Government Policy and SME Viability: The Heat Transfer Model for Diffusion of Government Policy for Technical SMEs

Chinweike I. Eseonu, and David A. Wyrick, *Members, IAENG*

Abstract— A successful technical organization must consistently out-train and out-innovate its local and global competitors. It is also true, however, that Research and Development is one of the first departments downsized or cut in times of austerity. This paper acknowledges this cycle and relates it to national policy conditions. It is expected that countries in which the level of national need is high (lower on hierarchies of need and quality of life indices) would see less sophisticated targeted policy initiatives, lower levels of technical innovation and associated policy innovations, and vice-versa. Given the rapid diffusion of technology and of emergence of national economies, we discuss need based policy, and policy advocacy avenues for technical policy entrepreneurs.

Index Terms— **Technology Policy, Government Policy, Technical Entrepreneurship, SMEs**

I. Training for Innovation

"Innovate or perish," the popular saying goes. This notion has considerable currency in light of dynamic global competition — an organization that can out innovate rivals, at home and abroad, whilst maintaining competitive pricing for goods or services provided, is one that can achieve and maintain market dominance. Wyrick [1] describes the efforts of a waning industry leader to regain prominence after innovative new entrants usurped its position. In times of austerity, organizations cut back, or discontinue, research, development and training initiatives. As was the case in the company above, austerity is often followed by a period of fierce competition. In order to compete as a competent organization, it is essential that the workforce is well equipped (up to date) and that gaps in knowledge have been identified and are being actively addressed [2]. When organizational competence is lost due to cuts in training or research and development, the organization's ability to compete upon rebound and the resultant spurt in demand is greatly compromised [3]; in fast-paced industries, like that of mobile devices, such a failure to innovate could spell the end of the firm or considerable loss of market share — the rise of Apple and its constant releases of incremental updates buttresses this point.

This paper investigates how technology policy can impact the viability of technology-based small and medium enterprises (SMEs). The next two sections discuss training in SMEs and the effect of training on an organization's long-term viability. The role of a national technology policy on spurring innovation, vis-à-vis national needs, is then described. To explain how technology policy can diffuse across a country, heat transfer models will be applied. Next, the heat transfer context will be used to discuss SME policy and training for innovation. The paper concludes with key findings regarding technology policy and innovation.

II. Training in Small and Medium Sized Enterprises

The literature abounds with tips for niche identification and exploitation targeted at small enterprises. Smaller organizations, one might argue, are less able to incorporate diverse specializations in ways that larger organizations can. They are also less likely to provide comprehensive employee training, if any [4-6]. Are smaller companies unaware of the benefits of consistent training and organizational learning initiatives, opting instead for reactionary spurts [7], or is the discrepancy based largely on financial constraints?

It is true that SMEs lack the deep pockets of their larger counterparts. Their longevity is called into question with more frequency [8], and capital investment decisions are more short-term focused [6, 9] than said larger counterparts. It is also true, however, that investments deemed beneficial will be embarked upon, in increments where possible, in order to achieve or maintain a competitive edge. Because of the "innovate-or-perish" mindset among technical SMEs and the expertise it spawns, the threat of poaching by larger organizations, who might offer better pay packages [4, 10], looms large. Given the lack of an "internal labor market," trained employees are lured to more lucrative positions in larger organizations, leaving SMEs with a failed investment in employee training.

Figure 1 depicts the dependence of "industry leadership" on "innovation," "organizational competence," and"funding for training and R&D," which, in turn, are affected by austerity and level of complacency. Here, the differences between large and small/medium enterprises, outlined above, would imply that smaller organizations are affected by austerity to a larger extent than their larger counterparts

Manuscript received March 23, 2011; revised July XX, 20XX. This work was supported in part by the Bryan Pearce Bagley Regents Chair of Engineering endowment at Texas Tech University.

Chinweike I. Eseonu is a Ph.D. student at Texas Tech University, Lubbock, TX 79409 USA. (phone: +1 218-428-5868; fax: +1 806-742-3411; e-mail: chin.eseonu@ttu.edu).

David A. Wyrick is the Bryan Pearce Bagley Regents Chair of Engineering at Texas Tech University, Lubbock, TX 79409 USA (e-mail: dave.wyrick@ttu.edu).

and might be considered to be in a perpetual state of relative financial duress. As argued by Eseonu, Wyrick, and Vaccari [11], smaller organizations are often employed by larger organizations in need of specialized skills and, as Brown et al. [4] argue, small organizations in the United States have considerable political clout in addition to capital in the court of public opinion.

III. Effect of Training on Organizational Viability

Given the challenges SMEs face regarding innovation and retaining talented employees, what role, if any, does government technology policy play? If innovation is necessary for survival, but is driven by a competent workforce in a learning organization [3], one would expect smaller organizations to be less innovative than their larger counterparts and, thus, less competitive due to constant poaching [12, 13], lack of an up-to-date workforce, and other such detriments. The literature on training largely refers to formal training and associated costs. There is little consideration of the in-depth, hands-on training that occurs in smaller organizations, the ease of accessibility to decision makers and simpler organizational structure that allows for rapid experimentation, innovation and implementation. Because the players in smaller organizations are often expected to wear multiple "hats," organizational learning and collaboration is more streamlined than would be the case in larger organizations. New entrants are given more latitude, by necessity, and are "thrown to the wolves" earlier in the process. In addition, these firms are often niche specific and as such, are specialized in their chosen fields. This level of specialization, however, increases the risk, and effect, of poaching — it is financially tasking to replace trained employees — and contributes to the disparity in cash flow and financing options available to SMEs [13, 14]. These factors, alongside competition from larger firms, keep most small businesses in the survival step of small business management [15].

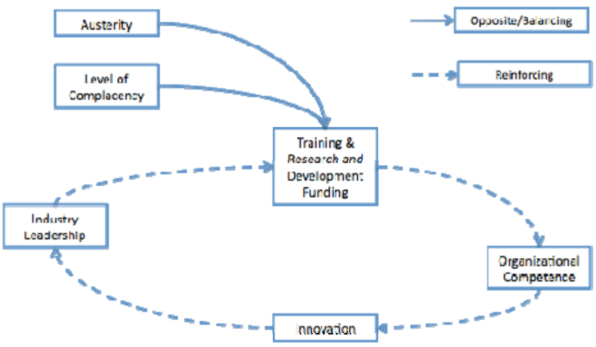

Fig 1: Expected causal loop diagram for the relationship between training and industry leadership

IV. National Need and Policy Innovativeness

In their studies on policy innovativeness across the United States, Gray [16] and Savage [17] describe policy innovation among and diffusion across the states. They discuss the role of economic, demographic, and political factors in innovation and policy diffusion. In essence, they would suggest that in areas such as technology growth, utilization and technical entrepreneurship, a state such as California, which, historically has had a culture of technical entrepreneurship, favorable demographics, and considerable wealth, would surpass other states — and possibly the Federal government — in creating policy that facilitates technical entrepreneurship. States with similar academic and demographic compositions would then seek to learn from California's example and implement identical or modified policies. Gray [16] describes some methods that facilitate policy diffusion and the avenues through which they occur, are largely mirrored on the global scale. The presence of "policy entrepreneurs," the networking events, and policy discrepancies — leaders and laggards — in accordance with economic, demographic, cultural and political differences, highlight this similarity between U.S and international states.

Fuchs [18] discusses the role of government in identifying areas for technical innovation through research funding. She highlights the need for a networked polity, a system in which knowledgeable government officials actively engage industry practitioners and facilitate the conversion of superior ideas into viable technologies. This, however, depends on the level of sophistication demanded of initiatives put forward by policymakers. Eseonu and Wyrick [19] deem this demand for sophistication, a reflection of the level of national need — education, affluence, health care, and other such attributes that would apply in both introverted and extroverted hierarchies of need. Using the stratification developed by Diener [20] that attempts to minimize the skewing effect of monetary wealth, which can often mask problems (misappropriation, failing educational and other systems), we would expect to find countries that have better quality of life indices serving as leaders in technology policy innovation alongside emerging economies in which the rate of diffusion is expected to be high — given the descriptors provided by Gray [16] and Walker [21].

V. The Heat Transfer Model for Technology Policy Diffusion

A classic application of diffusion comes from the field of heat transfer. Given a planar wall — an infinite plane, wall or barrier dividing rooms at different temperatures, T_1 and T_2, the thickness, Δx, and conductivity, k, of the wall determines the rate, and extent to which, T_1 (if higher) alters T_2. The thermal conductivity is determined, as shown in Figure 2, by the material composition of the boundary in question. A pure metal, such as silver conducts heat at almost 100 times the rate at which an alloy, like nickel does. Nickel is about 50 times as effective as plastic, which is, in turn, more effective than foam or carbon dioxide. What relationship is there between Fourier's law and technology policy?

Gray [16] and Walker [21] list several facilitators and hindrances to policy diffusion. The strength of interest groups, level of public awareness, and involvement in the political and policy-making process, we argue, can partly determine the conductivity of the policy diffusion barrier. In essence, where geographic, ethnographic, demographic and

ISBN: 978-988-18210-6-5
ISSN: 2078-0958 (Print); ISSN: 2078-0966 (Online)

socioeconomic conditions are similar, we expect to find faster rates of diffusion because fewer barriers to information sharing exist than would otherwise be the case. A lack of technology policy will therefore act to hinder diffusion of technology, whereas an effective technology policy will speed diffusion, analogous to raising conductivity, decreasing wall thickness, or both.

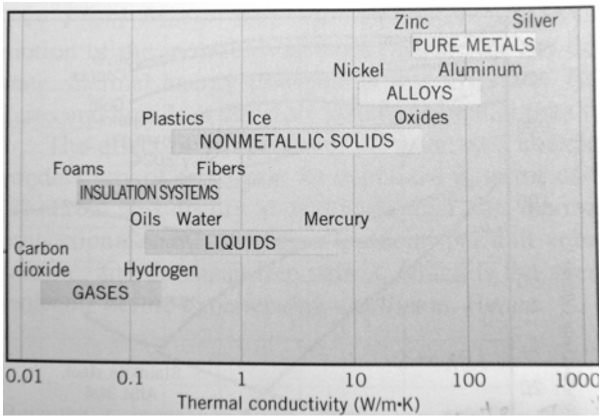

Fig 2: Range of thermal conductivity for various states of matter at normal temperatures and pressure. [22]

Diener's [20] value index for national quality of life provides a reasonable basis for determining similarity between nations. Sweden and Finland, for instance, score 1.94 and 1.88 respectively — a small difference of 0.06 - on his combined quality of life index, which accounts for literacy levels and that of advanced education, societal values, and other measures not readily operationalized in other indices. This, in addition to geographic proximity, makes for a highly "conductive" policy barrier that might be equivalent to pure metals in Figure 2. As a result, technology and SME policy in Northern Sweden and the Oulu region of Finland depict this diffusive behavior.

Ylinenpää [23] outlines the effects of technical SME growth, aided by a "networked polity-like" [18] collaboration, in what became known as the "Oulu way." The presence of larger firms like Nokia and successful academia-industry-government collaboration, fed advancement in the Oulu region of Finland that informed policy initiatives in Northern Sweden, where SMEs had been largely focused on the local mining industry. One such initiative, Centek, looked to apply research from a regional university to local industries, many of which they later helped internationalize [11] — a feat that had been central to success in Oulu.

Countries in the Middle Eastern Gulf also display a similar pattern of policy diffusion as regards SME growth. The rapid rise of media and education cities, science and technology parks, free trade zones, and other such initiatives that are often at odds with previous policy stances has successively progressed through oil rich countries that increasingly look to reduce their reliance on the volatile and finite resource.

A. Heat Transfer Across Composite Barriers

Barriers to policy diffusion are rarely ever monolithic or singular. American policy literature lists iron triangles and issue networks as formidable hindrances to, or champions of, policy diffusion [24-26]. Iron triangles are tripartite alliances between Congress (committees, members, or groups), interest groups, and government agencies who are in a mutually advantageous relationship that funds their common interest through the expenditure of government funds" [24]. Issue networks represent "a shared knowledge group formed around some aspect (or problem) of public policy" [25].

Taken together, iron triangles and issue networks can act as a composite barrier to technology transfer. Depending on their effectiveness or friction, they can enhance or constrain the transfer of technology from providers to users. If "other factors" are taken together as a third type of barrier, the net effect on technology diffusion is similar to the heat transfer across a three-panel composite wall as shown in Figure 3.

VI. SME Policy and Training for Innovation

Using the conceptual model of heat transfer through a a planar wall, let us consider its application to government policy regarding SMEs and training for innovation. Ihua [13] advocates an Oulu-like model for combating the challenges facing SMEs in capital generation, employee training and retention. Some solutions, such as signed employee time commitments to avoid poaching, require government backing or the provision of alternatives that are suitable for SMEs, the government, and larger organizations.

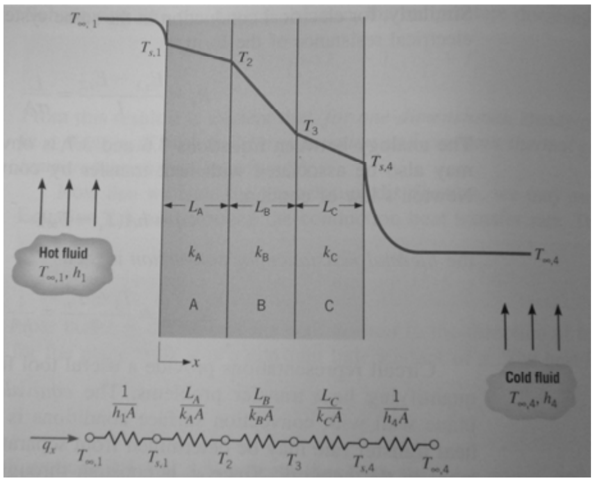

Fig 3: Relationship between barrier thickness and heat transfer. [22]

Walker [21] found that socioeconomic and political conditions determine the level of policy innovativeness — adaptation of policy in other locations, creation of unique policy solutions, and other forms of innovation — in a state or nation. In essence, follower readiness and level of national need [19] determine the existence, and quality, of SME, and technical SME, support policy.

Consequently, policy entrepreneurs and their issue networks [25] are an important part of the policy propagation process. The ability to frame the need for SME centric policy as a solution to various national issues — unemployment, innovation, trade imbalances, development, economic diversification, and other broad nationally acceptable symbols — becomes essential. In essence, technical SME issues must be framed, as other small business issue networks have often succeeded in doing, as a national problem with an unsustainable status quo that must be changed in order to compete with similar, and/or regional, countries in which desired policies have been enacted. This process of increasing the "conductivity" of national barriers to policy adoption or innovation, as has been pointed out [13], has been largely deficient - apart from military readiness - in many countries high on Diener's Combined QOL index, and non-existent in low Combined QOL countries.

Emerging economies appear to lead the focus on technical SME friendly initiatives. The promise of Enterprise Qatar and the Qatar Science and Technology Park, large government investments in SME research, development and implementation projects in China, and the rise of Indian technical SMEs are cases in point. The German government provides one instance of technical SME support framed as an issue of unemployment that has driven growth during austerity in politically and socioeconomically similar countries with similar advanced QOL rankings [27]. This suggests a third independent variable in Figure 1, *level of appropriate government involvement* as a factor that impacts upon research and development. This causal loop diagram showing the relationship between training and industry leadership can therefore be modified to include appropriate government involvement as shown in Figure 4.

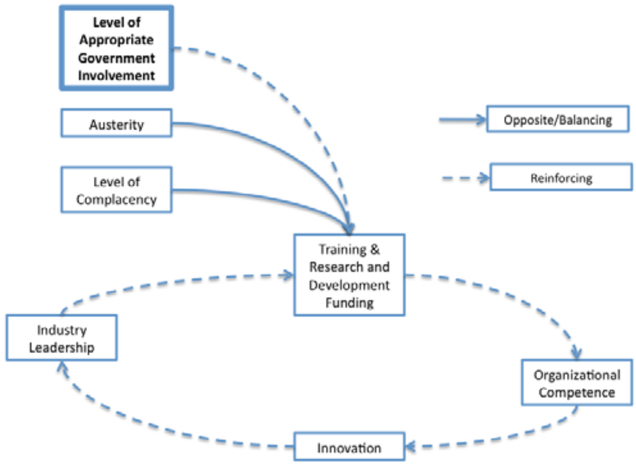

Fig 4: Improved Causal loop diagram for the relationship between training and industry leadership

The T3 approach provides a forum for SMEs to work together to develop competency and be able to focus on long-term technology developments by leveraging pooled resources [3]. The T3 concept utilizes this improved causal loop to provide an additional alternative, especially in highly competitive industries in which larger companies readily offer lucrative compensation packages.

It is expected that the degree to which government facilitation is needed for a scheme like the T3 to greatly facilitate technology diffusion will be negatively correlated with national need level. In other words, government facilitation will have more positive impact on SMEs in developing nations than in the industrialized nations.

VII. Conclusion

This paper has assessed training and competence development in small and medium enterprises and investigated the relationship of governmental policy on organizational viability given the level of national need.

A model of technology transfer has been presented that is based on heat transfer through a wall. The rate of diffusion can be facilitated by the thickness of the wall and the materials that compose it. Similarly, the rate of technology diffusion can be facilitated on the technology policies, assistance programs, and ability to work together, which can all be affected by governmental policy. This leads to an improved causal loop diagram to relate training and industry leadership by incorporating a third input to training and R&D funding. This may be particularly important for SMEs and for developing nations.

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ISBN: 978-988-18210-6-5
ISSN: 2078-0958 (Print); ISSN: 2078-0966 (Online)