Impact of Stake Holders in Technology Design Life Cycle in Tanzania

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Abstract: Technology design lifecycle has anumber of aspects embedded on it, in this paper the stakeholder’s participation in technology development has been made a focal point aspect for effective technology acceptance in the market. There has been great effort in Tanzania for the development technology but with incomplete life cycle. Factor that are affecting the life cycle and the market acceptance pattern are not well understood. Stage gate model for technology development seem to show a sign that this failure can have a link with the stake holders’ participation. There has been a need of studying the relationship between stake holders’ participation in technology development and technology life cycle perfection. Structured interviews, questionnaires and observations in R&D organisation, staffs and stakeholders and activities were used to collect data from sources identified. Literatures on engineering design, technology development life cycle and various models for innovation were studied. At the later stage, the model was developed and tested. Factors that were included in the model was the participation of stake holder in processes such as need identification, technology validation process, these factors were found to affect market acceptance. It was noted that the developers of technology are not just the technologist but the whole team of stake holders for that particular technology. The stakeholders’ participation is vital for effective technology development.

Keywords: Innovation diffusion, Technology life cycle stakeholders

1. Introduction

The extent of understanding the product design life cycle has been a relative term and somehow subconsciously regarded in many R & D organisations in Tanzania and other Least Developed countries. On the other hand, the process of product development had been rigidly driven by the end user expectations instead of stakeholders’ expectations. Most of technology developing organisation have been characterised with failure to transfer technologies after prototype development (Dugushilu et al., 2010, URT, 2012, EU- SCAR, 2012, Koshuma, 2005).

Mganilwa and Sanga(2012) shows that there are number of phases that technology development need to go through for it to be successful, namely initiation, conceptualisation, design development, prototype validation and transfer facilitation. In his study on technology diffusion Sanga (2016)realised that most of researchorganisation in Tanzania do not use the stakeholder analysis knowledge in their product development. The whole concept of Public Private Partnership (PPP)(Mwamila and Temu, 2005), the formation of industrial parks and clusters and technical business environment is not simple as many of scholars would like to conclude.

There has been a main problem in involving stake holders in the process of technology development in the whole concept of technology use, spill over effect and industrial and business orbital infrastructure development(Ford et al., 2007, UK, 2013). On the other hand, the key player in technology development are thought to be engineers while others are left out(Etzkowitz, 2008). However, to the researcher, stake holders’ analysis is standing to be the driver of many technology design and innovation models.

The Main Objective of this research is to develop a model that will guide the technology developer in analysing and including acceptable numbers of stake holder in the technology design life cycle for sustainable technology diffusion

1) To identifyeffect of the composition of stake holders in the technology development cycle
2) To develop the model that accommodates stake holders in technology development
3) To validate the model on technology diffusion effect

2. Literature Review

In consideration of the word stake holder in this research it implicating goes beyond the individual entity as discussed by Thomas (1995) and other scholars.However, the project management gurus are among the first people to refine the definition of stake holder in the project to business perspective.A stakeholder in an organisation is any group or individual who can affect or is affected by the achievement of the organisation’s objectives (Freeman, 1984) cited by Sharp et al.(1999). According to (Whitley and UK, 1997) the definition of stake holders need to be more improved so as to include the factor of inter-organisational links in the value addition processes.

Singh (2010) findings in the study done in India shows that the stakeholder needs to have sufficient resources to develop the prototype into business case with sufficient cash output, through sales to customers that would allow it to be self-sufficient and grow.Instead of stopping at the prototype development level, the design process for innovation diffusion need to be expanded to include participation of all stakeholders’ variables in the whole design cycle. It includes business setup that incorporates incubation service provision (ITSBIC, 2008 ).

The growing activities related to stakeholder (Figure 0-1) analysis reflects the need of how the characteristics of stakeholders’ individuals, groups and organizations
influence decision-making processes. Stakeholder analysis can be used to generate knowledge about the relevant actors so as to understand their behaviour, intentions, interrelations, agendas, interests, and the influence or resources they have brought or could bring to bear on decision-making processes especially in R&D organisations (Brugha and Varvasovszky, 2000, Elias et al., 2002, Sanga and Mganilwa, 2012).

Stage gate model introduces by Cooper (2010) in Figure 0-3 pave a way to include stakeholders in the technology development processes, however in the stage the analysis was not give a deep discussion on the identification of stakeholders. However, understanding of the stages involved in the design cycle is a very important kick to the start of identification of stakeholders involved. The model shows that there is a need of considering the item listed in each stage blocks and identify stake holders.

**Figure 0-2: Conceptual frame-work for technology diffusion**

**Triple helix model**
A triple helix regime model (Figure 0-4) typically begins when a university, industry, and government enter into a reciprocal relationship with each other in which each attempt to enhance the performance of the other. Benefits realised in triple helix is creation of industrial park and incubation of industries, all these leads to enhancement of technology diffusion through the participation of critical stake holders (Etzkowitz, 2008, Malerba, 2005, Qing-dong, 2010).

**Figure 0-3: Cooper Stage Gate Model, Source: (Cooper R. G, 2016)**
3. Methodology

3.1 Study Area

The study was mostly conducted in the research and development organisation namely: Tanzania Technology Development Centre (TDTC), Tanzania Automotive Technology Centre (TATC), Tanzania Engineering and Manufacturing Design Organization (TEMDO), Centre For Agricultural Mechanization & Rural Technology (CAMARTEC), Small Industries Development Organization, (SIDO)- Technology Development Centres (TDC), Tanzania Industrial Research and Development Organization (TIRDO), Vocational Educational and Training Authority (VETA), URC Financial Institutions like Cooperative Rural Development Bank (CRDB), Tanzania Automotive Technology Centre - (TATC), National Microfinance Bank (NMB), Tanzania Investment Bank, (TIC)Microfinance. Some manufacturing companies also were studies, such as Mzinga Corporation, Intermech Engineering Limited, Siaz (COSTECH, 2013). A total of 116 technologies that were developed by R&D organisations were enlisted.

3.2 Identification of factors affecting the composition of stake holders

The identification of the factors affecting the effective composition of stake holders in the sustainable technology development were accomplished in two stages, the first stage was to identify factors as narrated in the literature review and the interview by the R&D organisations selected staffs. The stage gate model, the Ishikawa fish born Diagrams, and Vensim software (Vensim, 2003, Raasch et al., 2008) enabled the development of factors affecting the composition of stake holders’ identification. The second stage was the application of the regression analysis to develop coefficients for the factor’s composition of stake holders. In all the study, the technologies identified were the driving population of the study.

3.3 Development of model to accommodate participation of stakeholders in technology development

The model was developing by firstly grouping stakeholders for each stage and gates in the process of technology development and there after using regression tools to establish their macro coefficients (Rawlings et al., 1998, Snee, 1977, Xin and Xiao, 2009). The macro group analysis was done to establish mathematical relationship between the groups.

3.4 To validate the model on technology diffusion effect

The comparison was done on the prediction of the model of technology diffusion and the actual diffusion for selected technologies the main item under scrutiny was on stake holders’ participation in the technology development. The conceptual system dynamic model was developed in Figure 0-5

Figure 0-4: Triple helix triangulation model
Source: Farinha and Ferreira (2012)

Figure 0-2

Initial Screen
Stage 1
Gate 1
Preliminary Investigation
Stage 2
Gate 2
Detailed Investigation (Build Business Case)
Stage 3
Gate 3
Development
Gate 4
Stage 4
Post Development Review
Testing
Validation

Volume 7 Issue 11, November 2018
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4. Results and Discussion

4.1 General study on the impact of stakeholders in various stage of technology development

Studies done by Sanga and Mganilwa (2015b) showed that the composition of stake holders in each stage of technology development do differ. On finding the factor that shows the weight distribution along the cycles stages of implementing the project, that is from need identification to the acceptance of the product by into the market, Weighted Least square analysis of stages (Standardized) was used. The main assumption was that stages, stakeholders’ effect cannot be the same in types and their input effects to the product market diffusion. The analysis with the R square of 7, the significance level of 0.002 and the identified factors are listed in Figure 0-5 Stake Holders Conceptual Model.

![Stake Holders Conceptual Model](image)

4.2 Stake Holders Importance in Need Assessment

The stepwise linear regression analysis was done of variables in

Table 0-1, the model gave the significance value of F chance of 0.002 and the R² of 0.64.

<table>
<thead>
<tr>
<th>Stakeholders at the Initiation stage</th>
<th>Mean</th>
<th>Std. Deviation</th>
<th>N</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sales (Dependent Indicator)</td>
<td>14.823</td>
<td>1.62494</td>
<td>30</td>
</tr>
<tr>
<td>StakeinNeed User</td>
<td>2.6083</td>
<td>0.78423</td>
<td>30</td>
</tr>
<tr>
<td>StakeHolders Eng</td>
<td>2.0583</td>
<td>0.49863</td>
<td>30</td>
</tr>
<tr>
<td>StakeHolde Socia Eco</td>
<td>1.4417</td>
<td>0.34543</td>
<td>30</td>
</tr>
<tr>
<td>Stakeholder Financial</td>
<td>1.5</td>
<td>0.32827</td>
<td>30</td>
</tr>
<tr>
<td>Government Gurantess</td>
<td>1.4417</td>
<td>0.34543</td>
<td>30</td>
</tr>
<tr>
<td>Transferer Influence</td>
<td>1.5083</td>
<td>0.35649</td>
<td>30</td>
</tr>
</tbody>
</table>

\[ Y_i = 0.522x_1 + 0.433x_2 \] \hspace{1cm} \text{Equation 0-1}

Where: 

- \( x_1 \) = Government as a main stake holder in need assessment process
significance of the average annual sales of thirty technology, with economists were subjected to multilinear regressions against\Incubator, user, government, financials, manufacturer and\engineer/scientist contribution, economist effects, financier\power of technology sales per Unum; users, engineers,\incubators effect.\(R^2\) is 0.7 and significance of 0.001 the relation is developed in equation\(Y = 0.141x_1 + 0.077x_4 + 0.441x_3\) \[Equation 0-2\]
Where 
\(x_1\) = User input effect
\(x_4\) = Scientist Input Effect
\(x_3\) = Social economist input effect

4.3 The Stake Holders participation in processing the PDS

This is idea scanning, handling and screening, capability gap\seeks, vet partners and outsourced suppliers, inclusion of the\voice of customer, technical feasibility, building business\case, legal and IP Strategy. Buy IP or technology solution,\technology adoption or adaptation. Sell of technology rights\(\) (Cooper, 2010). In this stage the so called Social economic\stake holders included, economists, financial, marketing\specialist, antirealists and other regulatory bodies, mixed\with other experts is very important. Though the system\was not well established in most of research organisation there\were having some trend observed on these stages.

Out of five regressed stakeholders, three were appeared as\outstanding. With \(R^2\) 0f 0.5 and the hard environment of\data collection the author is convinced there is a very great\lesson in the relation that is observe in Equation 4-3
\[Y_2 = 0.141x_1 + 0.077x_4 + 0.441x_3\] \[Equation 0-2\]
Where 
\(x_1\) = User input effect
\(x_4\) = Scientist Input Effect
\(x_3\) = Social economist input effect

4.4 Analysis Stake Holders

Variable considered wherein conducting the design analysis;\sales per Unum as dependent variable, user contribution,\engineer/scientist contribution, economic effects, financier\effect, government effect transferrers and incubators effect.
Sample of 30 technologies were studies. With \(R^2\) is 0.7 and\significance of 0.001 the relation is developed in equation\Equation 4-3.

4.5 Prototyped development stake holders

Incubator, user, government, financials, manufacturer and\economists were subjected to multilinear regressions against\of the average annual sales of thirty technology, with\significance of 0.1, and \(R^2\) = 4 Using the linear regression the\Equation 0-3
has been developed
\[y_2 = 0.328x_{11} + 0.346x_{12} + 0.213x_{13} + 0.688x_{14} + 0.104x_{15} + 0.004x_{16}\] \[Equation 4-4\]
using stages weights displayed in

Figure 0-6. The model was run to study the sensitivity of stakeholders’ variables in various items considered as important for successful technology development. That is rational technology need development, design analysis, design optimisation, design validation, stakeholder’s technology acceptance and technology transfer.

4.9 Dynamic model running on key stages

On design process success index the prediction of technology a good design has shown a good trend since technology 1 to ten were highly sold (per Unum), example of the maize mill technology “1” or maize huller technology “4” and the rest followed had a good between stakeholder and technology market acceptance (Fig. 4-3 and Fig. 4-4)
4.10 Dynamic model sensitivity analysis

On running the sensitivity analysis as shown in Figure 0-10, the lack of participation of stakeholders in the technology initiation, that is the need identification to need transformation to design specification causes 80% and 100% rejection by the stakeholders and vice versa.

On the impact of validation stakeholders participation, it was noted that make 20% effect of technology transfer process, this means is likely to be more of the work of scientist as long as the input in the need was perfect. 5% of design process
important for good end of technology. It was noted in other word the earlier participation of stake holder is detrimental to the development of technology and may cause 100% failure of the technology. Specification are so detrimental to the development of the technology development cycle, it was noted that the initiation stages, that is need of stake holder in the technology development process.

4.11 Model validation

The model is tested with data on customer satisfaction correlation of the predicted data and the actual data from the field sales. The model predicted values at 120 months and was compared to index from the field in (Kothari, 2004). The existence of good relationship between model predicted diffusion index (Fin_ind_2Ven) and the real value found in sales of the same technology, with confidence level of 95% and this is significant at the 0.001 level two tailed, shows a good model prediction of diffusion rate(Avner, 2010, Kothari, 2004).

5. Conclusion

Institution like bankers, manufacturers, guarantors and others are taken like stakeholders in the model developed, this shall lead to harmonisation of R&D activities in Tanzania.

Stake holders were identified as follows: Government, Scientist Social, economist Engineer, Financier, Manufacturer and Transfer Incubator as main stake holder with higher effect on the technology development cycle for market penetration.

Model for the effect of stakeholders in different stages are developed and their composition as show in equation 4-1 to 4-7. These mathematical models obtained through the multilinear regression method were loaded into Vensim system dynamic model and run to process data that were used to validate the model. On sensitivity analysis of participation of stakeholders in the technology development cycle, it was noted that the initiation stages, that is need assessment, conversion of stake holder’s attribute to design specification are so detrimental to the development of technology and may cause 100% failure of the technology. In other word the earlier participation of stake holder is important for good end of technology. It was noted the impact of stake holder on technology development reduces as the technology cycle approaches the end with an impact between (20% to 10%).

The model was validated to see its prediction of technologies acceptance by the stake holder and reflection of the sales of the current technology in Tanzania were correlate. It was observed that at the confidence level of 95% and the significance value of 0.001 two tailed. With better practices in technology development processes and more readily available information further studies can be taken to enhance the use of stake holder in the technology development cycles.

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