

A QUALITATIVE INVESTIGATION OF TECHNOLOGY TRANSFER*

A CASE STUDY

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TECHNOLOGY transfer is an issue of national importance and it requires careful planning. Effective transfer of technology and its management ultimately leads to increased modification, adaptation and integration of foreign technology with indigenous technologies. If, however, that does not happen, any technology transfer dependent economy will be unable to become self-sufficient and lose its competence in the global economy. ASEAN countries, in general, addressed technology transfer issues within their national development plans, but technology transfer still remains a major challenge. The nature of technology transfer, timing and mix of technology interventions in the economy are still not clear. As part of a major study, the authors studied the technology transfer issues in Brunei, a wealthy oil-rich member of ASEAN countries. Through successive national development plans Brunei attempted to strengthen its technological capability. Technology transfer issues gained prominence in Brunei in its effort to industrial and economic diversification. This paper provides some insight into the directions of technology transfer in Brunei from multi industry perspective.

Introduction

Several Asian and Latin American countries adopted competitive protectionism policy for industrialization [Etzkowitz & Brisolla, 1999]. Many newly industrialized countries (NIC), such as Singapore, South Korea, Malaysia and Taiwan, opted for technology transfer as core strategy for industrial and economic diversification [Cherion, 2000; Weiss, 1988]. Technology transfer issues, however, for a country should be considered in association with many developmental issues such as:

- æ* Possibilities of forming strategic alliances with more technologically advanced nations to facilitate the industrial and economic development process.
- æ* Opportunities to diversify the existing economic base through the undertaking of resource based industrialization plans, as well as export oriented industrialization and import substitutive industrialization initiatives.
- æ* Utilization of sustainable technology transfer options in view of effective technology management requirements.
- æ* Country's ability in attracting foreign investment.

The authors conducted a major study in providing a framework for industrial and economic development in Brunei. The study explored the potential opportunities for industrial and economic development, and analyzed the future directions for Brunei. In this paper we identify some of the important technology transfer issues for Brunei, a less researched but economically wealthy country. In-depth analyses of relevant literature and documents, as well as observations and interviews were undertaken in the data collection process. We analyzed the direction Brunei adopted towards diversifying its existing technological and economic base.

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There are three primary objectives of this paper: one, to provide a better understanding of the technology transfer issues in Brunei. Two, to study the technology transfer issues from a holistic point of view, which encompasses qualitative evaluation of various sectors of the economy and their interactions on each other. Three, to provide specific policy options for Brunei to strengthen its economy through technology transfer.

The paper has been organized in six sections. After this brief introduction, we discuss the concepts behind the technology transfer framework as suggested by the Asian Development Bank in Section 2. In this section we also discuss the interactions between the levels of technological capability with technological applications in an economy. Section 3 examines technology policies from demand, supply and linkage perspectives in the economy. The next section, Section 4, examines in detail the technology transfer framework as applied to Brunei. The technology environments in various sectors of the economy are described. Technology options for Brunei are discussed in Section 5.

Technology Transfer

Some of the ASEAN nations' ability to quickly follow on the heels of industrial success of the newly industrialized countries (NIC) had a lot to do with the transfer of technology from more technologically advanced nations [Ariff and Hill, 1987]. Technology transfer is not a simple channeling of hardware from one advanced nation to another developing or underdeveloped nation [Inkster, 1991]. According to Inkster (1991), the idea of indigenous technological capabilities must be seen as conditional upon the physical character of imported technique itself, and this has changed through time.

The experiences of Asian nations like Taiwan and South Korea have provided empirical evidence that industrial development is enhanced significantly through effective technology transfer and technology management. Critics of technology transfer often argue that technology transfer would invariably lead a recipient nation to become overly dependent upon the donor nation. This is likely to be an accurate viewpoint in so far as the recipient nation does not put into place suitable mechanisms to manage this technology and learn to adapt the technology as required. Adaptation and understanding of technology has to follow closely if technology transfer is to be managed successfully. The continued industrial success and growth of the Asian NIC's such as Taiwan and South Korea and the ASEAN frontrunner Singapore, can be attributed to the export oriented path taken by these countries and the effective adoption, assimilation and adaptation of suitable technologies through technology transfer from advanced nations [Inkster, 1991].

Effective technology management should ultimately lead to increased modification, adaptation and integration of foreign technology to cater to indigenous conditions and demands otherwise, any technology transfer dependent industry will be unable to become suitably self-sufficient to justify its existence and compete in the global market.

Figure 1 shows the elements that play important roles in the application of technology for productive purposes.

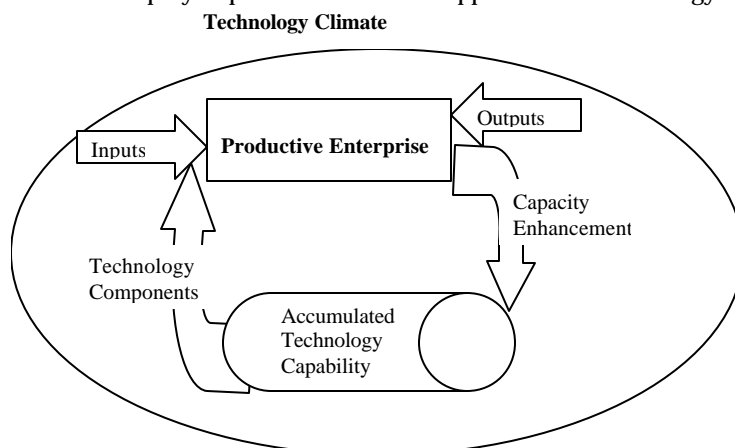


Figure 1: Framework of Technology Transfer and Development

Source: [ADB, 1995]

From the diagrammatic representation in Figure 1, it can be seen that the main element is the productive enterprise, which constitutes the heart of the nation's economic activities. This productive enterprise is the organization responsible for transforming inputs into useful outputs for the benefit of the nation. The inputs used by these productive enterprises to deliver value added useful outputs could be separated into two main categories, these being (i) Resources and (ii) Technology. Resources would encompass raw material inputs, land, capital, energy and semi-finished goods.

Level of Technological Capability

The level of technological capability is important to determine the level of technology being transferred. The level of technology being transferred from a technology advanced source to a recipient can only be absorbed by the recipient if the recipient has a level of technological capability befitting the level of technology being transferred [Hewitt, Johnson, and Wield, 1992]. The stages of technological application depend upon the activities such as modification, imitation, improvement, redesign or innovation. Figure 2 illustrates the relationship between the level of technological capability against the stage of technical application or activity as espoused.

Four aspects of technological capability are important:

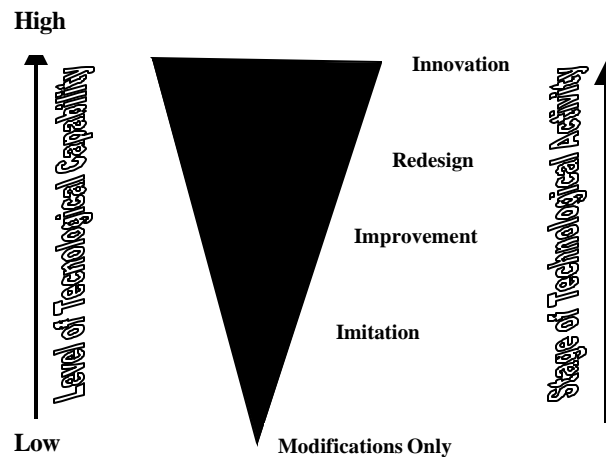


Figure 2: Relationship between levels of technological capability and stage of technical application

- ⌘ *Operative capability* - which includes the operation and maintenance of the technology components used in transformation activities
- ⌘ *Acquisitive capability* - which includes upgrading the components of technology through searching, selecting, negotiating and arranging timely procurement.
- ⌘ *Supportive capability* - which includes: project execution, human resources development, defining market needs, arranging funds for business development, and re-orienting enterprise business and technology strategies.
- ⌘ *Innovative capability* - which includes adapting and duplicating imported technology, building of prototypes and facilities for testing and developing new products and processes (see Figure 2).

From a firm level or micro-level perspective, all these capabilities can only be developed and enhanced if the technological infrastructure and climate in a nation is conducive and supports such innovation and enterprise. Therefore, the success of local firms is highly dependent upon these technological infrastructures available or provided for in any particular nation. The ADB suggests that the technology infrastructure consist of the three factors: technology mentors, technology guiders, and technology innovators.

The technology climate and technological capabilities of firms determine the policies applicable at national and industry level. The following section describes various policy alternatives.

Technology Policies

Technology policies can be examined under the following categories:

- ✍ Demand side policies.
- ✍ Supply side policies.
- ✍ Linkage policies.

Demand Side Policies

In order to create a market for technology, the demand for technology has to be stimulated accordingly. This is achieved through “influencing factor prices and availability, the nature and extent of domestic demand for goods and services, the nature of competition in the market place, and the mode of production activities” [ADB, 1995]. Some of the more commonly applied demand side policies are as follows:

- (a) *Sectoral Policies*: These policies have predominance over specific sectors of the economy and cover areas such as agriculture and foreign investment.
- (b) *Monetary Policies*: These policies are essentially devised to control the degree and depth of capital supply as well as determine the exchange rate of money.
- (c) *Infrastructure Policies*: These policies sustain the provision of physical infrastructure such as utilities, telecommunication and transportation.
- (d) *Resource Utilization policies*: These policies are designed to influence the utilization of natural resources and monitor as well as regulate environmental conditions.
- (e) *Procurement Policies*: These policies govern the purchase and provision of goods and services by domestic as well as international firms / organizations.
- (f) *Trade Policies*: These policies essentially ascertain the extent and distribution of imported and exported products and services.

Supply Side Policies

In order to ensure that there is an appropriate response to the demand for better quality and new products, technology capabilities have to be built up accordingly to be able to react to this need to satisfy demand. In order to ensure technology capabilities for this purpose, supply policies have to be put into place.

The more commonly applied supply side policies include the following:

- (a) *Research and Development Policies*: These are essentially targeted to improve and strengthen research and development capabilities. These policies assist to provide support to establish research associations, professional associations, learned societies and other such related organizations.
- (b) *Innovation Enhancement Policies*: These policies are meant to strengthen all related activities involved in the commercialization and launching of a new product or process. These policies include the guidelines for government purchases, tenders, contracts, etc., disclosure on the development of new technologies, the protection and preservation of local firms that are producing state of the art products, and also outlines the mechanism by which technological information networks should be developed and enhanced.
- (c) *Human Resource Development Policies*: These policies are related to education (primary, secondary and tertiary), vocational and industrial training, the application of foreign expertise, repatriation of skilled personnel, mobility of, and reward systems for, skilled human resources.

Linkage Policies

The demand side policies and the supply side policies need to be suitably interfaced in order to ensure that both these policies facilitate the effective building up and management of technological capabilities. In

view of this need to have a proper interface between demand side policies and supply side policies, linkage policies are utilized. The linkage policies utilized to facilitate this interfacing of demand side policies and supply side policies are as follows:

- (a) *Financial Instruments:* These include measures such as special credit line for the development of prototypes, the provision of loans at preferential interest rates in strategically selected areas of technological development, as well as exchange control mechanisms.
- (b) *Fiscal Instruments:* These include measures such as selective tariffs to serve as barriers to protect certain areas of local technology development from imported technology. Tariff exemptions on the importation of capital goods in designated priority areas of technology development, as well as tax exemptions and other incentives for research and development, and human resource development.
- (c) *Legal instruments:* These include laws, decrees, by-laws to guard against intellectual property theft, environmental conservation, adoption of codes and standards, enforcing adequate compensation of human resources, foreign investment guides, the regulation of trade practices, the facilitation of the setting up of new enterprises.
- (d) *Administrative instruments:* These include special provisions as well as government orders such as those that assist in establishing new science and technology committees and advisory councils.

The policy considerations, as stated above, also need to be viewed in relation to four more characteristics:

- ✂ Physical facilities such as tools, equipment, machinery and structures, which enhance human physical powers in transformation operations.
- ✂ Human abilities such as skills, knowledge, expertise and creativity, which contribute to the utilization of available natural and technological resources.
- ✂ Documented facts such as design parameters, specifications, blueprints and operation, maintenance and service manuals, which facilitate rapid learning and save time and resources.
- ✂ Organizational frameworks such as methods, techniques, linkages and practices, which coordinate the productive activities enterprise in order to achieve positive results.

These four characteristics have to interact effectively to produce useful synergy. This synergy is important to ensure the proper performance of productive enterprises in an economy. In the next section, we discuss technology transfer issues in Brunei.

Framework of Technology Transfer and Development in the Context of Brunei's

As shown in Figure 1, the productive enterprise is the main element, which constitutes the heart of the nation's economic activities. The productive enterprise is essentially the organization responsible for transforming inputs into useful outputs for the benefit of the nation. Firms in Brunei have to understand that these inputs are required to deliver value added useful outputs. The research undertaken suggests that Bruneian firms are indeed appreciating the fact that quality outputs can only be delivered if the initial inputs are considered carefully in the first place (Cherion, 2000). There is evidence to show that Brunei's firms are starting to embrace new technology and the more open market.

The companies that do manage to embrace new technology and move forward accordingly will have the potential to contribute positively towards building of locally based resource capabilities and facilitate the industrial and economic development of the country. Similarly, the organizations that are currently serving the existing established industry, i.e. the oil and gas industry, are also transforming themselves to embrace the new technological climate. These organizations must appreciate that in time to come, only those companies that are able to successfully implement change agents and evolve with the times, will ultimately be key players on the local scene.

The mixing and matching of characteristics such as organizational framework and human resources has to be done selectively and appropriately. The result of adding inputs from one category to another without proper consideration can in fact suppress the dynamism required to produce useful synergy. Interaction and trade-off have to be considered carefully. The Brunei government appears to lead from the front when it comes to any major vision or objective. This is the case with industrial development as well. The government has stated in their Seventh National Development Plan (1996-2000), that human resource development is a pre-requisite to industrial development. Firms in Brunei have to invest in their personnel by providing them with career and professional development paths and opportunities. The government of Brunei plays a major role in spearheading the adoption of technology for facilitating development. The Brunei government wants to ensure that the application of technology is done in accordance and within the guidelines of its own socio-economic development philosophy. This philosophy is essentially based upon Brunei's Melayu, Islam, Beraja (MIB) concept. Melayu, Islam, Beraja, literally translated means Malay, Islamic, Monarchy. MIB is the government's initiative to ensure that Brunei's traditional culture, values, folkways and mores are captured and retained despite technological, economic and social advances. Therefore, in Brunei, socio-economic development will only proceed within the guidelines of the Brunei Malay, Islamic, Monarchy, cultural backdrop. The Brunei government has made it clear that it will not allow elements that are deemed to undermine the MIB concept to be embraced in the name of any form of progress, be it social, political, economic or technological. In Brunei, the productive enterprise must take into account these philosophies when considering their overall direction and the selection of their technological inputs.

Technology may be generated either through importation (technology transfer) or by development (technology development). In Brunei's present case, it is most reliant on the importation of technology for development. Development of technology locally is being pursued and needs to be continuously improved in order to reduce the dependence on foreign technology transfer. Currently though, the options available are limited.

As shown in Figure 1, the enterprises' competitive edge can be improved by increasing the productivity of the technology utilized. The Seventh National Development Plan (1996-2000) reported that four Brunei based garment factories had successfully exported their products to the United States of America (USA) and the European Union (EU). This apparent success has been construed by some local entrepreneurs to imply that these Brunei based firms have the capability to produce quality goods. It is suggested by these entrepreneurs that nations such as the USA and the EU would not consider importing products into their market unless the products imported meet certain minimum quality control and assurance requirements. However, though quality and capability to produce quality products are likely success factors, these must be put into perspective in the context of Brunei's ability to export garments to the USA and EU. As pointed out by Hiebert [Hiebert 1995], Brunei does not have quota imposed on it as have some other developing nations, with regards to garment exports to the USA and Europe. This opportunity has been exploited by joint ventures in Brunei such as Perkasa-Huaky Garments, a Brunei-Singapore private joint venture [Hiebert, 1995]. The lack of such trade barriers as well as the generous tax incentives and other incentives accorded by the Brunei government has indeed assisted in the success of such joint ventures in exporting to foreign markets. There have been at least six other textile manufacturing companies established in Brunei since 1989. These joint ventures are mainly from Hong Kong, Singapore and Malaysia who mainly want to gain access to the USA and EU markets by exploiting Brunei's export quotas by being registered as Bruneian firms. Garment manufacturing has risen to being the second largest contributor to foreign export income after oil and gas. The total export value of garments had risen from B\$10.0m in 1989 to B\$40.0m in 1994 (The Far East and Australasia, 1997).

Bruneian firms must appreciate the fact that the competence to produce quality outputs consistently, can only be achieved through experience in the process and the resulting understanding on how to apply and adapt technology to suit specific applications. This is an important step towards enhancing technological capability through institutionalized learning. Nation's such as Brunei that rely significantly on foreign technology transfer options need to be able to learn and apply effective technology management. The local Bruneian workforce must be able to reach a level where they are able to add value to imported technology through their experience gleaned from working with and applying this foreign technology. Individual firms that contribute to Brunei's industrial development and economic growth, require this enhanced capability to effectively use appropriate technology for organizational transformation as well as to manage technology and its applications in the pursuit of sustainable development.

This process of determining and selecting the correct combination of technological inputs to achieve desired productivity outputs is complex and requires effective planning. The selection of technological inputs by the productive enterprise in Brunei is also determined largely by the market condition (both domestic and international), the firm's own direction and government policies.

Firms in Brunei, especially those serving the oil and gas industry, have been slowly but surely progressing in this regard. Operative capability is a key ingredient in securing products and services contracts within the oil and gas industry. Firms that are able to prove their operative capability to the oil and gas operating companies stand a much better chance of securing profitable products and services contracts. Brunei Shell Petroleum Company for instance is increasingly sub-contracting out supply and services work to reliable and established contractors. This is to enable them (Brunei Shell) to concentrate on their core business and operations activities. Domestic out-sourcing has become commonplace, and local firms have to gear themselves up to benefit from this trend.

Despite the challenges faced by private sector firms such as a shortage of skilled labor, private sector firms in Brunei must adapt to changing market conditions and improve their operative capabilities. Apart from firms in the oil and gas industry and related services sector, local firms in the computer and IT industry in Brunei have increased considerably and they too need to be capable of meeting the demands of improved operative capabilities. As the local market becomes more augmented, local consumers will expect a certain level of service quality and capability from their local service providers. Taking the industrial markets as an example, if the local firms can meet the expectations and satisfy the demands of their clients, only then will the local Bruneian firms be able to sustain transformational activities to keep pace with the evolving market trends and technological advances. The impetus is required for acquisitive capabilities to be perfected. This is especially so since there are a number of projects (oil and gas as well as non-oil and gas related) being undertaken on a turnkey basis. The only way to prove their capability is to be able to meet customer needs and progress from there. Local firms have to prove that they have the necessary skills, capabilities and human resources available to successfully participate in some way or form in these projects. There is a profound need to increase the local content related to such projects in all aspects of project coordination, successfully pursuing and increasing local content in both Greenfield and Brownfield projects, to further enhance locally based capabilities. In this regard, local firms have managed to take positive steps towards sharpening their acquisitive skills though there is still much room for further development and improvement. In order to grow, local firms have to start developing their own in-house human resource capabilities. The pursuit of developing supportive capabilities has begun in some local firms and the reality is that only those firms that succeed in doing so will ultimately survive and command market share.

One of the successes of many of the newly emerging markets in Asia, was due to the ability of the firms within these nations to adapt and duplicate imported technology and produce relatively good quality products and services based upon the knowledge gleaned from overseas. These newly emerging Asian nations pursued value-added philosophies in developing new or hybrid products, service and processes. Though the economic crisis that affected the region has slowed the momentum down marginally, the seed of innovative capability has been sown and the fruits will be reaped. This is evident through the economic recovery of nations such as Malaysia and Thailand for example, who have shown greater commitment, transparency and wisdom in financial and economic management, as a result of the lessons learnt from the 1997/1998 Asian economic and currency crisis. Firms in Brunei too need to adopt this approach towards building their innovative capability. This is not a simple short-term prospect. There is a long and difficult road ahead for most Brunei firms to effectively develop their innovative capabilities.

As with all other organizations worldwide, the direction taken by Bruneian firms towards technology transfer and development is ultimately determined by its stakeholders. The stakeholders essentially determine the overall philosophy and path taken towards technology transfer and development. An organization that decides to pursue the path of technological self-reliance will therefore undertake to secure licensing agreements with other entities that own the intellectual property (IP). This will of course be only possible if the local organization has the appropriate level of capabilities and resources to support, add value and sustain the technology that has been licensed. If such technology or IP is new or state of the art, it is unlikely that the IP owner would be willing to license the technology to any third party. The IP owner therefore would most likely insist on a joint

venture with the local organization as this enables the IP owner to control degree and depth of the technology transfer and ensure that the local technology assimilation is kept to a minimum.

Local market conditions and attitudes also play a key role in determining the kind of technological activities an organization should employ. The organization has to be customer focused and market driven in order to be able to apply appropriate technology, depending upon customer preferences, perceptions, demands, attitudes, etc. If local market demand is not sufficient to sustain the production of an organization's goods and services, the organization will have to look for overseas markets to survive and grow. Local market competition is another important factor that affects the technological direction pursued by firms in Brunei. Due to the small size of the local market, the competition for market share is high. The market conditions and transparency of laws that govern the market structure is dependent upon government policy and the implementation of such policy. The technological direction of a firm therefore, is affected by these macro level conditions. Government policies and laws governing technology transfer, commerce and trade, foreign investment and ownership, capital flow and control, etc., all have a major bearing on the direction taken by local firms at the micro level. In Brunei, government technology policies are formulated to provide an overall picture and direction the government intends to pursue with respect to technology and its applications, in order to facilitate the effective management and assimilation of suitable technology by both government and non-government institutions.

Local culture in general also determines the success or failure of local firms and industries. This can be illustrated by using the consumer industry as an example. For instance, considering the fashion industry, if society is extremely brand conscious and perceives only Italian or French fashion products to be worthy of acclaim, it would be extremely difficult for a local firm to venture into this industry. The local firm could enter the industry at a lower level targeting cheap, ready to wear fashion, or try its hand at expensive custom made fashion. This high-end option will require significant resources for marketing and business development in order to change customer perception and mindset. Alternatively, the firm may try and secure a joint venture with reputable foreign organizations for the manufacture of branded products locally. This however will require the local organization to prove its capability in maintaining high quality and standards as well as a myriad of other requirements that can cause the venture to be unattractive for both parties. Even in such an arrangement, customer perceptions are difficult to overcome. If the local market perceives the locally produced branded product is inferior to the product manufactured at the country of origin, the venture would eventually fail. To overcome this perception, significant and profound marketing efforts would be required which in turn would be extremely costly.

Technology Options and Discussion

This study has found that Brunei will require sustained and well-managed technology transfer in the foreseeable future, if it is to effectively pursue its industrial and economic development plans. This study has shown that technology transfer is characteristically complex and it is difficult to summarize technology transfer as a simple definition. This is because technology transfer encompasses several processes and mechanisms, each linked either explicitly or implicitly, and requires supportive structures within the recipient nation for effective management and sustainability. Brunei has to be able to adapt imported technology to suit local requirements. By forging strategic alliances with its major trading partners like Japan, Korea, Taiwan, and ASEAN neighbors such as Malaysia, Singapore and Thailand, Brunei will be able to take full advantage of trade leverage to solicit favorable technology transfer options.

This study has shown that the level of technological capability is important to determine the level of technology that can be transferred. Consequently, technology recipient nations like Brunei need to evolve the required level of technological application changes. Based on the analysis of data, it is evident that at present, Brunei is very much still in the modification of technology phase. Even here, modification of technology is limited because indigenous technological capability is still lacking. Nevertheless, the study has also shown that in some areas such as garment manufacture and the poultry industry, Bruneian firms have managed to apply technology to suit their requirements and produce outputs through the utilization of this applied technology for commercial benefit. More importantly, it appears that the application of technology in these sectors has been relatively well managed and the output sustained at profitable levels. This study has shown that this success has been achieved largely due to appropriate government intervention in terms of subsidies, quotas and import restrictions.

This study has also shown that the development of human resources is required to facilitate the industrial and economic development of Brunei. Analysis of data indicated that the Brunei government has been doing its part to enhance local technological capabilities. The data analyzed provides evidence that the Brunei government has continued channeling a sizeable portion of the nation's revenues into setting up several educational institutions from primary school level to tertiary level, including practical technical and vocational institutions. Given Brunei's small population size, the financial cost of establishing, operating and maintaining such institutions is significant.

This study has been largely qualitative, based on literature search, official documents and selective interviews with government and industry experts. Even with its limitations, the study provided a general understanding of various technology transfer issues at various sectors of the industry. There is a need for more in-depth and comprehensive study of technology transfer in Brunei, for such a study will help planners to develop more meaningful plans for the future.

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