accommodate mandatory joint venture and sub-contracting part of the work to local firms. Another enabling factor such as capacity building needs collaborative efforts between firms and government to make sure that Public procurement Act creates a preferential arrangement to local firms so as to improve their capacity. Therefore, it is high time for the government to take a champion role in TT for the construction industry by addressing factors which require legal or policy framework.

REFERENCES

- [1] Tatum, C.B. (1989a) Managing for increased design and construction innovation. *Journal of Construction Engineering and Management*, Vol. 5 No 4, pp. 385-399.
- [2] Kumaraswamy, M. M. and Shrestha, G.B. (2002) Targeting technology exchange for faster organizational and industry development. *Journal of Building Research & Information*, Vol. 30 No 3, pp. 183-195.
- [3] Carrillo, P. (1996), Technology transfer on joint-venture projects in developing countries. *Journal of Construction Economics and Management*, Vol. 14, pp. 45-54.
- [4] Carrillo, P. (1994), Technology transfer: A survey of international construction companies. *Journal of Construction Management and Economics*, Vol. 12, pp. 45 – 52.
- [5] Devapriya, K. A. K and Ganesan, S. (2002) Technology transfer through subcontracting in developing countries. *Journal of Building Research and Information*, Vol. 30 No. 3, pp. 171-182.
- [6] Ofori, G. (1994) Construction industry development: the role of technology transfer. *Journal of Construction Management and Economics*, Vol. 12 No pp. 379-392.
- [7] Szog, A; Chaminade, C; Azatyan, R (2008) Building absorptive capacity in less developed countries: The case of Tanzania, Paper No. 2008/05, available at <http://www.circle.lu.se/publications> (Accessed: 09-10-2013).
- [8] Wangwe, S.M (1992). “*Building Indigenous Technological Capacity: A study of selected industries in Tanzania*” In: Stewart F.; Lall, S. and Wangwe, S.M. (eds.): *Alternative development strategies in Africa development*. London: Macmillan.
- [9] Eliufoo, H.K (2005). *Knowledge creation and transfer in construction organizations in Tanzania*. Doctorial thesis. Royal Institute of Technology (KTH), Sweden.
- [10] Egan, J. (1998) *Rethinking Construction*, A Report for construction task force on improving Quality and Efficiency of UK construction, construction sector unit of DTI, London.
- [11] Nourbakhsh, M; Zin, R.M; Irizzary, J; Zolfagharian, S; Gheisari, M (2012) Mobile application prototype for on site information management in construction industry. *Journal of Engineering, construction and architectural management*, Vol. 19 No.5, pp. 474-494.
- [12] Henderson, J. R and Ruiker, K. (2010) Technology implementation strategies for construction organizations, *Journal of Engineering, construction and architectural management*. Vol. 17 No.3, pp. 309-327.
- [13] Kamal, E. M. and Flanagan, R. (2012) Understanding Absorptive Capacity in Malaysian Small and Medium sized (SME) construction companies, *Journal of Engineering, Design and Technology*. Vol.10. No. 2, pp. 180-198.
- [14] Hasan, S. A; Othman, A; Mustafa, S; Ismail, H. H. and Wahab, W.N.Z. (2011) Development of absorption Capability attributes for Technology Transfer performance. A pilot Study in National Automotive Industry; *International management conference*. Universiti Sultan Zainel Abidin.
- [15] Omar, R; Takim, R and Nawawi, A.H (2011) The concept of absorptive capacity in Technology Transfer (TT) projects. *International conference on intelligent building and management*. Vol 5. Singapore.
- [16] Sexton, M., Barret, P. and Aouad, G. (2006) Motivating small companies to adopt new technology. *Journal of Building Research and Information*, Vol.34 No 1, pp. 11-22.
- [17] Niosi, J., Hanel, P. and Fiset, L. (1995) Technology transfer to the developing countries through the engineering firms: the Canadian experience. *Journal of World Development*, Vol. 23 No. 10, pp. 1815-1824.
- [18] Cohen, W. M., & Levinthal, D. A. (1989). Innovation and learning: The two faces of R&D. *The Economic Journal*. 99 (September) pp. 569-596.
- [19] The United Republic of Tanzania; Ministry of Finance & Economy (2010) *Economic condition of a nation in the Year 2009*. Dar es Salaam.
- [20] Construction industry policy (2003) Ministry of works, United Republic of Tanzania.
- [21] Agmon, T. & Von Glinow, M. (eds) (1991), *Technology transfer in international business*. Oxford: Oxford University Press.
- [22] Laborde, M. and Sarvido, V. (1994) Introducing new process technologies into construction companies. *Journal of construction Engineering and Management*, Vol. 120 No. 3.
- [23] Mugabe, J. (2009) *Knowledge and innovation for Africa development: priorities, policies and programmes*. Available at; <http://info.worldbank.org/etools/docs/library/250707/Knowledge%20and%20Innovation%20for%20Africas%20Dev.pdf>. (Accessed: 09-10-2013).
- [24] Kim, J. I. (2004) *A study on factors affecting technology transfer in Korean construction industry*. Doctoral thesis. University of Reading.