



Identification of Hurdles in Establishing Technological Innovation System (TIS) for Solar Thermal Technologies (STTs) in Sindh

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Received 12th March 2016 and Revised 28th January 2017

Abstract: This research identifies the hurdles in establishing Sindh's Technological innovation system (TIS) for Solar Thermal Technologies (STTs). To achieve this task, various hurdles in "emerging TIS" were identified through literature. A survey conducted to compare and contrast these hurdles in Sindh province context, keeping in view its stage of development. Thus, the hurdles emerged were further mapped to identify the key policy recommendations to strengthen it. Finally, it is concluded that in absence of linkages among stakeholders, lesser funding opportunities, low awareness, un-involvement of communities, lack of proper set of policies and policy institutes, the Sindh's TIS can be characterized as "Shadow TIS" having no impact on diffusion of simple renewable energy technologies such as STTs.

Keywords: Hurdles, Technological Innovation System (TIS), Solar Thermal Technologies (STTs), Sindh.

1. **INTRODUCTION**

Innovation is the commercial and social utilization of the results of scientific research that primarily takes place in industry and through the process of entrepreneurship (Osama *et al.*, 2015). The relevant literature gives a distinct idea about the development of National Systems of Innovation (NSI) frameworks. For instance, some researchers elaborated the basic notion of National Systems of Innovation (Freeman, 1987; Lundvall and Nelson, 1992), some researchers conceptualized Regional Innovation Systems (Asheim and Isaksen, 1997; Cooke *et al.*, 1997), whereas, Breschi, 1997, and Malerba, 2002 explained Sectoral Systems of Innovation and Production. Similarly, the idea Technological Systems was described by Carlsson and Stankiewicz, 1991. Moreover, other comparative ideas of the socio-technical system framework are also documented in the literature (Bijker, 1995; Geels, 2004). Technological Innovation Systems (TIS) idea was similarly presented by Bergek *et al.*, (2008).

(Bergek, *et al.*, 2008) pointed out that in the past the effective dispersion of any innovation, technology and development were assessed through the market success and failures, yet now it is being broke down in terms of basic framework to deal with advancement. The parts of these frameworks can either have reliable or feeble connections, which cause the effective or unsuccessful diffusion of technologies. It now and again meets up in a deliberate and arranged manner, however,

can likewise exist together in unintended/spontaneous manner. They could hold shared or common objectives.

Historically, the concept for system approach of technological innovation has emerged gradually and began to be associated with stage of development in a society. In 1950's many of financial experts, analyzed the various degrees of improvements across different nations using the criteria of sum amassed per laborer. From 1960's it was assessed in respect of the technological distinction among nations in light of the Schumpeter's theories of 1930's and 1940's. Notably, this approach remained focus of the researchers in the similar manner during 1980's (for example: Freeman, 1982; and Fagerberg, 1987). In 1990, Romer (1990) referred it as "a new growth theory". In the mean time, some key notions, such as idea of technological capability (Kim, 1980), the absorptive capacity (Cohen, 1990) and innovation system (Lundvall's, 1992) were also emerged. Nonetheless, Gerschenkron (1962), as well as Moses Abramovitz's (1986) related technological capabilities, upgraded the abilities of social orders known as social capabilities, through gaining support from studies based on USA and UK's historical development. Different scholars adopted this conceptualization in terms of explaining the development of different nations. In this regard, Johnson (1982) concentrated on Japan and some parts of the studies by Kim (1980) and others likewise centered on newly industrialized countries.

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Innovation is the outcome of interactions among multiple actors and institution (Kim *et al.*, 2016), whereas (Tang, 2015) indicates that innovation has evolved in the local sense of industrial districts and networks. Therefore, the actors, institutions, networks and setup of local industry and regions are needed to be investigated to define Sindh's TIS. As innovation system suppose to be work as an analytical imaginary tool, having capabilities to measure the S and T performance within a society, the undertaken research attempts to provide overview of hurdles in establishing TIS for Sindh (TISS), which ultimately become part of national technological innovation system of Pakistan (TISP). In current circumstances, neither TISS's nor TISP's signs for its existence are witnessed. Whereas, in past lesser research is conducted to identify hurdles in establishing regional TIS i-e: TISS. The aim of this research is to fill this gap. In order to identify hurdles in Sindh's TIS (i-e: TISS), the focus is laid on renewable energy technologies (RETs) such as solar thermal technologies (STTs). The motive behind investigating TIS through STTs is based upon the reason that despite of much shortage of energy supplies, why no setup is being emerged to diffuse even simple RETs like STTs. By investigating TIS through STTs will not only provide means to witness TIS hurdles in its establishment but will also helps to devise policy recommendations needed for diffusion of RETs as well. These recommendations have much importance to diffuse RETs in communities to solve the problems of energy deficiency on sustainable basis.

2. MATERIALS AND METHODS

Through the literature review various hurdles were identified and later classified on the basis of (Bergek *et al.*, 2008) framework. The identified hurdles are further classified into seven groups of functional parameters i-e. (i) Awareness creation among masses through education in Sindh's TIS for STTs (ii) Viability and funding of STTs with their Policies Measures (iii) Provision of household services (iv) Policies (v) Creation/alignment of institutes (vi) Community Involvements and (vii) A survey was conducted from stakeholders to compare and contrast these hurdles in Sindh's context, which hampers the establishment of TIS. Once these obstacles are identified, were evaluated with respect to relevant policy issues. Finally, the policy recommendations were proposed and conclusion was drawn.

3. RESULTS AND DISCUSSION

Identification of TIS hurdles for STTs

Various trends were emerged after analyzing the data collected through survey. The outcome indicates key barriers in establishing Sindh's TIS for STTs. The hurdles are discussed below:

Absence of awareness for RETs through education is the main obstacle emerged for establishing TIS for STTs in Sindh. In regions of emerging TIS, the hurdles identified through literature relates with less research and lesser research output, which resulted in few experts and slow learning curve for diffusion of RETs in a society. However, the trends emerged from research indicate that according to mean value, the significant focus on individual perception is on STTs training (4.9), which is then followed by the Tertiary/University education (4.78), the contribution of specialized technical training institutes for the promotion of STTs (4.65), etc. This indicates that there is inadequate attention is offered to STTs in general and technical education. Therefore, the hurdles identified through this research are of very basic nature such as no mechanisms and facilities to obtain basic awareness about STTs are available. Hence, based on RE education for creation and change in educational policies, policy measures are required. At secondary education level, general topics and courses about introduction of RE based on general and technical education must be introduced.

For the parameters i-e: Viability and funding required by TIS to function, the hurdles identified through literature are minimum seed and venture capital, sluggish volume and nature of HR (for example quantity of university/college degrees), stagnation of correlative resources. Though, the patterns rose out of this research is that that a negative correlation (- 0.065) exist among business incubators and indicators of human resource development. It shows that no essential activity, for example, the foundation of business incubators to facilitate novel firms is set up to market STTs in Sindh. So, in Sindh the stakeholders possess low expectation in terms of popularizing STTs through mobilization of human resources, until and unless more funding is invested in popularization of these technologies. Hence, the hurdles identified are lack of funding, less or no knowledge mechanism system to distinguish the feasibility of STTs in the local rural community. There was reduced efficiency pertinent to STTs as domestic utility services (for example: drying, cooking), absence of business incubators and funding limitation. Therefore, the policy measure are needed for the increment in funding for more ventures based on RE and institutes and communities should focus on accuracy of RE and ST technologies. Efforts are needed for accessing seed and investment and development of corresponding resources. Increased funding through giving priority to human resource development practices in RE at the community level.

Inefficiency in market identification, unavailability of proper details regarding users and their purchasing trends, institutional un-alignment are the main hurdles

identified in literature for provisions of household services (for example: cooking, heating, drying) to general population through RETs/STTs. But the trends emerged from research in such dimension are of very basic nature such as the government have shown lack of interest that RETs/STTs can be used as substitutes for conventional energy technologies. Necessity arises for minimizing operating/maintenance difficulties of STTs, lack of awareness regarding incentives/disincentive details and lower affordability / cost element. Hence the emerged hurdles include high cost for RETs/STTs. Incorrect perceptions pertinent to RETs/STTs up-gradation capabilities. Therefore, the policy recommendation could be of widening of STTs awareness and reduction of RETs/STTs expenses by means of awarding incentives and awareness creation about RETs/STTs in local communities for their cost considerations, financial up-gradation and poverty reducing competencies in masses. Extension of STTs learning among general population, for example, increased know how regarding STTs like solar dehydrator.

The Sindh has no policies to establish its own TIS to diffuse technologies. In literature in terms of legitimating TIS strength in relation to its legitimacy and stakeholder are un-identified, absence of knowledge about in what way legitimacy impacts demand, lawmaking, firm's response and what (or who) impacts legitimacy, and how are the main hurdles being identified. Whereas the, trends emerged from this research identifies that presence of RE policies on permanent basis is a critical strategy to diffuse these technologies. The correlation test conducted for the item of survey questionnaire i-e "Should Sindh Govt. also launch its own policies for promotion of RE on regular basis" depicts negative relationship with respect to two statements i-e (i) Availability of RE policies on regular basis affects the commercialization/diffusion of STTs (-0.010), (ii) In order to promote STT all other policies [Education, S&T etc] may also contain some components of RE (-0.084). This negative relationship indicates the seriousness of legitimating issues, which emerges due to the application of RE based technologies. Therefore, the hurdles identified in terms of policy perspectives for Sindh to establish its TIS are absence of RE policies, lack of RE components in other policies; unavailability of Sindh RE based policies, lack of involvement of policy experts in developing policies, and un-availability of RE policies. Therefore, the policy measure needed is development and reinforcement of RE policies on regular basis and necessity for speeding up of governmental activities in the field of STTs, when awareness in general population is low regarding STTs.

With regard to creation/ alignment of policy and educational RE based institutes, lack of incentives/disincentives, absence of regulatory enforcement and weak will of society are the main hurdles, which are identified through literature hampering the institutional alignment to cater the needs of common people through renewable energy technologies including STTs. Whereas, the trends emerged from this research identifies that very less pilot field studies showcasing the utilization of (STTs) are being conducted in Sindh, especially in local communities. This resulted in lesser firsthand knowledge regarding STTs. The lack of involvement of RE policy experts in developing relevant policies is another reason for setting irregular priorities for diffusion of STT in Sindh. Hence, the hurdles identified are absence of pilot field studies and unavailability of policy institute alignment with the needs of society to be catered with STTs. Therefore, the main policy measures needed are initiation of policy making based on professional expertise, enhancing the number of pilot field studies, participation of policy experts in developing relevant policies.

In respect of community involvements, the hurdles identified through literature for community involvement to diffuse STTs are unavailability of trends pertinent to new entry firm and existing firms, minimum use of various technologies, reduced applications offered by technologies. However, the trends emerged from research indicate that NGOs and other private sector could successfully diffuse STTs in Sindh by promoting them at community level. Since the correlation parameters indicates a positive association between NGOs and private sector for diffusion of STTs. Hence, the hurdles identified through research are weak NGO's and private sector role to diffuse STTs, lesser exposure and involvement of communities in STTs diffusion. Therefore, the policy measure to establish TIS in Sindh are the amplification of NGOs and private sector role by offering incentives in the field of RE.

Weaker potential and lesser knowledge flow are common hurdles identified through literature to establish TIS by interlinking various policies. Whereas, the trends emerged through this research is that the technical education could promote the diffusion of STTs in Sindh. As the reported higher average mean (28.15) points towards the fact that the stakeholders are well aware concerning the importance of technical education and the pivotal role it can play in development of STTs in Sindh. Further, it is also emerged that the national policies have failed to interlink educational and RE policies, which resulted in flaws in National policies priorities. Hence, the hurdles identified through research

are non-utilization of technical education infrastructure, and avoidance of considering the regional/ provincial view point for technology needs and diffusion approaches. Therefore, the policy measures required to overcome these hurdles is to make national policies for RE by interlinking them with different policies. This could be achieved easily if technical education infrastructure can be efficiently utilized for the promotion/diffusion of STTs.

3.1 TIS hurdles mapping for emergence of key policy recommendations

After successfully identifying the hurdles for seven functional parameters, the hurdles/blocking mechanism of Sindh's TIS were mapped by considering the interrelationship between functional parameters, hurdles, policy issues and relevant policy recommendations as shown in (Fig. 1).

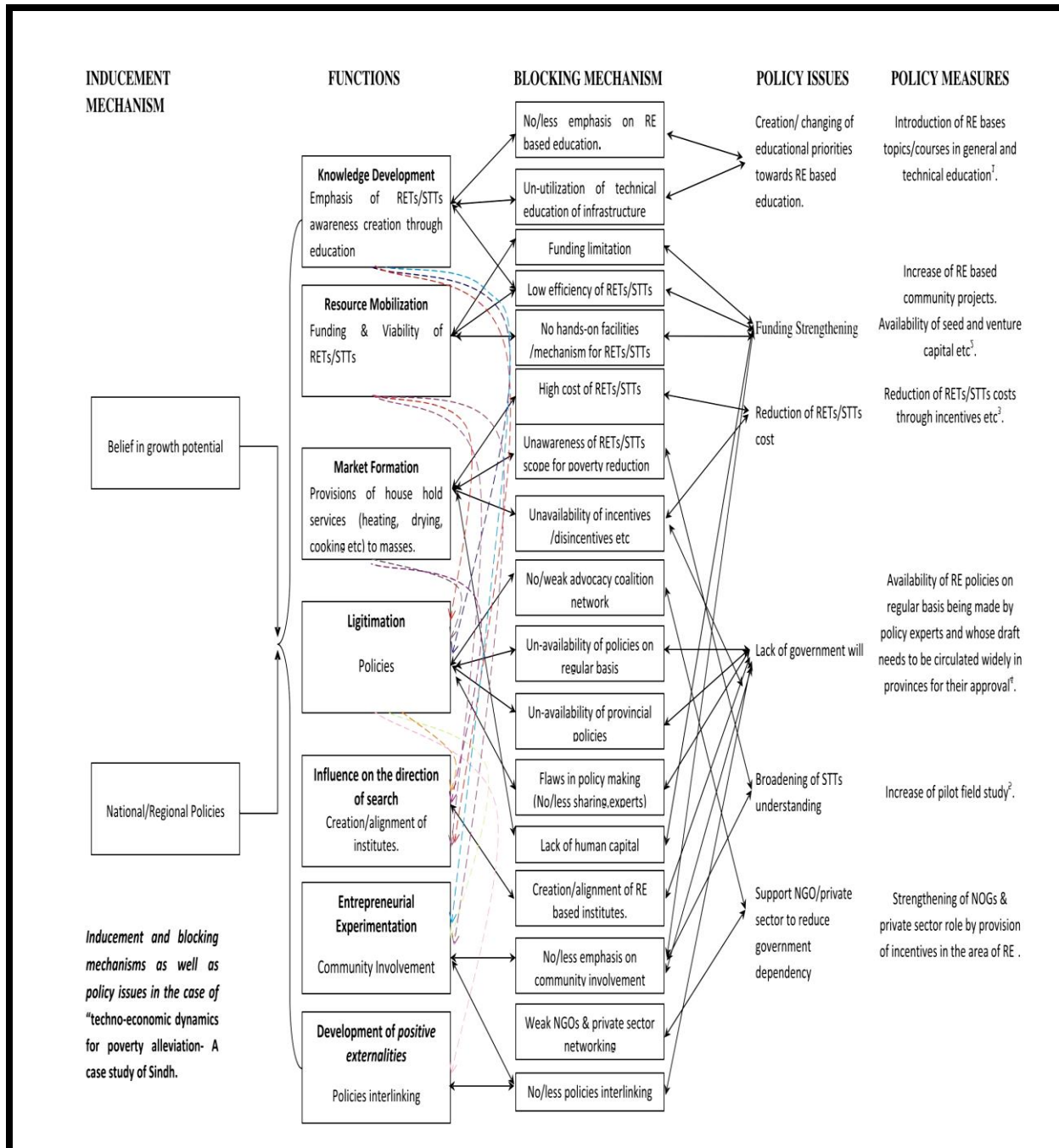


Fig. 1: Mapping of TIS hurdles for STTs

These obstacles speak to the blocking system of Sindh's TIS for STTs. Consequently, keeping in view this study, the same are spoken to as far as key strategy issues and cures distinguished. Subsequently, the key strategy proposals and policy recommendations are:

1. The Provincial Government of Sindh ought to fortify the Science and Technology (S&T) Cell in the Department of Planning and Development or better resuscitate and restore the different Department of Science and Technology built up before yet surrendered before long.
2. The S&T Cell or the Department ought to outline a far-reaching strategy and its arrangement of activity to present the TIS, instead of should make it possible all through Sindh province up to town level, to lighten destitution.
3. The action plans encircled as well as policy framed in this context be checked on standard premise and should be founded on the evidence basis.
4. It ought to be made obligatory that national approaches and policies necessarily be generally circled to take the perspective of provinces.
5. The proposals of Pakistan Participatory Poverty Assessment (PPPA, for example, the plan of emotionally supportive network for individuals falling into sudden ailment ought to likewise be fused in Poverty Reduction Strategy Paper (PRSP).
6. When devising the directions of S&T at National/Provincial extent the idea of comprehensive development approach ought to be mobilized through communities.
7. A gritty study of human and common natural resources as well as different prerequisites to be led for every doable unit at Taluka, Village, and to the extent of entire Sindh province. A significant suitable innovation and technologies to be recognized for each extraordinary unit to present TIS marvel for destitution lightening viably around there.
8. A proper extensive program must be propelled for professional instruction and special training for Innovation to advance TIS. The ideas might be presented as a rule through unique themes/modules at the secondary level of instruction to produce innovative personalities in this domain.
9. Monetary benefits/incentives might be given to advance STTs and other important innovations with a specific end goal to maintain the wheel of TIS moving in Sindh.
10. The Government necessarily strengthens the coordination among various concerned associations to shape them into Innovation Systems to accomplish the targets of Poverty-reduction with the help of TIS.
11. The share of NGOs and private units necessarily be fortified in TIS push to quickly draw the advantages of STTs and other fitting advances to general citizens.

12. Financial resources should be awarded to pilot field studies and prepared them to give STTs and other proper advances direct information to general citizens.

4. **CONCLUSION**

This study identified that the main obstacles in Sindh's TIS for STTs are of an extremely fundamental nature. Sindh's TIS can't be assigned as an "Emerging TIS". A group of entire new parameters are seemed, by all accounts, to be molding the Sindh's TIS. These identified parameters which are yet to develop. The obstacles recognized in this manner should have been explored before the start of TIS based research in developing regions. At long last, it is inferred that the "Rising TIS" notion as introduced by Bergek et al., can be named as "Shadow TIS" in Sindh's specific situation, keeping in view its crumbling status of improvement and non-working of its S&T framework.

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