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Integrating Business and Technology Strategies in Developing Countries

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ABSTRACT

In the present era of deregulation, privatization and increasing global market competition, most industrialists in developing countries have come to the realization that better technology is needed for the survival of both public and private sector enterprises. Therefore, they acknowledge that technological considerations must be properly incorporated into overall business strategies. However, in the absence of an established theory and due to lack of relevant data, they face enormous difficulties. This paper describes a simple framework for integrating business and technology strategies, particularly in the context of developing countries. Possible strategic mixes are identified by considering four commonly practiced business strategies, namely: price, value, niche and image leadership; and four evolving technology strategies, namely: technology leader, follower, exploiter and extender. Necessary considerations for technological capability development and technology strategy progression path are also discussed for different enterprise situations and development conditions.

Introduction

Technology is an indispensable means for all individual enterprises. Technology not only enables necessary transformation operations, but it also provides the vital underpinning for survival and prosperity of the enterprise in an increasingly globalized and interlinked world economy [1, 2]. Recent technological advances are contributing to changes in industrial productivity and costs, impacting on global and national structures of production, trade, and employment [3]. A successful global business, in the present era, manages technology to create a competitive edge [4, 5]. Therefore, the most important strategic consideration for international industrial competition is the management of technological innovation faster than others [6, 7, 8].

In the developed economies, there is an observable emphasis on technological innovation and specialization in industrial restructuring for boosting international trade as more and more the value of a product is determined by the technology that goes into it, and not by the raw-material that constitute it [3, 9, 10]. A thorough study on industrial productivity in USA by the MIT Commission [7] clearly states that "for continued success in world trade, new ideas generated in the United States and elsewhere must be converted into products and processes that world-wide customers want, when they want them, and

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before competitors can provide them—and those must be produced efficiently and well." This prescription is equally valid for developing countries, which accept the free market concept and aspire to join the global economy [11]. Therefore, to compete effectively in the open global marketplace, a company must learn to integrate technology management with strategic planning [1, 12]. In other words, all top managers have to link technology capabilities to marketing requirements [10, 13].

In a developing country like Indonesia, which is now introducing trade liberalization policies, the state-owned enterprises are under strong pressure to improve productivity and become internationally competitive. To the top managers of these enterprises, the need for integrating their business and technology strategies is, therefore, obvious. But a methodology for doing so is still lacking. Current literature includes many papers on business strategies, which have looked into the causes of superior performance and the process by which competitive advantages are created [14, 15, 16, 17]; methodology relating marketing and manufacturing strategies to choice of technology [9, 6, 10], and papers focusing on the intersection of technology, competitive strategy, and organizational theory [1, 18]. Recently, Pavitt [23], Porter [19], and Stacy [5] argued that analytical framework needs to be designed to integrate technology and business decisions, which can ensure a long-term view in investment planning in the highly competitive globalized economies. Others have looked into the innovation aspects and shown that success of business depends on timing of innovation, investment in infrastructure and technology climate [15, 18]. However, in the context of developing countries, attention has been given so far only in technological capability advancement through local research and development efforts [11, 20, 21, 22]. Attempts to integrate business and technology strategies in the developing countries are not common yet.

Besides the absence of a theory for technological change management in developing countries, there is also a lack of clear understanding of options and opportunities. For example, in the forseeable future, existing Indonesian industries will have to attempt the difficult task of survival in an open economy on the basis of upgrading their production facilities through imports. But they find that, exporting raw-materials and primary goods, to pay for imported machinery and process know-how, is a losing business, because the purchasing power of these commodities have steadily fallen while that of machinery has continuously risen over the last two decades. Furthermore, state-of-the-art machinery, which can give true competitive edge in the international market, is normally not sold but can only be exchanged for something equally valuable [23]—which means that they will have to produce some exportable technologies. Therefore, consideration of technological capability building for both technology generation as well as for transforming raw materials to high value-added products is becoming extremely important for enterprises in developing countries ambitious to join the global market [11, 20, 21]. This implies that there must be a balanced emphasis on import and self-generation of industrial technologies.

Using some of the recent concepts of measuring technology for capability building [24, 25] in developing countries, the author has developed a simple technology-management information system and introduced a few technology-based planning methodologies for productivity growth and corporate strategy formulation in a number of state-supported strategic industrial enterprises (BPIS) in the Republic of Indonesia (known as BUMNIs of the BPIS), which are being prepared for privatization during the next five years. As Lead Consultant, the author had the privilege of close interaction with the following Indonesian industries involved with the "science and technology management information system" project (project no. INS/89/015) sponsored by UNDP/UNESCO:

PT.IPTN (aircraft); PT.KRAKATAU (steel); PT.BARATA (construction); PT.INTI (telecommunication); and PT.INKA (railways). Experience gained in dealing with these BPIS BUMNIs in Indonesia so far indicates that although each enterprise has to develop its own unique competitive strategy, it is possible to start with a general framework using some generic strategies to arrive at their specific positions.

This paper describes briefly a general framework for integrating business and technology strategies in a way that aligns the firm's strengths and weaknesses with the external opportunities and threats existing in a developing county economy, which is introducing trade liberalization. The framework is based on an analysis of the overall systems structure and an understanding of the technology capability development process in a developing country.

Dynamics of the Production System Structure

Michael Porter, in three successive books [26–28], has developed a set of detailed and highly regarded paradigm for the analysis of business strategies based on different aspects and considerations. First, he presented a framework for analyzing the competitive industry structure [26], which is built around five market forces (power of suppliers, power of buyers, threat of entrants, threat of substitution, and intensity of rivalry). Second, he proposed that the basic unit of competitive advantage is the set of nine activities in the value chain [27] of a firm (five primary activities—inbound logistics, operations, outbound logistics, marketing, after-sales service; and four supportive activities—procurement, technology development, human resource development, and firm infrastructure). Third, he asserted that the determinants of national competitive advantage form a diamond [28] of four attributes representing the surroundings of a firm (factor conditions, demand conditions, related and support industries, and industry structure). Based on the ideas contained in these models and adding the necessary focus on technological considerations, it is possible to construct the productive enterprise system structure as schematically presented in Figure 1. Brief description of this diagram follows.

Technology is a human-made resource comprising various components, which enables an enterprise to perform its productive activities. The key elements that influence the technology content potential of the enterprise are: technology components available to the enterprise and technology capabilities possessed by the enterprise. The enhancement of any enterprise's competitive edge in the marketplace can be accomplished by increasing the quantum of the technology content added by the enterprise operations, which in effect is achieved through the enhancement of the degree of sophistication of technology components utilized, and the level of accumulation of technology capabilities. Technological components enable desired transformation and technological capability of the firm from performing activities over time, acquiring resources from outside, or some combination of the two. Capability accumulation is a process of institutional learning, which results in both increased productivity and economic efficiency of the enterprise.

Commonly distinguished technology components [24, 29] for conversion of inputs to marketable outputs are: object-embodied physical facilities (such as: tools, devices, equipment, machinery, structures—called technoware), which enhance human physical powers and controls for the transformation operation; person-embodied human abilities (such as: skills, expertise, creativity—called humanware), which contribute to actual utilization of available resources; record-embodied documented facts (such as: design parameters, specifications, blue-prints, manuals—called inforware), which enable quick learning and help time and resource savings; and institution-embodied organizational frameworks (such as methods, linkages, practices—called orgaware), which coordinate activities for

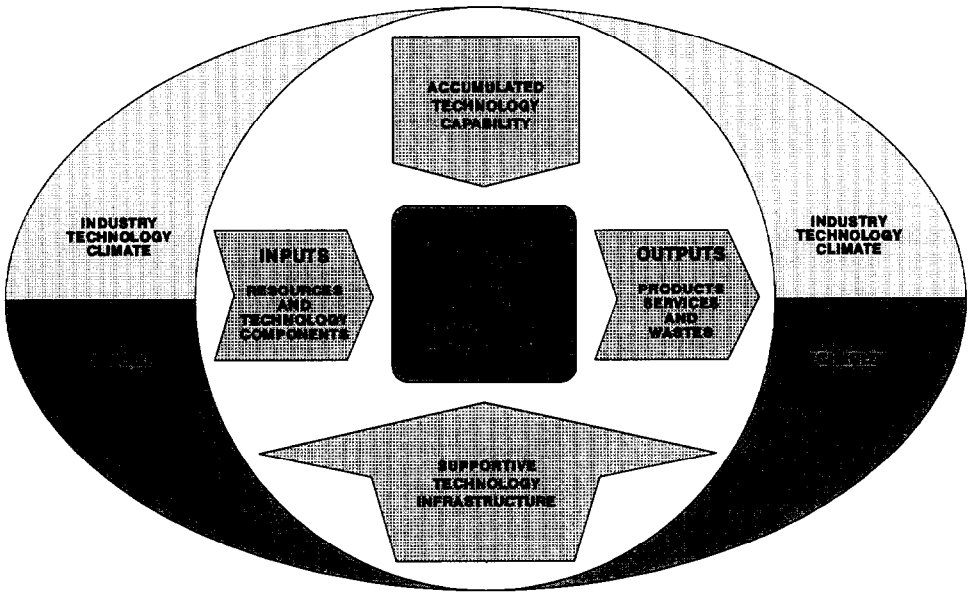

Fig. 1. Productive enterprise system structure.

achieving purposeful results. Generally, technoware degree of sophistication corresponds to increasing complexity of the physical transformation operations; humanware degree of sophistication indicates increasing level of competence; inforware degree of sophistication represents increasing utility of available facts; and increasing orgaware degree of sophistication results in improved overall performance in the marketplace. Improvement in the degree of sophistication of the four components of technology gradually enhances the technology capability potential of an enterprise.

The enterprise in a developing country may obtain the above-mentioned components of technology in two ways—either through import or local development. However, to use imported technology or to develop technology components, experience of "doing" and "institutional learning" needs to be accumulated which gives rise to different technology capabilities [25]. Technology capability of an industrial enterprise can be classified into four types in the following order of development—technology utilization capability, technology compilation capability, technology acquisition capability, and technology generation capability. Technology utilization capability includes operation and maintenance of technology components for transformation activities. Technology compilation capability includes commissioning all required physical facilities and coordinating mobilization of all resources. Technology acquisition capability includes upgrading all available embodiment forms of technology through searching, selecting, negotiating, and securing arrangements for timely procurement. Technology generation capability includes defining market driven needs through continuous customer preference surveys; designing new products and processes by staff training and applied research; developing prototype and scale-up facilities by providing adequate research and development (R&D) funding; deriving commercial benefits by patenting; and arranging venture capital fund for product-process innovation. Different technology capabilities become important over time as an enterprise needs to react to and take advantage of new opportunities of the changing world [25].

The components of technology and technology capabilities are interrelated in a systematic way. Moreover, acquiring technological competitiveness is progressive in nature, and is not a once-and-for-all event but a continuous process of accumulation and innovation [11, 20]. Developing countries are initially dependent on imports for sophistication in the degree of technology components. For advancement of technological capabilities, these countries are also very much dependent on the transnational corporations (TNCs) or national technology infrastructure and climate for innovation [15]. Without utilizing advanced technologies and blends of the traditional and advanced, the surpluses needed for self-reliant economic growth cannot be generated [11]. Therefore, considerations for technology transfer and development can be more effective if one attempts to take advantage of the unique characteristics of the four technology components, the process of technological change, and the strategic progression in enhancing technological capability at the enterprise, industry, and national levels.

It may be interesting to note here some of the observations regarding the evolution of competitive industries described by Porter [30]: an initial advantage in factors of production often provides the seed for a competitive industry, some early competitors may emerge out of a specialized factor creating mechanism like research university, the seeds of competitive industries are also found in related and support industry clusters that stimulate factor creation, intense rivalry spurs enterprises to move beyond the initial factor advantage to upgrading specialized factors for more advanced segments of the market, the need to overcome factor disadvantages influences the direction of improvement and innovation, a demand surge, an input price shift or a significant technological breakthrough can create discontinuity in competition, etc. The above observations imply that for competitive advantage, in addition to the basic factors of production (land, labor, and capital), we also need to consider other specialized factors, which may be called technology infrastructure and technology climate, which are explained in later sections of this paper. The (industrial and national) technology climate is, however, dependent on the industry competitive structure and cultural-political aspects. A cascade of various infrastructure and climate factors determine a firm's ability to manage technological change effectively [24].

Available Generic Strategic Mixes

Considering the overall system structure discussed in the previous section, an attempt is made here to integrate technological considerations into overall business strategies of an enterprise for successful competition in the international market, under the current circumstances in developing countries. It is found useful to begin the desired integration process by considering presently practiced business strategies which give rise to comparative advantage in the marketplace. The business strategies can be categorized as striving for:

- price leadership through producer cost minimization;
- quality leadership through user value maximization;
- niche leadership through segment feature specialization; and
- image leadership through customer prestige creation.

The rationale for considering these strategies are explained in the following paragraphs. Additional details and further explanations regarding the commonly known business strategies of "price leadership" and "market differentiation" can be read from many recent publications [14, 1, 10, 23, 19, 17].

Initially, price competition remains to be the most preferred strategy for market entry. However, as an enterprise grows, there has to be an increasing emphasis on output quality, flexible manufacturing methods and organizational sophistication [9, 6, 3]. Quality concern is supplemented by market differentiation as technological innovations contribute to economic welfare and progress of an enterprise through market gains based on segmentation [26, 31, 18]. First, a new product or innovation is introduced in a market niche where the unique properties of that product or innovation is highly valued. As experience is gained, and the product and processes are improved, it can be introduced in still other niches where its special properties and better qualities are also valued. With the increase in sales volume, due to learning effect, economy of scale and much higher competition, product price diminishes [9, 10]. If improvements in product design, manufacturing and distributing efficiencies continue, then the differentiated products eventually gain large market shares [3]. During this process, it is known that the product attributes must be approximately equivalent with competing offerings in order for cost to influence the customer. Similarly, costs must be near parity in order for a price premium for unique features to yield advantage. As different segments of the market has different needs, differentiation allows a firm to command a premium price by providing unique and superior value to the customer in terms of product quality, specialized features, and/or after-sales services. However, firms have to be innovative to find new niches in the market in order to cope successfully with the saturated markets for existing mature products, as benefits of a comparative advantage soon level off as other firms introduce similar changes. Hence, well established firms use a strategy based on appeal or image strategy. The image strategy at present is focused on environment. This is relatively new and the emphasis nowadays is to directly prevent or reduce negative or adverse effects on environment due to industrial activities [32, 13]. There is already competition among countries (and their TNCs) for leadership in attending to the environment [13].

Although price competition (for declining markets), quality competition (for growing markets) and feature competition (for mature markets) have been meaningful strategies for a long period [28], increasingly nowadays it is observed that retaining comparative advantage will depend on the ability of enterprises to compete beyond quality and feature on the basis of the current image factor—environmental soundness or green leadership [32, 13]. It has been suggested that companies ignoring "green" pressure would be casualties that will sweep the global marketplace [32]. This is because most governments (both in developed and developing countries) have now recognized their special responsibilities for the conservation of natural environment and thus they are introducing necessary legislation for strict enforcement. In anticipation of being branded as the blacksheep, the business community has also accepted a proactive responsibility and is voluntarily introducing a strategy of green leadership [32, 13]. Environment related business is expected to be the driving force of the future economy and the source of most new competitive advantages in international market. It is also hoped that developing new technology for sustainable development will naturally link environment management with innovation management of the firm [30].

The ramification of technology is implicit and pervasive in each of the above-mentioned business strategies. However, to consider technology aspects explicitly, it is desirable to pay attention to the possible technology strategies for securing competitive advantage. A plausible classification of technology strategies can be identified as pursuing:

- leadership through generation of state-of-the-art technologies;
- follower position through adaptation of advanced technologies;

- exploitation of standardized technologies in a growing market; and
- extension of the salvage value of obsolete technologies.

The growth of a firm and the trajectory of its technology are closely interwoven [4, 23]. It is a major factor in determining the cost, quality, feature, and image, which may be observed to be directly linked to the life-cycle characteristics. In the introduction phase, the performance requirements for new products and market needs are not well defined, which means the source of innovation is often the users and the business strategy is customer and environment responsiveness. In the growth phase, the basis for competition is on performance and specific features. In the maturity phase, with achieved standardization, the basis for competition shifts from performance to diversification with respect to niche markets. In the decline phase, when new technology is substituting an older one, the continuation of older but still functional products and processes can give competitive edge to companies with significant brand loyalty due to image or to small enterprises serving the price sensitive market vacated by industry leaders (who adopt new technologies for higher value markets).

From the discussions presented above it is possible to identify the available business options as: to make products/processes which are cheaper, better, segmented, and also greener. It is also possible to observe that the available technology options are related to the life cycle in terms of generation, adaptation, exploitation, and extension. And the market value is seen to be closely related to the stages in the product life cycle. A synthetic overview of the strategic mixes corresponding to market focus can be seen in Figure 2, which provides a general picture of the full range of strategic options that could be considered to identify the most desirable strategic mix by a firm. The shaded area in Figure 2 indicates that although strategic emphasis may shift but earlier stages are not ignored. Different combinations of the business and technology strategies may be utilized for different segments of the market that give different values to the customers and profit to the enterprise. However, it may be noted that success and failures of technology strategy progression depends to a large extent on the intensity and nature of interactions among the elements of the system structure.

According to Porter [28], success of an enterprise is manifested in attaining a competitive position that gives superior performance, and there are three stages of advancement in international competition: (1) basic factors of production driven, (2) investment driven, and (3) advanced factor based innovation driven. In order to expand and diversify the industrial base of a developing country and to increase the competitiveness of its exports, a coherent technology strategy is essential. Furthermore, the technology strategies of enterprises in developing countries should change over time coinciding to different stages of industrialization and for different stages in the life cycle as follows:

Stage 1 – imported and old technology based small and medium scale enterprises for low-value local market;
Stage 2 – selective importation of technology mostly through joint ventures by medium-size firms;
Stage 3 – creative imitation based on licensed technology enabling large-firms enter international market; and
Stage 4 – introducing self-developed technologies giving rise to temporary monopoly in emerging areas.

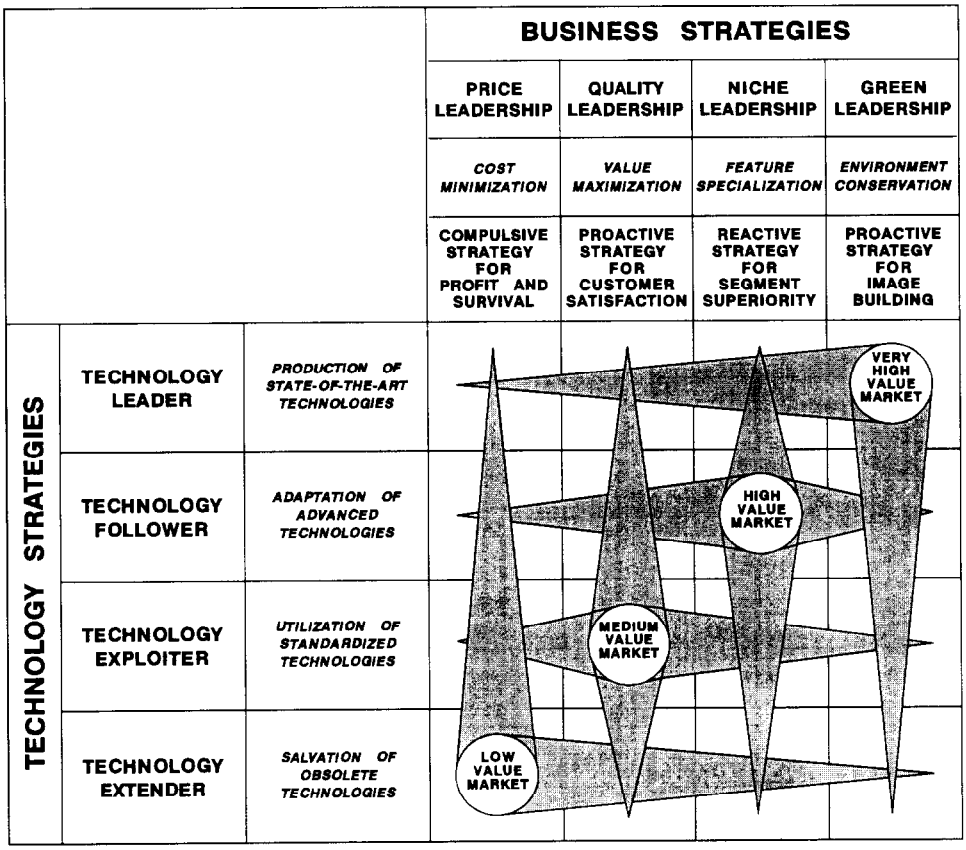

Fig. 2. Integrating strategic mixes to markets.

There is significant technological implication of the above restructuring process in a developing country like Indonesia. As indicated earlier, to ensure adequate consideration of technology strategies, one must assess the dynamics of the technological innovation process and also understand the nature of the technological progression path. These are discussed in the next section.

Technology Innovation and Strategic Progression

As the underlying process for strategy advancement is the continuous introduction of technological innovation [18], it may be worthwhile to consider the implications of the three major types of innovations which help an enterprise to attain competitive edge, shown in Figure 3. The innovation triangle comprises the crucial linkages among three types of institutions—academic institutions engaged in science and technology education and research, wide range of science and technology related research and development (R&D) organizations, and the engineering and industrial productive enterprises. Three major technology innovation chains resulting from the above mentioned triangular linkages are: product-process innovation, knowledge-skill innovation, and methods-package innovation. However, all phases in any development chain are not necessarily of equal importance, and development is not a linear process (feedback loops). A large number

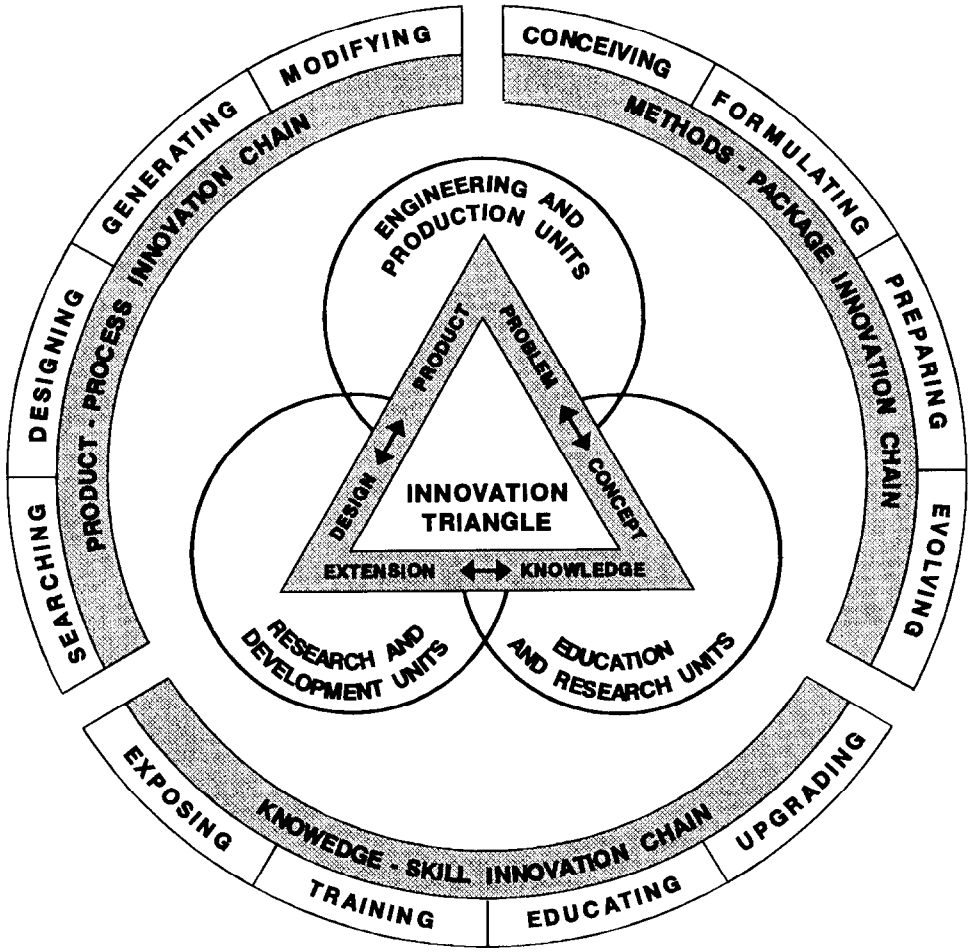

Fig. 3. The triangular innovation processes.

of promotion agents (institutions) are engaged in supporting any or all of the innovation chains. The totality of these institutions can be called the "advanced factor creation mechanism" or simply the technology infrastructure.

Special preferences of the customers often make technological innovation essential under free market conditions. Whether the customers are price, quality, feature and image sensitive, determines to a large extent the mix of business strategies of an enterprise, which in turn influence efforts in technology components and capability development. Global leaders often begin with some advantage at home, although their global strategy creates new advantages that are sometimes more durable [28]. One key success factor for innovation is that the enterprise must be located in a place that has the reputation for evaluating and using the outputs in a demanding way—a location with better technology climate.

Industry technology climate can be either a constraint or a catalyst for achieving the full technological potentials of an enterprise. Strong competition from rivals and

openness of the market put pressure for continuous technological innovation. One competitive industry helps to create related industries in a mutually reinforcing process. This process of industry evolution at a place often breeds new competitive industries and hence builds or extends a cluster. Once a cluster forms, the whole group of industries become mutually supportive. Well developed cluster of related industries helps pooling of private resources for technology factor creation – human resource development, information services, consultancy services, etc. Clusters provide mobility of skilled manpower, which magnifies and accelerates the process of factor creation. A concentration of rivals, customers and suppliers promote efficiency and specialization. Geographic concentration of a cluster can also influence the innovation process [28].

Besides the support of the technology infrastructure and the conduciveness of industrial and national technology climate in developing countries, most important considerations in identifying strategic progression path requires a thorough assessment of the status of available technology components and accumulated technology capabilities of the enterprise. Although all four components of technology are necessary for each type of capability, the specific combination and the relative importance among the four components of technology are different. And because of the interactions and trade-offs among the four components, choice of technology is a very complex decision. For an enterprise to develop competitively from the initial start-up stage to expansion stage to consolidation stage and then to mature stage, technological capabilities need to be upgraded through institutional learning effect and progressive addition of sophisticated technology components, which are required specifically for each of the capability type. In addition to the relative importance of technology components for different technological capabilities, the relative importance of technological capabilities also changes as an enterprise attempts to move from the extender strategy to the leader strategy.

Considering all of the above, the general path for technology strategy progression and corresponding requirements with respect to degree of technology component sophistication and the level of technology capability accumulation is schematically shown in Figure 4.

The proven path for strategic progression in the developing country context is from technology extender to technology exploiter to technology follower and then to technology leader (in very carefully selected areas of specialization). To achieve this desired progression, it is crucial to allocate adequate resources for technology capability development infrastructure and promote better technology climate [20, 15]. The nature and success of technology transfer would depend to a large extent on the existing technological capabilities of an enterprise and its technology strategy [23]. It may be noted that, internationally technology is moved either for economic benefits or/and to take advantage of environmental regulations. It can be observed from international market trends that technology transfer to developing countries encounter the following limitations: latest physical facilities cannot be bought in the open market; human abilities, provided as foreign assistance, is of generally poor quality; documented facts, particularly critical ones, are protected; and organizational frameworks need adaptation for transplantation. However, observing from the sequential substitution process of technological change, it may also be noted that "leapfrogging" is possible (by skipping intermediate stages) by late-starter developing countries in physical facilities, provided one is very selective and considerable investment is made in developing human abilities, documented facts and organization frameworks [29].

Being a technological leader requires that firms are fast, fearless, fluid, facilitative, and flexible with respect to technological innovation [9, 3]. They become industry leaders, cater to a very high value market, spend heavily on research and development, and

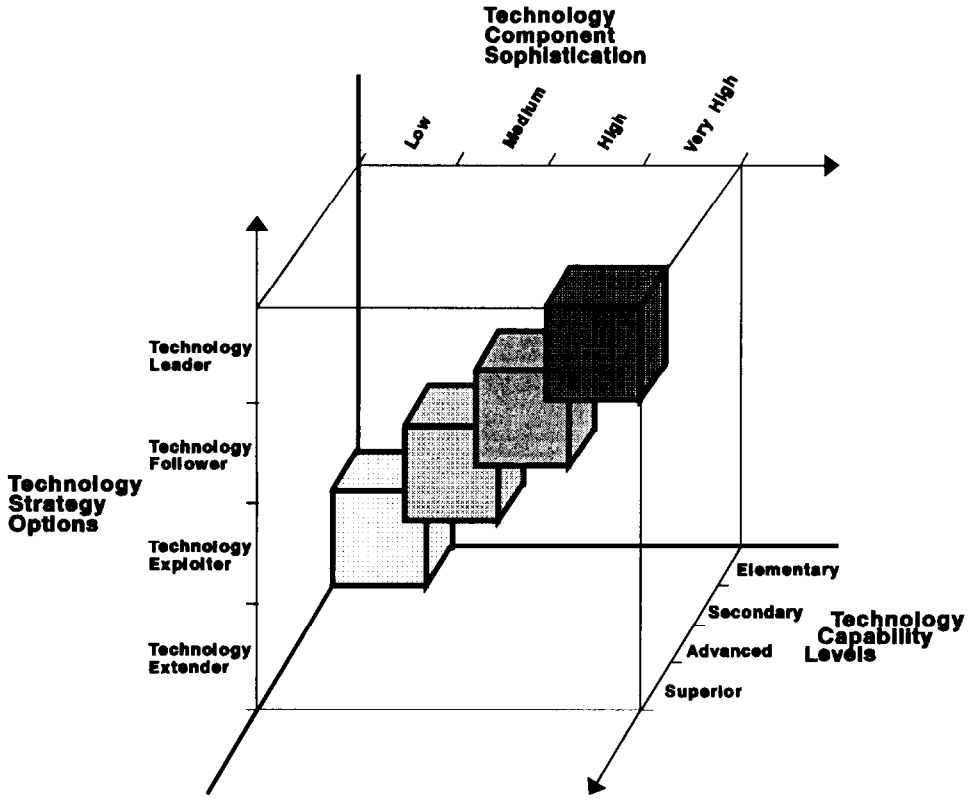

Fig. 4. Plausible technology progression path.

determine to a large extent the technology trajectory of the industry. Technology followers can reap benefits if they could buy state-of-the-art facilities or modify products and processes through reverse engineering. They need to be very good at quickly adapting advanced technologies to join the high value market in the beginning of the growth phase of the product life cycle. Technology followers neither have the first-mover advantage (super-normal profit) nor their disadvantage (high cost and risk). When the market is growing, exploitation of standardized technologies may give rise to rapid growth (strategy successfully implemented by the newly industrialized countries, like Korea, Singapore, Taiwan) [28]. They cater to medium value market with advantage in production factor costs (cheap labor and raw-materials). But, exploiter strategy cannot be sustained unless the infrastructure is built to move into follower and then leader strategy in selected areas. Technology extenders cater for the low value price-sensitive markets which have been vacated by the industry leaders. This is one of the reasons why production technologies that are suitable for extender strategy are readily transferred to the developing countries.

The technological progression pattern from extender to exploiter to follower to leader does reflect a process of industrial restructuring broadly determined by competitive market forces. At the beginning, a developing country industry is almost exclusively dependent on imported mature technologies to take advantage of relative abundant endowments of either natural resources or unskilled labor, or both. During this period local technological

capability likely to involve principally the effective operation of simple imported technologies. These resource or labor intensive industries face difficulties over the years due to either depletion of natural resource or decline in labor productivity. For quality competition, industry needs capability to acquire better technologies and also capability to maintain and adapt imported technologies (highly skilled human resource is needed) and thus it has to move into exploiter situation. The transition to the next level requires a greater degree of local capability for improvement of imported technologies. Although all firms need not be able to engage in major product and process innovation, they must at least have the capacity to undertake incremental improvements in existing technologies, as competition is increasingly based on product differentiation and value addition. Successful entry into this follower strategy requires a large number of scientists and engineers. To move into the leader category, innovative capability becomes most important prerequisite and entrepreneurship is often the critical bottleneck in many countries.

Strategic Options and Illustrative Examples

Many kinds of quantitative and qualitative measurements are necessary to analyze the productive system structure as discussed in the previous sections. If measured, status of technology components and capabilities of the firm can indicate strengths and weaknesses (levels of selfreliance/independence of capability in developing countries). The status of the technology infrastructure and technology climate indicate opportunities and threats. The relative gap in the technology components utilized by an enterprise vis-à-vis the best practice elsewhere (that is, state-of-the-art) can give an indication of the potential for improvement through technological innovation. However, to determine the preferred strategic development path it is essential to assess the technological capability of the enterprise. Any firm needs to progressively develop its technological capability if it is to achieve sustained growth. For instance, a firm which starts with a technology extender strategy should achieve outputs of desired quantity and quality very efficiently. Thus, the firm needs at least operative (utilization) capability. But, to move on from the extender strategy to the exploiter strategy, it will need (in addition to utilization capability) the capability to mobilize (compilation) and acquire (acquisition) new technologies. The need for acquisitive capability becomes even stronger as the firm develops further and starts pursuing a technology follower strategy. Ultimately, to become a world leader, the capability to develop (generation) new technologies on its own is most critical. It may also be noted here that the relative importance of the four components of technology are quite different for different capabilities. For example: facts and abilities are more important for acquisition; facilities and abilities are more important for utilization; facilities and facts are more important for compilation; whereas abilities, facts, and frameworks are all very important for generation. How to measure some of these are mentioned in the following paragraph.

Some of the possible measures for assessing (relative to state-of-the-art or best practice) technology components are technoware complexity, humanware competence, inforware utility, and orgaware effectiveness. Major factors determining technoware complexity include scale of operation, scope of outputs, quality of outputs, and safety or environmental soundness of operation. Factors determining humanware competence may include level of general education, appropriateness of training, relevant experience, and motivation of the personnel. Important factors determining inforware utility are relevance, timeliness, and reliability of acquired facts. Major factors determining orgaware effectiveness of an enterprise may include cost, quality, time, and environment related

advantages. Some of the factors that are important in assessing various technology capabilities are full capacity utilization capability, most efficient compilation capability, independent acquisition capability, and self-reliant generation capability. Some of the desired measures for assessing technology infrastructure are continuity of development chains indicated by absence of missing links with respect to all technology components and capabilities development processes, adequacy of the infrastructure indicated by the presence of minimum critical mass for each promotion agent, and the strength of innovation triangle linkages (product-process, knowledge-skill, methods-package development chains) with respect to actual functioning in terms of flow of money, technoware, humanware, inforware, and orgaware. Some of the common measures for assessing the dynamism of industry technology climate are intensity of market competition, size of cluster, sophistication of customers, and conduciveness of policies. Progressiveness of national technology climate are indicated by general attitude toward innovation, and society's reward structure for risk taking.

It is possible to use a relative scoring method in terms of selected qualitative attributes, such as "low-medium-high-top" for degree of sophistication of technology components; "elementary-secondary-advanced-superior" for level of advancement of technology capability, "poor-average-good-excellent" for status of development of technology infrastructure, and "negligible-weak-moderate-exceptional" for order of stimulation by technology climate. Once the individual positions are assigned the attributes (with predefined scores), a simple weighted average can give the overall situation. These measurements can reveal the probable implications for strategic decisions and they may strengthen the exercise of foresight and prudence in identifying proper business strategies along with the technology strategies. Such measurements need wholehearted commitment of the top management and invariably involve enterprise specific information perceived to be confidential. Therefore, the systems analysis framework presented in this paper were tested by the enterprises themselves and were found to be useful. Even though the author participated in a series of working sessions to operationalize the methodological framework, the comments in this section are by design very general.

All of the enterprises recognized that, although overall strategy requires choosing to emphasize combination of the business and technology options at any particular time, the progressive nature of technological capability building cannot be ignored. The dynamism of the strategic choices is therefore derived from a strategic selection of the route for gradual but determined advancement from the extender, exploiter, or follower situation to the leader situation and then continuous innovation for retention of the leading position. Furthermore, it was also observed that, in selecting the current option and in determining the development path, it is also essential to consider another level of distinction: new firms based on new technologies, new firms based on old technologies, and introduction of new technologies (either self-generated or adopted/adapted) to existing firms that are either growing or mature. The following paragraphs illustrates possible options and strategic implications for different situations. Wherever suitable (without infringing upon confidentiality), reference is given to the general situation with respect to some of the BUMNIs of BPIS in Indonesia.

Young (start-up) enterprises have two alternative strategic options:

1. Technology leader strategy—new technology-based start-up companies, venture capital and information link very critical, location near research university known for state-of-the-art knowledge generation, small scale flexible production, creating

own high value market, niche and image leadership, make own technology components, need advance technology capability, and conducive technology climate.
2. Technology extender strategy—old technology based new companies, price and service sensitive market, filling market vacated by industry giants/leaders, low value market, utilizing time and production factor cost advantage, niche and price leadership, buy readily available technology components, starts with elementary technology capability.

In the context of Indonesia, the technology leader strategy is not possible in any of the BPIS enterprises. It is apparent that, unless there is a world-class research institution producing state-of-the-art knowledge, it is virtually impossible for a small-scale developing country enterprise to start with a technology leader strategy. The extender strategy is being practiced (even though not explicitly recognized as such) by PT.INTI (telecommunication).

Growing enterprises can opt for any of the following three strategies:

1. Technology leader strategy—pioneering companies using state-of-the-art technologies for competing in growing global markets, niche and image leadership, very high value market, demand sophistication accelerates quality improvement, make advanced and specialized technology components, need superior technology capability.
2. Technology follower strategy—international companies adapting and using advanced technologies for growing regional and global markets, niche and quality leadership, high value market, buy and make technology components, need advance technology capability.
3. Technology exploiter strategy—emerging international companies basically using advantage of production factor costs and market differentiation, utilizing standardized technologies, generally price leadership in medium value market, buy available technology components, need secondary technology capability, should have adequate technology infrastructure.

In the context of Indonesia, the PT.IPTN (aircraft) company is currently focusing on the technology follower strategy and it is possible that in another decade it could emerge as a technology leader [9] in small commuter segment of the civilian airline market. PT.KRAKATAU (steel) companies are trying to move from the exploiter strategy to the follower strategy.

Mature enterprises face limited strategic options:

1. Technology exploiter strategy—multinational companies continue to dominate the high value market, leave low value market, and move production facilities to cheap labor and less regulated environment; niche and quality leadership; buy and make technology; product design often reflects foreign market needs; advance technology capability.
2. Technology extender strategy—companies take advantage of the factor cost in price-sensitive markets and fill the gap created by industry giants' shift to emerging areas, price leadership, buy technology components, at least secondary technology capability.

In the context of Indonesia, PT.BARATA (construction) and PT.INKA (railways) are still focusing on technology extender strategy. It is clear that they will have to try to move into the exploiter strategy very soon.

For each of the cases mentioned above, attempting strategic progression will mean enterprise's own resource allocation for (1) acquisition and generation of more sophisticated technology components; and (2) accumulation of more advanced technology capability. Also the government has to allocate commensurate additional resources for (3) further development of the technology infrastructure; and (4) improved technology climate. The specific requirements can be identified by taking into consideration the measurements related to the systems structure suggested in this paper. As in many developing countries, a major factor contributing to the low level of technological development in Indonesia may be traced to the poor science and technology infrastructure. Market failure is endemic to investment in science and technology education and to the collection, analysis, and dissemination of technical information, which are central to the operation of new-era flexible industrial organizations. For gradually moving from the initial technology extender strategy to the aspired technology leader strategy by an industrial enterprise in a developing country, it is necessary to ensure continuity of the technology development infrastructure and availability of minimum critical mass with respect to all promotion agents. Not only is it important to recognize that each promotion agent must have the minimum critical mass, but it is also important to note that relative importance of the distinctive phases in each of the technology development chains are not necessarily the same. Some of the phases are much more critical and require considerably more resources than the others. For self-reliance, it is essential to attain sufficient strength in each phase of the development chains by adequately supporting the promotion agents. Complete absence of any particular phase in the development chains can make any industry vulnerable to foreign competition.

Conclusions

Genuine progress requires that senior management take a strategic view of technology: setting priorities, identifying what's most critical to the success of the enterprise, and focusing improvement efforts on technology capability for producing better-quality products at lower costs to the marketplace faster [6, 1, 8]. The framework presented in this paper can help corporate strategic planners in developing countries to meaningfully integrate technological considerations into their business strategies for joining the global market. It may be noted, however, that any strategic development process should be interactive and provide for regular updates through monitoring and evaluation.

Enterprises that actively introduce technology-based strategies are likely to prosper in the emerging international economic order, while those that do not will progressively lag behind. This implies that all industrial enterprises of the Strategic Industries of Indonesia (BUMNIs of the BPIS) need to adopt corporate policies in "managing technological change" so as to avoid being bypassed by the enterprises in other countries of the ASEAN (Association of South East Asian Nations) region. Dr. Habibie (long-time minister for research and technology of the Government of the Republic of Indonesia) himself started the Indonesia Aircraft Industry (PT.IPTN) and promoted a concept of four stages of technological transformation with a very catchy phrase: "begin at the end and end at the beginning," encompassing four distinct stages – assembling final products, manufacturing components for assembly, designing product components, and producing new systems [21]. Although he did not disclose the strategic mix explicitly, it is apparent that the commuter aircraft production history of IPTN: CN-212 (12 seater) assembling in 1976,

CN-235 (35 seater) manufacturing in 1983, CN-250 (50 seater) design and manufacturing in 1989, and the plan to produce a completely new aircraft (around 100 seater) by 1995. The company is already producing parts through subcontracting for Boeing (USA) and undertaking high-level design activities for CASA (Spain). Analysis shows that this industry has successfully moved from an exploiter strategy to the present level of follower strategy, and hopes to move into the leader strategy. Other enterprises could try to emulate this shining example.

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