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**MAPPING THE DIVERSE ROLES OF UNIVERSITIES IN SUPPORTING INNOVATION:
OPPORTUNITIES AND CHALLENGES FOR ALGERIA, INDONESIA, MALAYSIA AND INDIA**

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ABSTRACT

This paper is aimed at investigating various opportunities as well as challenges facing universities from developing countries in their role of creation and exchange of knowledge as a basis of innovation. It intends to do so by investigating the links of these universities with regional and/or national systems of innovation and their position within the three stage evolutionary process (*statist, laissez-faire and hybrid*) of the Triple Helix system. These links will be highlighted and discussed in terms of proximity and impact on knowledge creation and exchange as well as on innovation. The paper argues that a healthy balance of diverse types of higher education institutions in a country might be necessary for better national innovation performance.

Keywords: Triple Helix; National System of Innovation; Regional System of Innovation; Higher Education Institutions; Developing Countries

1. INTRODUCTION

The main objective of this paper is to gain a better understanding on different opportunities opened to the universities² in developing countries as well as challenges facing them if they are to be expected to play more active roles in the creation and exchange of skills and knowledge as a basis of innovation. To conduct this investigation, the paper intends to build a theoretical framework linking these universities with regional and/or national systems of innovation and their position within the three stages evolutionary process (*statist, laissez-faire, hybrid*) of the triple helix system (Etzkowitz, 2003). This paper argues that the challenges and opportunities for the universities to contribute to the innovation system would be contingent upon the position of universities in the framework. These challenges and opportunities within this framework will be discussed in terms of proximity and impact of the universities on knowledge creation and exchange as well as on innovation system. A greater focus will be given on the role of institutional, geographical, cognitive and social proximity concepts in explaining the different opportunities and challenges facing the universities in their mission of supporting innovation. We use the case studies of four developing countries (India, Malaysia, Indonesia and Algeria) to illustrate our argument.

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² In many countries, the term universities and higher education institutions are often used interchangeably. In this paper, similarly we are also going to use both term interchangeably.

In addition to the introduction, this paper comprises seven sections. Section two identifies the main actors involved in the production of innovation at a macro-level. It also investigates the different possible scenarios of interaction amongst these actors. It will use the Triple Helix concept to conceptualize these different scenarios and gain a better understanding of the possible roles of the universities within each scenario. Section three discusses the different concepts of proximity and how they can contribute to our understanding of the different arenas of innovation system (i.e. national and regional). Section four proposes a theoretical framework of possible roles of universities in supporting innovation systems. We contend that, at national level, a healthy balance of universities across different positions within the theoretical framework might be necessary to optimize the country's innovation performance. Section five explains our research methodology which is essentially qualitative and based on a multiple case studies approach which includes India, Malaysia, Indonesia and Algeria. Section six summarizes the results of the four case studies while the section seven provides a comparative analysis of the roles of the universities, from the four selected developing nations, aimed at mapping their relative position within our framework. The final section concludes and discusses the policy implications of our findings.

2. KEY ACTORS OF INNOVATION SYSTEM, THEIR INTERACTIONS & THE ROLE OF UNIVERSITIES: A TRIPLE HELIX APPROACH

The concept of innovation systems can be understood as a network of actors/institutions that interact in the production, transfer, diffusion and the use of new knowledge or technology to produce innovation. For, Edquist (1997), a system of innovation includes "all important economic, social, political, organisational, institutional and other factors that influence the development, diffusion and use of innovations". Many scholars (e.g. Freeman (1988); Nelson (1993)) agree that – in general – one can group these various organizational, institutional and other innovation actors into three main key categories of actors: Authorities, Suppliers of Knowledge and Skills and The Users/Adopters/Transformers of these knowledge and skills into innovation. In many countries, the position of authorities are often held by the Government (either central or local), while the suppliers are often represented by Higher Education Institutions (HEIs) and the users are usually Industrial sectors. Scholars argue that the successful innovation performance of the system is determined by the effective interaction between these key actors (e.g. Archibugi & Michie, 1997).

The Triple Helix model (Etzkowitz and Leydesdorff, 2000) can be seen as an approach that can help in analyzing the different types of interaction between those three key actors. The Triple Helix proposes three different regimes of interaction between the three key actors. In the *Statist* regime, government exercises control over academia and industry. In the *Laissez-Faire* regime, industry and academia are independent to government as well as to each other and the three actors are set apart from each other with minimal interactions. In the third regime, often called *Hybrid*, while institutional spheres maintain their identity and often their independence, they can also take each other role.

Universities (or HEIs) which play a pivotal role in the innovation system (Edquist, 2006) are viewed as crucial partners in the Triple Helix model (Etzkowitz and Leydesdorff (2000)). In a *Statist* regime, universities act mainly as a government tool to fulfill their social contract in providing nations with skilled human resources and necessary knowledge (such as knowledge for innovation) usually if only required. Meanwhile in the *Laissez-Faire* regime, universities play a specialist role as the provider of skills and new knowledge – within a larger system of the division of labour – of which some of it can be changed into innovation or else be absorbed by industry.

In a *Hybrid* regime, universities are expected to take a new role and to become a more entrepreneurial entity. Universities, from both developed and developing countries have started assuming this new mission of entrepreneurs by incubating technological projects in their incubators and technology parks. Entrepreneurship is becoming increasingly integrated with their teaching and research to foster and exploit new initiatives within and outside the university. This has led to universities increasingly viewed as sources of regional economic development. It is also becoming clear to developing countries that strengthening their capacity to generate, apply, adapt and disseminate knowledge is crucial to future economic growth and social development (World Bank, 2002; UNDP, 2001). This presumes a significant change in the role and status of universities in developing countries. However, not all developing countries are in the same boat as situations vary from one country to another³.

³ as the United Nations Development Programme (UNDP) Technology Achievement Index ranking king of developing countries shows (UNDP, 2001).

3. DIFFERENT INNOVATION SYSTEM ARENAS: ANALYSIS BASED ON PROXIMITY CONCEPTS

In addition to the interactions between key players, it is also important to take into consideration and investigate the arena within which these players engage in the process of innovation in the system of innovation. As the “system of innovation” concept deals mainly with the effective flow of knowledge between key players to produce innovation, the different innovation system arenas in which these actors mainly get involved can be adequately understood according to the concept of proximity.

The concept of proximity deals with the relative quality of interaction between two or more agents. According to Orlemans, et al. (2010), the concept of proximity assumes that a greater level of networking is seen as a means of facilitating learning, transfer of technology and innovation. Proximity can lead to the development of trust and mutual understanding which can help establish strong relationships (Doloreux & Parto, 2004) which are crucial for effective innovation systems. Proximity facilitates information flow and knowledge sharing between people and hence between groups, organisations and institutions. It is also instrumental in reinforcing group identity and recognition which in turn fosters informal norms, trust and strong inter-group ties (Lin, 2001).

Depending on the characteristics of the interaction, one may distinguish differences between the concepts of institutional, geographical, cognitive and social proximities. This section shows that in the context of spatial analysis, there are mainly two competing proximities concepts in Innovation System studies: National and Regional system of innovation. It can be deduced from these two concepts that universities are supposed to be involved in either the national or the regional system of innovation.

Initially, the concept of innovation system was used at national level to explain the [uneven] innovation performance of nations by a series of monographs, papers and books written by Freeman (1987, 1988, 1995), Lundvall (1992) and Nelson (1993). They argue that the innovativeness of a nation depends on the close relationship and proximity between key institutions that operate at a national level to support and produce innovation. Since then, these works have been the sources of inspiration for subsequent macro-level studies of innovation for many academics and even policy makers alike (e.g. OECD, 1997). One of the corollaries of this concept is that universities are expected to play significant role in innovation system at the national level.

However certain scholars started to question the adequacy of using a nation as a unit of analysis for studying innovation performance as there might be many unobservable which might come into equation and failed to be recognized by those studies. Furthermore some empirical evidences show that the ability to innovate is believed to be more likely dependent on local than on distant linkages (Audretsch, 1998; van Dijk & Sandee, 2002). Indeed, substantial empirical studies show the existence of geographically bounded spill over of knowledge and graduates from university to industrial innovation (Mansfield, 1995).

To take into account this geographical dimension, Cook and others (Cook, 2001; Cook et al., 1997) propose the concept of Regional System of Innovation. This system which adopts region as its main unit of analysis contends that geographical proximity should be considered as the central focus of any discussion of innovation system. Corollary of this proposition is that universities are expected to play a significant role in innovation system at the regional level. This argument is supported by some previous theories in Innovation Studies, notably the Innovative Milieu study (Longhi, 1999).

4. VARIOUS POSITIONS OF UNIVERSITY IN THE SYSTEM OF INNOVATION: A THEORETICAL FRAMEWORK

This paper proposes that the opportunities and challenges facing any university in supporting the system of innovation of a particular nation would be contingent upon two factors above. Firstly, there would be different roles, opportunities and challenges for higher education institutions whether they are positioned within the *Statist*, *Laissez Faire* or *Hybrid* regime. Secondly, there would be different roles, opportunities and challenges between higher education institutions that operate within certain regional/local boundary or mainly interact with regional/local partners or else serve the interest of regional/local needs; and the institutions that operate, interact or serve nationally – in line with the idea of proximity explained beforehand.

4.1. The Position of University between the Different Types of Triple Helix Interactions

As already explained, the TH concept argues for the importance of hybrid model of organization between University, Government and Industry to produce innovation (Etzkowitz & Leydersdorf, 2000). Since its conception, it has been used and adopted by many scholars to analyse the rise of industrial innovation of particular sectors/technologies in both developed and developing nations (e.g. Giesecke, 2000).

Unlike the “classic” innovation system concept (e.g. Freeman (1995), Nelson (1993), Rosenberg & Nelson (1994)) that implicitly suggests the “disciplined” division of labour amongst its constituents, TH concept suggests not only for a more collaborative but also aggressive approach to its constituent institutions by actively playing the role of the others. For instance, if the industries are not able to absorb their breakthrough knowledge production, universities should try to pursue its exploitation in order to develop innovation and thus be more entrepreneurial (Etzkowitz, 2003). The university thus takes the role as an “exploiter” of knowledge [to produce innovation].

In the *Statist* regime, higher education institutions are expected to carry out their social contracts under the supervision of the government/authorities. They act as “subordinates” and “executor” of government [e.g. innovation] programmes. We can expect that many universities from developing nations would fall into this category.

On the contrary, in the “*Laissez Faire*” regime, all institutions are autonomous and independent one from another. Their interactions are more likely contractual or transactional across institutional boundary (Williamson, 1973) as actors are expected to act competitively rather than cooperatively. According to Etzkowitz (2003, universities – true to their nature – usually operate in accordance to their scholarly role in society. Taking it too far, the higher education institutions in this regime may develop into an elitism academic institution (Ivory Tower Universities) which pursue teaching and research according to their own academic agenda. Within this regime, universities act as an “explorer” of new knowledge and opportunities.

The types of challenges that universities face would depend upon the regime within which they positioned. In the *Statist* regime, the universities are unlikely to have sufficient “ready-on-time-to-use” capabilities as well as incentive to lead their own innovative activities unless they are initiated or planned by the government. The capability building and innovative research for innovation is likely to be conducted in a more reactive-way in accordance with the government initiatives. It is expected that the reaction-time of the higher education system to match with industrial and societal needs of the nation will be limited as the ability of the government to foresee the changes of needs in society, industry and economy is somewhat limited.

Nevertheless, despite these problems, the universities in this regime would enjoy relative safety from risks associated with capital loss due to innovation or experimental failure. It may also enjoy from preferential treatment for undertaking specific innovation projects which are deemed by the authority to be important and necessary without worrying about its cost. Thus the opportunity for the *Statist* universities to get involved in innovation system usually comes from the government innovation procurement projects.

The challenge for the university in this regime is to be able to bargain with the authority to obtain a certain degree of freedom for managing its own resources to build necessary capability to react rapidly to social and economic change in the society.

Meanwhile, the universities which operate in “*Laissez Faire*” regime would enjoy a certain independence to develop its own capabilities and research agenda. However, this capability building and research development are not necessarily oriented towards societal or economical needs. In many universities within the “*Laissez Faire*” regime, these developments are mainly scholarly driven. The match between university research agenda or capability building with certain societal or industrial short term needs is at best unplanned or at worst accidental. Even though universities have the capabilities to explore new knowledge, they lack the urgency to develop their capabilities to exploit the new knowledge and turn it into innovation (let alone the urgency to develop their managerial capabilities to manage the process of innovation). The gain that this regime enjoy from the relatively lower cost of structural adjustment for innovation (partly due to lower interventions of each other institution) can be offset by the inefficiency of the interactions (partly due to hit and miss phenomenon of matching university research with societal and economical needs). As the opportunity to participate in innovation system would come from the match between

university resources and capabilities with certain societal and industrial short-term needs; and given the independency of relationships between university and other innovation key actors; the university needs to always grow by itself its diversity of resources and capabilities in order to be able to contribute to the innovation system which in turn would be very costly to run.

One of the challenges for the university in this regime is to be always able to deal with sustainable financial plan for growth. This can be done partly by planning and managing the direction of its resources and capabilities development so that they are always relevant to societal and industrial needs (not merely pursuing scholarly needs).

Finally, in the Hybrid model, universities are expected to always have at least sufficient⁴ capability not only to explore for new knowledge but also to exploit it and innovate. By having these multiple sources of innovation (i.e. from the universities instead of merely from Industry), innovation performance of a region or a nation can be accelerated. However, this Hybrid model of universities should be expected to require a higher amount of organizational flexibility as well as managerial/entrepreneurial capability to respond to the changing needs of society and industrial economy. The challenge of the university in this model is to be able to manage its structural adjustment inexpensively while responding to ever changing needs of society and industry.

4.2. The Position of University within Different Level of Innovation System

In this theoretical framework, the difference between National and Regional System of Innovation from the point of view of higher education institutions is associated with the scope of university activities.

Some universities in some particular countries – due to their particular resources or characters – may limit their teaching and research activities as well as their economic uses to serve mainly regional or local needs. They may be private (religiously related or not) or public but they operate within regional boundary and interact mainly with local partners and fill specific needs (both on providing skilled graduates and specific problem solving knowledge) to the particular region. They play somewhat a more focus role serving niche social and economical needs.

Other universities operate rather at the national level. Their scope of teaching and research activities (deliberately or not) are so wide and diverse that can serve the needs of various innovative regions within particular countries. In the case where the institutions specialised in particular subjects or activities, its interaction with other type of innovating institutions happen mainly at the national level rather than the regional level. Again, these universities can be public or private higher education institutions, serving a variety of different societal needs and/or dealing with a variety of partners and stakeholders.

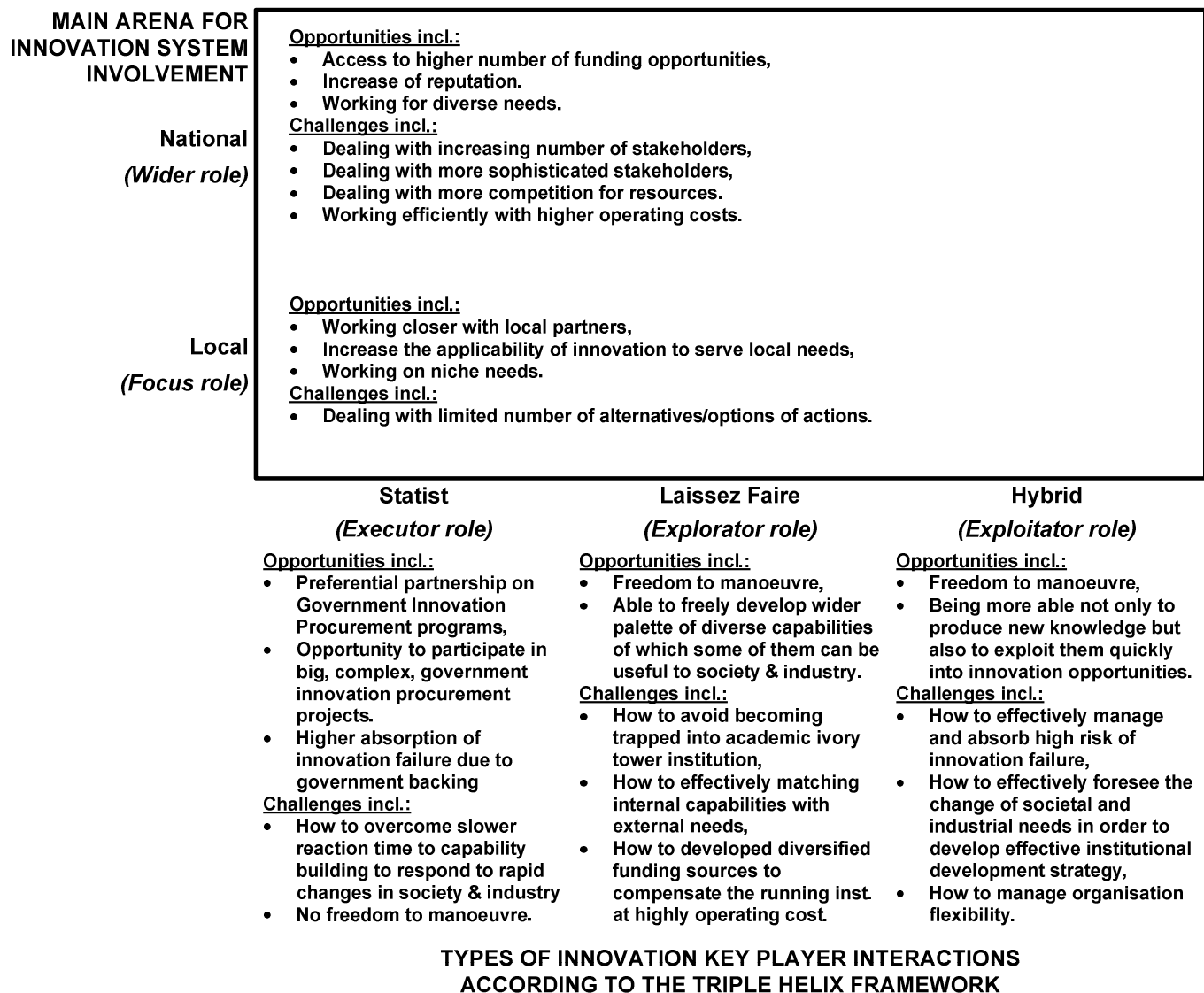
The universities which operate in the different spectrum of innovation system above can be expected to face different challenges and opportunities in their teaching and research activities. The more universities are situated at the national level of innovation system, the more stakeholders that have to deal with. They are also more likely to have to deal with more sophisticated stakeholders. They can also be likely to have to deal with more competition for resources while at the same time having to operate at larger operating cost since they have to provide a wider scope of teaching and research activities. Nevertheless, they might enjoy more institutional reputation which can be beneficial for their funding.

4.3. A Healthy Balance of Universities

These different challenges and opportunities along the two dimension explained above will certainly create different paths of development if the government or policy makers want to develop higher education systems which support their national/regional innovation system. Figure 1 summarises this framework.

⁴ Not “surplus” such as in the case of “*Laissez Faire*” regime.

Figure 1: Different Roles & Positions Of Higher Education Institutions in Supporting Innovation System: Their Challenges & Opportunities



We argue that a healthy balance of universities across different positions in our theoretical framework might be necessary in order to accommodate different innovation needs, requirements and opportunities of a nation. In any nation, there is a variety of innovation needs of which particular needs may be suitable to particular type of universities. For example, even within a mainly “*Laissez Faire*” countries such as the United States (US) where the government keep its distance from its HEIs, certain type of higher education and its associated research can still be under the direct control and supervision of central government such as higher military academy (e.g. West Point). Also, in order to particularly serve local needs, some of these institutions might be under supervision of local authorities (e.g. Police Academies). In other case, a certain number of “*Laissez Faire*” type of institutions has to be maintained in order to *always* provide the nation with a *wide range of academically-advanced variety of knowledge and skills* which can be useful later for the society. In the US certain institutions such as Princeton and John Hopkins universities arguably maintain this role at national level and we may certainly find similar type of institutions which operate at the local level. Finally, a certain number of more entrepreneurial institutions needs to exist in order to fulfil the needs to react quickly to new innovative opportunities. Arguably, in the US, this role is occupied at the national level by HEIs like MIT and Stanford (Etzkowitz, 2003).⁵

Corrolary, we also argue that an unbalance university population in a country would create problem to the innovation system because certain type of innovation needs and opportunity might be overlooked to be supported by its Higher Education sector. We suspect that this situation occurs frequently in developing countries. In order to illustrate our argument, in the following sections, we are going to map the state of university population diversity in various developing countries into our framework of analysis.

5. RESEARCH METHODOLOGY

This section briefly explains and justifies the research methodology which is essentially qualitative based on multiple case studies (Yin, 1994). This approach is deemed appropriate for comparing the study of the dynamics of relationships that exist between universities, government and industries within the four countries (Algeria, Indonesia, Malaysia and India). Data about the relationships between universities, industries and governments and the role of universities have been collected through in-depth interviews and desk research. The case studies, which are built from the collected data, provide an insight of government policies and their impact on the relationships and the roles of universities. From this exercise, we expect that patterns can emerge in terms of similar as well as contrasting features across the cases. The above theoretical framework is expected to help us analyse the roles of university on developing nations. Additionally quantitative data from patent and publication databases are added to compare the relative performance of the country on knowledge production and innovation-related activities (e.g. Moed et al., 2004).

6. VARIOUS ROLES OF UNIVERSITIES IN ALGERIA, INDONESIA, MALAYSIA AND INDIA

The four cases to be discussed in this paper are selected because of their relatively contrasting features. Algeria and Malaysia represent relatively small size countries in comparison to Indonesia and India of which the tension between local and national system of innovation might be noticeable in later two countries. Meanwhile, Malaysia and India can be regarded as the two countries which have a more advance and effective implementation of TH strategy for their Higher Education sector in comparison with Algeria and Indonesia.

The complete description of the four case studies is presented in the Appendix A of this paper. It provides us with information on the various roles of universities in Algeria, Indonesia, Malaysia and India. The noticeable features of these roles from the four case studies can be highlighted in the Table 1 below.

⁵ Previous management and economic scholars have also noticed the effect of diversity on performance. For example, Nelson and Winter (1982) in their “An Evolutionary Theory of Economics” book for example argue that variation (diversity) of institutions [firms] is the engine of economic growth and development. Meanwhile, Audretsch *et al.* (2004) argue on the role of variation (of firms) on Industrial evolution. Others like Eastman and Santoro (2003) contend on the role of diversity of values on organizational performance. Finally, Matutinovic (2001) argue that diversity is a natural property of any socioeconomic systems which give their resilient and systemic characters. He argues that the coherence and stability of any socioeconomic system require diversity. Reducing the diversity below a certain threshold may provoke a critical instability of the economic system leading to its collapses.

Table 1: Summary of the four country case studies

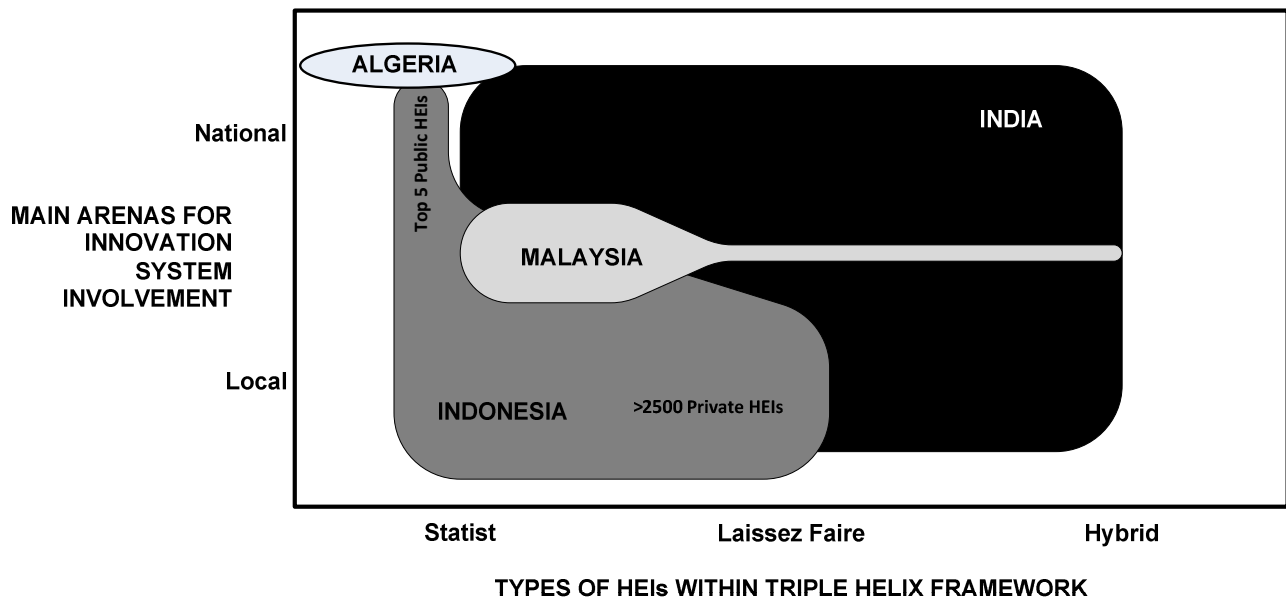
	Arena of Innovation System (Regional Vs National Institutions)	Evidence of Autonomy	Evidence of Institutional Entrepreneurial Activities
Algeria	<ul style="list-style-type: none"> Mainly Public Institutions at national level (<i>HEIs mainly as the "executor" of central government</i>) 	<ul style="list-style-type: none"> Minimal 	Hardly existent
Indonesia	<ul style="list-style-type: none"> Both for State/Public Institutions (<i>Mix roles of public HEIs as the executor of central/local government</i>) Mainly local for private institutions 	<ul style="list-style-type: none"> Partial for Public Institutions Maximal for Private Institutions (<i>Private HEIs are expected to act as the "explorer" of local knowledge</i>) 	No noticeable evidence
Malaysia	<ul style="list-style-type: none"> Both for State/Public Institutions (<i>Mix roles of public HEIs as the executor of central/local government</i>) Mainly national for private institutions 	<ul style="list-style-type: none"> Partial for Public Local and National Institutions Greater Autonomy for Private Institutions (<i>Private HEIs are expected to act as the "explorer" of knowledge</i>) 	Exist in some institutions (<i>Some HEIs take the role of the "exploiter" of knowledge</i>)
India	<ul style="list-style-type: none"> Both for Public Institutions (<i>Mix roles of public HEIs as the executor of central/local government</i>) 	<ul style="list-style-type: none"> Minimal for the majority of public institutions Significant for certain selected institutions (<i>Certain public HEIs are expected to act as the "explorer" of knowledge</i>) Greater autonomy for private universities (<i>Certain HEIs are expected to act as the "explorer" of knowledge</i>) 	Exist in some institutions (<i>Some HEIs take the role of the "exploiter" of knowledge</i>)

7. RESULTS AND DISCUSSION: MAPPING THE POSITIONS OF UNIVERSITIES IN DEVELOPING COUNTRIES WITHIN INNOVATION SYSTEM – TRIPLE HELIX FRAMEWORK.

The result of the above case studies is quiet straightforward. There are different patterns of university population diversities across various studied countries.

Algeria shows a certain concentration of universities towards the upper-left hand corner of our framework. Most (if not all) of Algerian HEIs are under the control or direct supervision of Algerian government. Even though, there might be some trace of autonomy granted to these institutions, in general their contribution to innovation system would be as the result of government intervention into their research and teaching agenda. Also in parallel to this, most (again, if not all) of these institutions operate at national level. Even though their geographical positions might be spread all over Algeria, their role is essentially as the extension of the central government arms to local region. There is no evidence that these geographically spread HEIs to serve local and regional innovation needs. The map of Algerian HEIs in our Innovation System – Triple Helix framework can be illustrated in Figure 2 below.

Figure 2: Map of Algerian, Indonesian, Malaysian & Indian HEIs within the System of Innovation – Triple Helix Framework.



Meanwhile, Indonesian case shows another interesting pattern. There are a mix between *Statist* type of HEIs which are public and the “*Laissez Faire*” type of institutions which are mainly private (i.e. some public institutions have recently been granted a wider autonomic rights). However, practically no HEIs have shown some entrepreneurial flair for example by establishing noticeable Science & Technology incubators or noticeable formal Technology Transfer Office (TTO). In addition, most of these HEIs operate at local/regional level serving local needs of skilled graduate as well as work with local partners. Only a small number of institutions have the capability to operate at the national level to contribute to the national system of innovation of the country. Amongst these HEIs, practically no private institutions with their “*Laissez Faire*” autonomic privilege have established the reputation at national level to serve the needs of Indonesian national system of innovation. Even though, the Indonesian HEI system is more diverse than the Algerian, at national level they are more or less comparable in their capacity to contribute to their respective national system of innovation (See Figure 2).

Unlike Algeria, Malaysia HEIs are more diverse. In fact, for a relatively small country with a small number of institutions, Malaysia HEIs are more diverse in comparison to Indonesia according to our Innovation System – Triple Helix framework. Even though the majority of its HEIs are either Federal or Regional State public owned institutions, some of them enjoy certain degree of autonomy to develop their own teaching and research agenda. One may trace an early evidence of entrepreneurial flair of as some of these institutions have started establishing TTO offices and being involved in patenting and technology licensing activities (See Figure 2)

The HEIs in India are more diverse than the other previous countries. In India there are HEIs that operate both at National and Regional (State) level. Although the traditional institutions are under strict control of authorities, some institutions enjoy complete autonomies such as IIT, IIS and other private universities. Certain private universities operate both at regional and national level⁶ Some of the institutions have shown some entrepreneurial activities such as IIT and IIS (See Figure 2).

⁶ (E.g. Birla Institute of Technology and Science).

It can be seen easily from the map that the diversity of roles of HEIs in a country can be associated with its relative innovation performance (See Table 2 below for publication data as an indicator of knowledge production performance and Table 3 for patent data as an indicator of innovation performance). Even a slight trace of diversity as shown in the case of Malaysia can be associated with its relatively higher performance of this country in innovation. Even though Indonesia has a relatively higher number of HEIs, their positions are rather concentrated within the local *Statist* and “*Laissez Faire*” region of the framework. Only a small number of public universities that are somewhat under the *Statist* regime have the capability to operate at the national level. This explains the relatively lower performance of this big country in innovation in comparison to its peer country such as Malaysia. Algeria can be clearly considered as the least performing country with most of its institutions are situated within the smallest region of the map, while India is the better performing in comparison with the other 3 as it occupy most of the region in the framework.

Table 2: ISI Science Citation Indexed publications between 2005 to 2009

	Total	University Contribution (Approximate Value)	University Contribution To Total (Approximate) (%)
Algeria	6281	4959	78.95
Malaysia	13850	12734	91.94
Indonesia	4113	2947	71.65
India	179727	133257	74.14
Vietnam	4249	3484	82.00
Thailand	21540	19519	90.62
China*	258643	251336	97.17
Japan	457374	412579	90.21

* In the case of China we only count the publications between 2005 to 2007.

Source: ISI Science Citation Index

Table 3: USPTO & WIPO (PCT) Granted Patents applied between 2005 to 2009

Assignee Country	Patent Database	Total Patents	University Patents	Government Patents	Private Patents [#]
Algeria	USPTO	0	0	0	0
	WIPO	45	1	0	44
Indonesia	USPTO	30*	0	0	30
	WIPO	110	0	1	109
Malaysia	USPTO	101	4	5	92
	WIPO	967	***	***	***
India	USPTO	n/a	n/a	n/a	n/a
	WIPO	7357	***	***	***

[#] Including Individuals

* The majority of these patents are Design patents

*** Several but not specifically counted

Source: USPTO

8. CONCLUSIONS AND SOME IMPLICATIONS TO POLICY MAKING

In conclusion, it is not a question of the sheer number of HEIs that a country should have but rather the diverse roles and types of HEIs that exist in a country – fulfilling the needs of various innovation opportunities and requirements – that, at the end, can determine the innovation performance of the country. A high number of HEIs can become worthless if they only serve the needs of particular segment of society and industry. A healthy balance of different types of HEIs would provide the country with a wider palette of knowledge production and exploitation needed for effective innovation performance.

For policy makers, the implication of this conclusion to the selected countries above is then pretty obvious. The countries which have a higher proportion of *Statist* HEIs controlled by the government and operate at national level, like Algeria should grant certain autonomy to some of its institutions while at the same time offer the opportunities to some of its institutions to operate at local level addressing their social and industrial needs. Meanwhile, the countries which have a higher proportion of their institutions operating at the local level, should help some of them rise up their game, building sufficient internal capabilities in order to support innovation at national level. They should also start supporting some of its institution to become more entrepreneurial in order to better exploit knowledge that these institutions have produced. Finally, the countries which already have a diverse type of institutions like Malaysia and India should enhance more the diversity of their HEIs by addressing certain area within our framework of which the number of universities is still lacking. These various policy implications can be schematised in the figure 3 below.

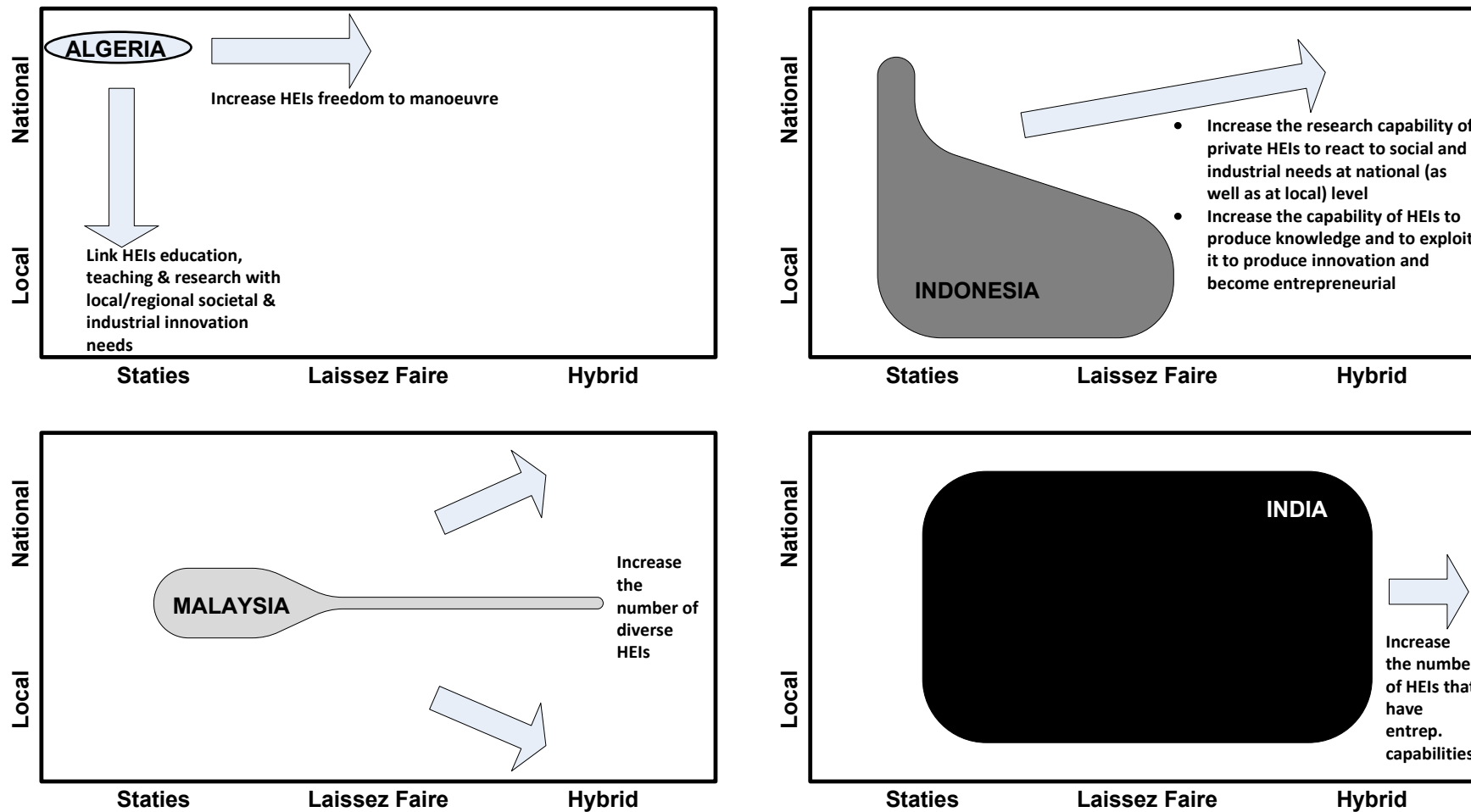
In general, government should ensure the diversity of its HEIs. It should grant them freedom to regulate their own affairs while protecting, supporting and helping the area in the framework where their involvement is seen to be lacking. In this system, each HEI is expected to adopt a differentiation-type of strategy which will maximize its competitive advantage. This in turn will maximize the diversity of HEIs in the countries.

This conclusion is somewhat different than that of the TH concept which implicitly suggests that all universities are expected at the end to become entrepreneurial universities. We argue that this type of suggestion can be counterproductive as in the long-run, such HE system can run out of ideas for its exploitation activities and may need new fresh knowledge produced by its more explorative institutions⁷.

In the future, a more quantitative approach will be used to assess whether diversity of HEIs in a country can be associated with its innovation performance as well as the direction of causality between the two constructs. In order to do this exercise, exhaustive survey questionnaires have been designed to capture the diversity of HEIs in particular country.

⁷ As it has been suggested by previous scholars (Rosenberg & Nelson, 1994 and discussed in Eun et. al. (2006))

Figure 3: Options for Algerian, Indonesian, Malaysian and Indian Policy Makers to increase the impact of their HEIs on Innovation



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APPENDIX A: CASE STUDIES

A.1. The Algerian case study

The main role of the Algerian universities has essentially been aimed at creating the required capabilities to support the economic development and industrialization of the country through the acquisition of advanced and new technology from developed nations. A series of reforms have been introduced in Algerian higher education Policy. In 1971, radical changes were introduced such as the increase of the number of student intake and the change on the contents of teaching programmes with the aim to enable universities to support the ambitious economic and social government programs (Bennoune, 1988).

In 1999, a second major reform was introduced with the objective to prepare Algerian universities to support the transition from a centralized to a free market economy (Benziane, 2004). A degree of autonomy was then granted to universities and faculties in order to align part of their activities to the specific needs of their region and industry in order to diversify their sources of funding for research and development programs. This has stimulated demand from local private and public companies for specialized postgraduate courses and consultancy services which, in turn, has been crucial for the emergence of a fledgling entrepreneurial academic culture. However, this demand has been limited in extent, occasional in character and dependent on isolated actions or instructions from the top (Ministries or National headquarters for state companies).

This second reform did not provide for sufficient power to be devolved to local actors. Algerian universities are still heavily dependent on the Algerian Ministry of Higher Education and Scientific Research of which the main mission of the Algerian universities is around teaching. The level of research activities is rather low and essentially limited to fundamental research of which the themes and objectives are fixed and funded by the State and the Ministry of Higher Education and Scientific Research. The research priorities and management are essentially led by the General Direction of Research and do not always fall within the responsibility of universities.

There are 43 universities and most of them provide similar courses across the country. There is no spécialisation by region or by subjectif except for the 'Grandes Ecoles' such as 'Ecole Polytechnique, Ecole de Travaux Publics, Institut des Telecommunication, Ecole Nationale de l'Administration, Institut du Petrole and Ecole du Commerce. These special universities or institutes are increasingly being removed from the responsibility of the Ministry of Higher Education and transferred to the other Algerian ministries in charge of their sector of specialisation.

Most of the research activities linked to the national priorities are conducted by full time researchers working in research centres such as the 'Centre de Recherche en Economie de Developpement', l'Agence National du Developpement de la Recherche sur la Sante, etc. The status of academic staff is essentially described in terms of teaching (Enseignant) rather than teaching and research (Enseignant/Chercheur).

In 2009, there were around 1200 academic staff involved in 7000 research projects within the Algerian universities. This research is essentially fundamental and hardly linked to specific economic, social or cultural needs of the surrounding environment. The industry is scarcely linked to or involved in this research whose findings are far from being capitalised or published.

Even though in the most recent decision, the Algerian government proclaims that scientific research and technological development are national priorities¹⁰ and setting up of new organisational and institutional practices and mechanisms with an investment of 100.000 Millions Dinars ((1.6 billion \$) for 2008-2012, the Algerian universities are still heavily dependent upon a centralised system which clearly corresponds to the *Statist* stage of Etzkowitz (2003). The development of adequate forms of proximity which can have a positive impact on the creation and exchange of knowledge as a basis for innovation is still impeded by the issues of heavy centralisation, power, bureaucracy, rigid boundaries, hierarchy, adversarial relationships and lack of trust.

¹⁰ Of which the first priority includes the importance of the scientific research to contribute to address the economic, social and cultural aspects of the national development.

A.2. The Indonesian case study

The Higher Education Element of Indonesian National Innovation System consists of the mix between Public and Private Institutions. According to the Indonesian Higher Education survey in 2007, 97% of Indonesian HEIs are private (Gunawan, 2008).

In spite of their small number, Indonesian public HEIs usually enjoy higher academic reputation than their private counterparts. It usually attracts the most gifted students from all over the country. There is usually competitive national entry examination test for public HEIs. 80 to 90% of their budget come from the government subsidies. In general, the salary of the faculties of public HEIs is low by international standard which make them often do secondary jobs to supplement their salary. In recent year, this has led to the departure of certain faculties abroad, notably to Malaysia.

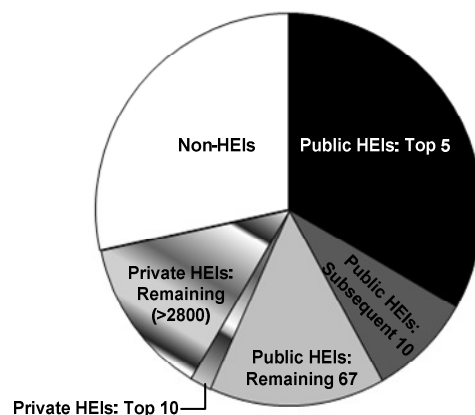
Private HEIs which receive little support from the government are usually run by foundations and are almost tuition-fee driven institutions. As a result, they enjoy a certain degree of autonomy in terms of its academic and managerial activities. However, government has recently started strengthening the Teaching Quality Assurance in order to clamp down low standard teaching delivery of some of these private institutions (Jardine, 2010).

Even though, Indonesian public HEIs receive a majority of their budget from the government, they also enjoy a relative degree of autonomy. Unlike in the primary and secondary education, HEI faculties are allowed to tailor and design their own curriculum and the internal academic structure of their institution. Recently, this autonomy has started including the power to increase/decrease the number of student admissions; to manage their revenues and expenditures as well as the change of university control from 100% government to a board of trustees (of which the government – through the Ministry of Education – would act as a member of the trustee) (Fahmi, 2007).

There are around 3000 HEIs in Indonesia. However, there are not more than 10 institutions which have established a national reputation. The majority of these “National” institutions are from the public sector. From these institutions, no one appears in the top 500 of any international university ranking system. The majority of Indonesian HEIs focus their activities to fill local demand of skilled graduates. Unfortunately, local economy cannot absorb all universities graduates.

There are huge differences on the ability of HEI institutions to contribute to Indonesian’s knowledge production. Around 80% of knowledge production outputs are produced by public institutions of which Top 5 leading public institutions have the biggest share (See Figure 4 below).

Figure 4: Share of Publication of various Indonesian Institutions in Web of Science between 2005 to 2009



Source: ISI Web of Science

In general, the level of innovation performance of Indonesia such as the number of patent granted is low in comparison to its other peers. The contribution of HEIs to this innovation performance is quasi inexistent¹¹. There is no clear evidence on the existence of entrepreneurial university activities across the country. Entrepreneurial

¹¹ Please refer to Table 2 and 3 in the discussion part of the paper.

activities are often undertaken by individuals academic without any measurable impact both on the University and Indonesian national innovation performance.

The Indonesian government has, for the 10-20 years, been relatively active in terms of developing and implementing policies (e.g. ABG oriented policy (Academic, Business, Government), etc.) and regulations (e.g. R&D Tax Relief, etc.) aimed at supporting the development of innovation. Dedicated institutions (e.g. the establishment of Agency for the Assessment and Application of Technology¹² in 1975, the establishment of Indonesian Committee for Enhancing Indonesian System of Innovation, creation of Business & Technology Incubators, etc.) and other specific programs (e.g. Advanced Cooperative Research Grants (RUK), etc.) have also been set up in particular by the State Ministry of Research & Technology¹² (RISTEK, 2009). However, tangible performances are yet to be seen. It is nevertheless worth noting, actions aimed at formally enhancing the participation of Indonesian HEIs on supporting Indonesian Innovation System start being taken only for during the last 5 years with the establishment of the ABG oriented policies¹³ (Kadiman, 2008).

A.3. The Malaysian case study

Malaysian Government has made a great commitment in pushing the universities to be entrepreneurial. Some public universities have set up, or are in the process of setting up commercial arms in the form of a private holding company (NSTP II, 2000).

In a recent development the Government has conferred a research university status to its top four local universities. These universities are designated under the Ninth Malaysia Plan to be the country's first fully fledged research universities where each would receive RM50 million for (USD15 million) research, development and commercialisation activities. Furthermore in 2008, the Malaysian Government has launched the Accelerated Programme for Excellence (Apex) for its universities. Under the Apex programme the universities were promised autonomy in finance, service scheme, management, student intakes, study fees and determining the top leadership. Thus far, only one public university, Universiti Sains Malaysia (Science University of Malaysia) has been selected for the programme.

There is also evidence of entrepreneurial behaviour in other Malaysian universities, as, for example, in the establishment of USains Holdings (the university's commercial arm) by the Universiti Sains Malaysia (Malairaja 2003). Almost all top public universities in Malaysia have their own technology transfer offices (TTO). However, the Malaysian universities and the government both are still having problems with the clarity of the roles and functions of TTOs. The first problem is related to the ability and expertise of the university to have the right policies and an adequate level of resources to run this rather new interface office.

Most universities in Malaysia are striving to establish active relationships with industry. However, these relationships are more related to educational development, consultancy and training. The university is seen by respondents from both the government and industry as the institution that can provide consultation and advice (mostly based on technical expertise). In fact, government also uses universities to implement their policies.

However, partners from industry are still doubtful about the attitude of universities towards changes and hence the nature of relationships which currently exist between universities and industry. This view is also echoed by those of university staff and government agencies who believe that administrative procedures and structures impose a constraint on the development of strong and trusting relationships between universities, government agencies and industry. Most universities in Malaysia are characterised by a significant level of bureaucracy and the absence of teamwork and a partnership culture (Malairaja, 2003; Saad and Zawdie, 2005).

Evidences from the fieldwork revealed that most Malaysian universities' are being positioned within either the *statist* or *laissez-faire* Triple Helix model, even though some of them inadvertently show some entrepreneurial flair. The Triple Helix system has yet to fully evolve in Malaysia. At the moment, universities are still struggling to fulfil their role as entrepreneurial institutions. Universities are still struggling to find industrial partners and to commercialise their research. In addition, R&D collaboration between universities and industry has not yet reached a satisfactory level.

¹² Which was established itself in 1962

¹³ This is somehow not an excuse for explaining the lowest degree of Indonesian HEIs publication outputs in comparison with their peers.

The Government remains to operate as the dominant sphere in the development of knowledge and innovation. Both academia and industry remain dependent upon the government in for overall coordination, objectives, planning and resources. This corresponds somewhat to a *statist* Triple Helix model. However, it is important to note that most Malaysian universities are no longer acting as just teaching institutions as they are conducting research and setting up incubators (with strong support from the government), thus playing a role in the sphere of industry with mix results.

A.4. The Indian case study

The University system in India was set up in imperial British India in 1857. It was based on the University of London model, as it was during the time, in which the university did not carry out any teaching and research but rather focussed on examination of students that were educated in affiliated colleges. This situation did not change till early twentieth century when post graduate teaching was gradually introduced. Research was an aspect that was traditionally neglected in the university system during the imperial period. Scientific research during this period was essentially fostered by native efforts outside the university system through establishments of autonomous institutions that did basic research but hardly any teaching. The separation of teaching and research that later came to characterise the university system in independent India thus had its genesis in the imperial era. As India gained its independence in 1947, the apathy of the State towards research, both basic and applied, not surprisingly changed. However in a decision that had far reaching consequence, the first government of independent India decided to keep the boundaries of the university system largely intact and focused on research on science and technology through institutions that were largely outside the higher education sector. Many publicly funded autonomous research institutions were set up to carry out basic and applied research but these institutions did not carry out any significant teaching or training of students. The separation between teaching and research thus became permanent feature of the academic landscape of India.

On the contrary, the nature of interactions between University and Industry in India has changed over the years. In the colonial era there was little interaction between the two, as the university system essentially supplied the human capital to staff the civil service and judiciary¹⁴. Post independence, the graduates of Indian university system found employment in a much wider range of careers including in the Industry. Other forms of university industry linkages such as industry sponsored research projects, joint publications of scientific articles, business incubators in universities, has started to flourish only recently in certain institutions such as Indian Institutes of Technology (IIT) and Indian Institute of Science (IISc). These institutions have witnessed higher intensity university industry linkages. For example almost all the business incubators that have been started in academia in India can be traced to the IITs and IISc. These institutions have also been the main recipients of industry sponsored projects albeit still quite small in number.

In general, traditional Indian universities suffer from a lack of autonomy (Dahiya 2001, Kanhere et al 2009) and this has led to not only in a fall of academic standards but also to poor linkages with the Industry. These universities have been starved of research funds and there is little institutional incentive for academic staff to engage in research activities. By contrast, the parallel higher education system comprising of autonomous institutes such as IITs and IISc has enjoyed relatively greater freedom from State control (Agarwal 2007). These institutes have been far more successful in forging different relationships with the industry, be it in the form of research projects or business incubators.

Currently there are around 20 central universities, over 200 state universities and more than 100 state HEIs other than universities. Under these institutions there are more than 10000 higher education colleges feeding the student to the university level. Some of Indian HEIs have international reputation according to different type of Global university ranking¹⁵. In recent decades, there have been also establishment of private universities, which add to the palette of diversity in Indian HEIs.

¹⁴ the two key institutions that supported and maintained the imperial government

¹⁵ For example, according to Times Higher Education, IIT, Indian Institute of Management and Jawaharlal Nehru university are amongst the top 200 universities in the world. Birla Institute of Technology and Science – a private university – were listed amongst top 20 Institute of Technology according to Asiaweek.