# INTERNATIONAL EXPRIENCES IN SELECTION OF IMPORT TECHNOLOGIES IN MECHANICAL ENGINEERING SECTOR AND SOLUTIONS FOR VIETNAM

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***Abstract:***

*The article focuses on analysis of experience from some countries such as Korea, Taiwan and Thailand who have starting points and development history similar to the one of Vietnam, technology import and selection of import technologies in mechanical engineering sector. On the basis of these experiences, some recommendations and solutions are proposed for Vietnam to develop the mechanical engineering technology potentials which are based on the selection of suitable import technologies.*

***Keywords:*** *Technology; Technology import; Mechanical engineering; Selection of import technologies.*

***Code:*** *18052901*

## 1. Introduction

Technology is the leading and core factor for development of production industries of any nation. It is the key to success of many sectors and fields. For a country in industrialization and modernization stage as Vietnam is now the production technologies in mechanical engineering sector are the crucial and fundamental topics which get the prime attentions. In the context where the domestic endogenic technological level of Vietnam remains low developed in comparison to the global standards of the countries in the region and the world, the import of technologies play important roles. They would promote science-technology (S&T) development, facilitate the access of research organizations and enterprises to advanced and modern technologies and give contributions to development of domestic producing potentials of the country.

Some countries which have now developed mechanical engineering industries such as Korea, Taiwan and Thailand started also from practice of

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import of technologies. Vietnam should learn the success and experiences of these countries. On basis of the made analysis, the paper provides lessons and then proposes recommendations and solutions for selection of import technologies suitable for development of mechanical engineering sector of Vietnam.

## 2. Lessons and experiences from some nations

### *2.1. Experiences from Korea*

Actually, Korea is among the nations which have leading positions in export of commodities in mechanical engineering sector in Asia. The success came after long stages Korea searches its own way for development as Vietnam does now.

As noted in a paper by Reinhard Drifte *(Reinhard Drifte, 1997)*, the starting point of Korea was a country with small sized and low developed industries. Korea had times to make policies for industrial development on basis of import of foreign technologies. The first policies of Korea were to follow the lessons from Japan. In mechanical engineering sector many technologies were imported from Japan and US. However, Korea had to make changes and adjustments of policies and criteria of selection of import technologies to make them meet its specific conditions of development. Namely, the selection of import technologies very early was oriented by definition of standard systems closely bound to development targets of the country and based on law regulations.

**Table 1:** 6 main laws of the system of national standards of Korea

| Laws | Years | Brief description |
|---|---|---|
| Law on Industrial standardization | 1961 | National Standards of Korea (KS) |
| Law on Metrology | 1961 | Regulations on metrology |
| Law on Management of quality of industrial products | 1967 | System of evaluation of product quality |
| Law on Control of safety of electric equipment | 1974 | Evaluation of safety of electrical equipment |
| Framework Law on National standards | 1999 | Management and coordination of the system of national standards |
| Framework Law on Safety of products | 2010 | Management and operation of the national system of product safety |

*Source: www.standards.gov*

Table 1 shows the 6 main laws of the system of national standards of Korea. The Ministry of Technology and Standard of Korea (KATS) is in charge of these 6 laws which means that KATS is the most important

Government agency in charge of setting up of the system of national standards of Korea. On basis of these laws, Korea orients its selection of import technologies to meet targets of industrial development including mechanical engineering sector through stages in the whole history of development of the country.

Policies of import and criteria for selection of import technologies of Korea were carried out and adjusted through the following periods *(Graham R. Mitchell, 1997; Sungchul Chung, 2010; Keun Lee, 2013; OECD, 2014)*.

*a) 1960-1970 periods*

It is the first stage of the opening and international integration process of Korea. During 1960s, Korea had a very low GNP rate (only USD2.7 milliard by 1962 which is equivalent to the average income rate per capita of USD87) quite not enough to buy foreign technologies. In initial time, the limitation in attraction of FDI sources causes difficulties to Korea in ownership of patented technologies. Facing this situation, the Korean Government chose the policy of long term loans to make investments for industrial development. This move led to the need to import many necessary technologies and gave contributions to form many corporations called "Chaebol". With this policy, Korean enterprises got many advantages when working with foreign companies. They got technologies, materials, experiences of management of quality of production chains from input to output. Through it, they learnt the arrangement of management of production chains of OEM (Original Equipment Manufacturing). However, the technological level of Korea remained fully depended of technological transfer from external sources (mainly from US and Japan). Despite of that, the volume of FDI capitals, foreign licensing and production materials passed a multiple growth in comparison to 1962-1966 periods (Table 2). Here the FDI capitals caused very low effects to import and transfer of technologies which made only 3.9% of the total volume of foreign investments while the one of other countries was 10-20% (according to UN reports) *(Sungchul Chung, 2010)*.

During this time, the Korean Government set up the first and basic steps for S&T development. Namely, Korea issued laws to stimulate development of science, technology and technical education by 1967. Also in that year, Korea established the Korean Institute of Science and Technology (KIST) and, one year after, Ministry of Science-Technology (MOST) which have functions to set up policies for S&T development of the country. By 1970, the Government issued a law regulation which allows the establishment of the Korean High Tech Institute which served as main foundation to establish the Korean Advanced Institute of Science-Technology which was

KAIS in that time and KAIST now. KAIST helped bring the US education system to Korea which gives contributions to receive and to digest technologies imported from US.

**Table 2**: Technological transfer of Korea through stages

*Unit: USD million*

| Period | From year - to year | FDI | FL | Commodities |
|---|---|---|---|---|
| 1960-1970 | 1962-1966 | 45.4 | 0.8 | 316 |
| | 1967-1971 | 218.6 | 16.3 | 2541 |
| 1971-1980 | 1972-1976 | 879.4 | 96.5 | 8841 |
| | 1977-1981 | 720.6 | 451.4 | 27978 |
| 1981-1990 | 1982-1986 | 1766.5 | 1184.9 | 86718 |

*Source: National Office of Statistics, Korea*

During 1960-1970 periods, Korea which was poor in natural resources experienced a shortage of human resource. Therefore, they decided to focus efforts on import of technologies in light industrial sectors such as textile-garment and food processing for production of export products in a short term vision. Due to shortage of qualified human resource, the import technologies remained fully depended on introductions and indications by partners through signed manuals. During this time, the criteria for import of technologies in mechanical engineering sector were only standards for import of low priced machines and technologies. The targets were to offer jobs for labors and to create sources of capitals for national economy. The import of technologies, at that time, was not largely extended but the Government issued policies to stimulate import technologies from advanced countries to enhance the technological level and to serve export oriented production activities.

*b) 1971-1980 periods*

Early 1970s, Korea shifted the development objectives to machinery industry and chemical industry through increased investments and technologies. For promotion of purchase of technology licenses from foreign sources (FL) for heavy machinery, the Government set up many organizations and research institutes such as Korean Institute of Machinery and Materials (KIMM), Korean Research Institute of Standards and Technologies (KRISS), Korean Institute of Energy Research (KIER) and others. These institutes have to combine with private enterprises to build up the platform for industrial development.

During this time, the purchase of technologies through non-official channels played important roles and was more practicable than the one

through official channels. The figures in Table 2 show the fast growth of import of technologies against a reducing trend of FDI capitals. This shows the higher attentions by the Korean Government for policies to attract technologies while still controlling well the domestic capital sources.

The Korean approach to technologies in this period had the dual aspects, positive and limited. The positive aspects are to help the domestic companies develop their technological level through purchase of technologies with low prices and to avoid trade barriers raised by multi-national companies. This approach also helped Korea maintain its independence to multi-national groups. However, the limited aspects are also here, namely the practice of this policy limited the access of Korea to new technologies through direct links with foreign companies. The limited FDI capitals also caused failures of Korea in its efforts to bring the global standards to domestic production activities. One of the important lessons here is the good training of human resources without which Korea would have no way to access to technologies through non-official channels.

For promotion of import of technologies the Korean Government made adjustments of policies which led to lower taxes. By 1972, the Korean Government issued a regulation for technological development and, one year after, amended the law to stimulate foreign investment capitals. At the same time, some requirements of standards necessary for import technologies were made lower to stimulate import of technologies while still maintaining the import of technologies from advanced countries. The technologies applied mainly for production were to serve product assembling and packaging segments. The purchase of used machines, modification of techniques and training of engineers for operation of technological chains, during that time, were conducted through non-official channels. However, for purpose to stimulate development and mastering of technologies, Korea still limited the import of machine tools which was reduced from 37% by 1974 to 39% by 1981. Thanks to these moves, Korea could itself develop its own technologies. By 1979, Korea became the 10$^{th}$ ranked country of the world in production of machine tools.

*c) 1981-1990 periods*

Also as seen from Table 2, the Korean Government issued more open policies in attraction of foreign investment capitals. This fact can be explained by increasing difficulties of import of technologies from external sources through non-official channels. Therefore, the Korean Government proceeded measures to attract technologies through permission for higher rate of investments by foreign companies in Korea.

By 1981, the Korean Government issued the system of registration of research institutes for private sector on tax free basis. At the same time the taxes were cut down for activities by these institutes for search and research of technologies. By 1985, for stimulation of establishment of small scaled research institutes, the Korean Government issued a regulation to reduce the required number of members of an institute from 10 to 5. At the same time, the Korean Government permitted the establishment of research institutes abroad. The purpose of this move is to target the access to the world's newest technologies and then their use in Korea. As result, the number of endogenous technologies started increasing which gets coupled with strong reduction of import technologies from 90% by 1975 down to 30% by mid-1980s.

From 1980 to 1990, Korean companies imported technologies for purpose to copy and re-produce them. They made strong investments for learning of these import technologies to enhance the technological level and the share in high tech sectors. For supporting the selection of import technologies, Korea, by 1984, issued the automatic system of examination and approval for import of technologies which replaced the previous system of announcement. The Korean Government also approved the quota system to limit the import of machine tools which can be produced locally. This policy permitted the Association of Machine Tool Producers to make the rules to define which type of machine tools can be produced locally and which one can be imported. For example, the lathes smaller than certain size have to be provided from domestic sources. Then the CNC lathes, due to big limit of size, could not be imported. As result, the import of CNC lathes was reduced from 85% by 1981 down to 31% by 1982.

Since December 1990, Korea entered OECD which includes solid members such as US, UK, Japan and others. During this period, Korea made priorities for cooperation with US while following its own strategies for industrial development. Then the technologies in mechanical engineering sector were mainly imported from US while the Japan market being still remained. Korean companies started setting up their research centers abroad for access to and selection of the newest technologies in markets and for supports for technological transfer. At the same time, the import of parts, machines and technologies for heavy industries through non-official channels was shifted to the import of parts, machines and high technologies through joint cooperation for development.

*d) 1991-2000 periods*

Korea still concentrated on purchasing and mastering of the most advanced machines and technologies of the world, mainly from advanced countries

such as US and Japan and took initiatives to search new technologies from other markets such as Russia and China. According to the Office of Patents of the Russian Federation, from October 1993 to early 1994, Korean companies received 365 technological patents from Russia where 31 have applications in machinery and metal technologies. Among the patent receiving companies of Korea, we see 22 Chaebols, 14 small and medium size trading companies and 5 research institutes. Technologies in mechanical engineering sector imported at that time, are related mainly to the sectors of materials, designs and production management. Attentions were paid also for high techs. The reception of a big number of patents has led to appearance of units for control of patents in some Chaebols.

During this period, the world's economy faced the monetary crisis and the economic reform conducted by IMF. In this context, the Korean Government issued the package of demand stimulation, fully opened the markets, facilitated FDI sources and import of commodities. Therefore, the import of machines and technologies for mechanical engineering sector was more comfortable. But then Korea entered a difficult period of competition in international markets due to dependence on import technologies and increasing labor costs. From another side, some Korean companies become large and turn to be potential competitors of foreign companies and then the latter do not want to make technological transfer for Korea. Naturally, Korea has to develop domestic platforms for further technological development and promotion of innovation.

*e) Early 21-th Century*

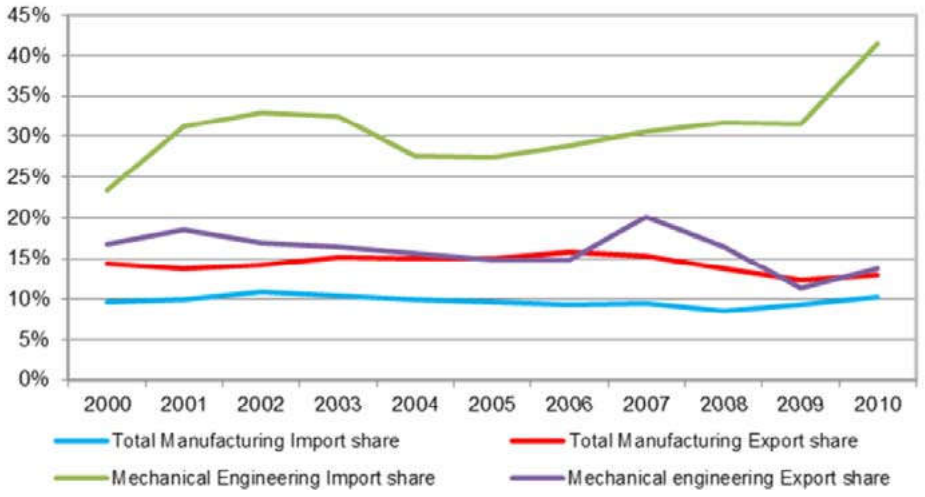
Korea has achieved outstanding progress in some sectors of new technologies such as bio-technologies, information technologies, nano technologies and space technologies. In addition, Korea still maintains fundamental industrial sectors such as textile and ship-building. At this time, Korea had shifted to a totally new stage of creativity and then the import of technologies gets very limited.

**Table 3**: Comparison of the total import-export values of Korea

| Sectors | Activity | 2010 milliard € | Annual average growth rate % | | |
|---|---|---|---|---|---|
| | | | 2000-05 | 2005-08 | 2008-10 |
| Total commercial values from production | Import | 271.3 | 3.9 | 12.1 | -4.2 |
| | Export | 298.0 | 4.2 | 7.9 | 1.9 |
| Korea-EU Commercial values from production | Import | 27.9 | 3.9 | 8.0 | 4.7 |
| | Export | 38.7 | 5.1 | 4.7 | -1.1 |

| Sectors | Activity | 2010 milliard € | Annual average growth rate % | | |
|---|---|---|---|---|---|
| | | | 2000-05 | 2005-08 | 2008-10 |
| Total commercial values from mechanical engineering sector | Import | 18.2 | 4.2 | 7.0 | -5.0 |
| | Export | 17.5 | 11.6 | 9.6 | -5.7 |
| Korea-EU Commercial values from mechanical engineering sector | Import | 7.6 | 7.6 | 12.2 | 8.7 |
| | Export | 2.4 | 8.8 | 13.5 | -13.8 |

*Source: VDMA; Cambridge Econometrics; Ifo Institute*




*Source: Eurostat, Cambridge Econometrics, Ifo Institute*

**Figure 1:** Import of machines between Korea and EU *(Hans-Günther Vieweg, 2012)*

However, in terms of import of machines and technologies in mechanical engineering sector, Korea remains an import nation. Korea focuses on cooperation ties with EU countries and, in this relation, the import grows faster than the export does (Fig. 1). According to data supplied from Korea, the import value of products in mechanical engineering sector from EU to Korea increases 16% by 2004 and comes to the level of 20% by 2007 and then reduces to 10% by 2009 and then increases to 14% by 2010. The figures in Table 3 show the total export values in production sectors are higher than the import values but the contrary picture is seen in mechanical engineering sector. The import values from EU in mechanical engineering sector increase fast during 2000-2008 periods and then reduce during 2008-2010 periods due to the world's economic crisis by 2008 while the growth rate being maintained at 8.7%. The situation can be explained by the fact that the policy for import of technologies in mechanical engineering sector

focuses on the growth rate of trade with advanced nations of EU and then this pushes up the technological level in mechanical engineering sector of Korea to achieve the level of the world leading nations in this field.

Instead of large extended imports, Korea starts a more selective policy for import of priority technologies for industrial development, particularly in sector of production of cars and trucks *(National Council of S&T policies, 2016)*. Now the export of Korean cars can compete toughly with the world leading nations such as Japan and the quality of Korean cars has been improved. By the end of this period, Korea made focused efforts for import of high techs capable to produce high value products and then the structure of import markets shifts gradually to US.

Since July 2009, KATS starts issuing the label to certificate new technologies and quality of products made by Korean companies - the move mainly to target the promotion of import-export activities. The Korean Government issues also requirements and procedures for import of certain products such as registration, safety standards and effectiveness check to secure the health of communities, national security, safety and environment protection. In addition to that, the specific commodities listed in the annual trade plan by Ministry of Trade-Industry-Energy (MTIE) have to be approved by the Minister. For being certified to be conform to Korean standards the commodities and technologies have to be indicated publicly by KATS. KATS would have rights to indicate commodities and technologies in the following cases:

- Technologies which bring in benefits in enhancing productivity, quality of products or other requirements in production process;
- Patents which meet standards such as ISO, ITU, ETSI and etc.

Machines satisfying these conditions and standards are mainly imported from US, Germany, Japan and some other countries. It is worth to note that Korea is the 6$^{th}$ ranked export market of welding equipment and tools and the 9$^{th}$ largest import market of cutting tools and mechanical engineering tools from US by 2015.

The import values of equipment and mechanical engineering tools from US to Korea are shown in Fig. 2 which present also the trends of selection of import technologies of Korea where the import of cutting tools, plastic and rubber machines, tools, cramps and moulds has increasing trends. The increasing trends of import values of equipment and technologies shows well the fact that Korea selects import technologies to meet development of mechanical engineering sector for production of parts in spearhead industrial sectors of Korea such as production of electronic parts or cars.

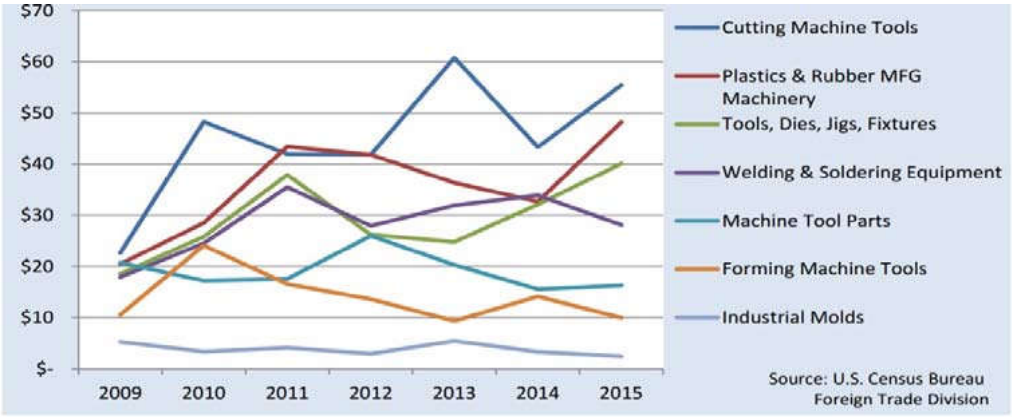



**Figure 2:** Import values of technologies imported from US to Korea, 2009-2015 periods

Clearly Korea is successful in development of mechanical engineering sector and in this process of development Korea conducts a selection for import and transfer of technologies by various ways, direct and non-direct, including large investments in stock share markets, joint ventures, joint cooperation for development of technologies, purchase of complete production facilities, licensing agreements, transfer of know-hows, supply of technical assistance, purchase of equipment and machines or, even, decoding of technologies.

### *2.2. Experiences from Taiwan*

With an extremely difficult start from an agricultural country *(UNCTAD, 2003)*, Taiwan became a country which exports machine tools in mechanical engineering sector. At the present time, the mechanical engineering sector of Taiwan focuses attentions on 4 main mechanical sectors, namely machine tools, high tech equipment, robots and parts of machine tools. For that purpose, the Taiwanese Government implements very early the policies oriented to development of industries in general and mechanical engineering sector in particular. The development process can be divided into the following periods *(Kung Wang, 2005; Trade Office of Swiss Industries, 2013)*:

*a) 1960-1980 periods*

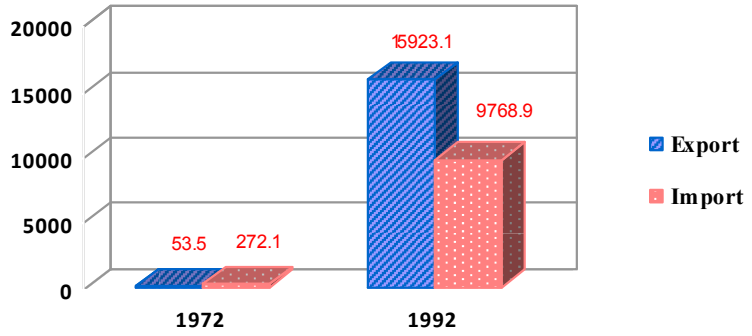
Taiwan made priorities to stimulate production and to recover the national economy, and issued export oriented policies. However, almost all the machines necessary for production process were imported early in this period. Therefore, since 1960s, the Taiwanese Government listed the mechanical engineering sector among the key sectors. Since 1969, Taiwan

implemented the 5th four-year plan for economic development where the main target is to help domestic producers to manufacture products necessary for development of mechanical engineering sector. Therefore, the sector of machine tools started development to serve other production sectors, to reduce gradually import needs and to come to final destination of full mastering of technologies. During this period, Taiwan implemented measures of policy based intervention to limit import of technologies in order to shift activities to support the development of technologies by domestic companies. This move does not mean to limit fully the import of technologies but only target to re-balance import-export activities and to adjust policies. By 1970, when the labor costs increased and the industrial sectors required to be upgraded, the Taiwanese Government oriented the development of technologies to higher level while still limiting FDI sources and stimulating investments for automation and high precision machine tools. The 1970-1980 periods was considered as the time of development of heavy industries of Taiwan. During this time, the import values of mechanical engineering machines were USD272.1 million and the export values were only USD53.5 million - a big gap *(Otto C. C. Lin, 1998)*. By end of 1970, the Taiwanese Government provided financial supports to establish laboratories for research of mechanical engineering industry which make now Industrial Technology Research Institute (ITRI). This institute is in charge to lead the development of machinery and mechanical engineering sectors in general and machine tools in particular through foreign channels of import of technologies *(Liang-Chih Chen, 2009)*. However, the roles of ITRI in this period were not found effective because the applied technologies were not found suitable for use and had low commercial and application values.

*b) 1981-1995 periods*

This period was considered as the focus of efforts for development of technologies. Since 1980s, the Taiwanese Government issued a ten-year plan for economic development where machinery and mechanical engineering sectors remain strategic sectors. Taiwan established a force specially for study of machinery sector and construction sector which had set up "Regulations and supports by the Government for machinery industry". By 1982, the Taiwanese Government issued "The plan of industrial automation". This plan not only caused extended influences to producing capacities and quality of products of machinery sector but also put a solid platform for Taiwanese OEM. During this period, Industrial Development Bureau (IDB), Ministry of Economic Affairs (MOEA) appointed Industrial Technology Research Institute (ITRI) to set up

"Standards for Industrial Machine Components". At this point ITRI really produced many contributions for orientation of development of mechanical engineering industry and for selection of import technologies. The most evident fact was the help it made for mechanical engineering companies to absorb and to apply effectively import technologies *(Liang-Chih Chen, 2009)*. Machine producers had built up the system of standardization of parts of mechanical engineering machines and then a supply chain for self-provision of parts. At the same time, Taiwan pushed higher the targets of high tech based mechanical engineering production which were defined from the previous stage. Many policies were issued for supports such as exemption of taxes during 5 years for high techs, intensive reduction of prices for equipment and exemption of import tax for tools and materials for R&D activities. As result, during this period, the import-export values of machines and tools in mechanical engineering sector of Taiwan experienced a great soar in comparison to the previous period.




*Source: Collected and built up by the authors from data presented by Otto C. C. Lin, 1998*

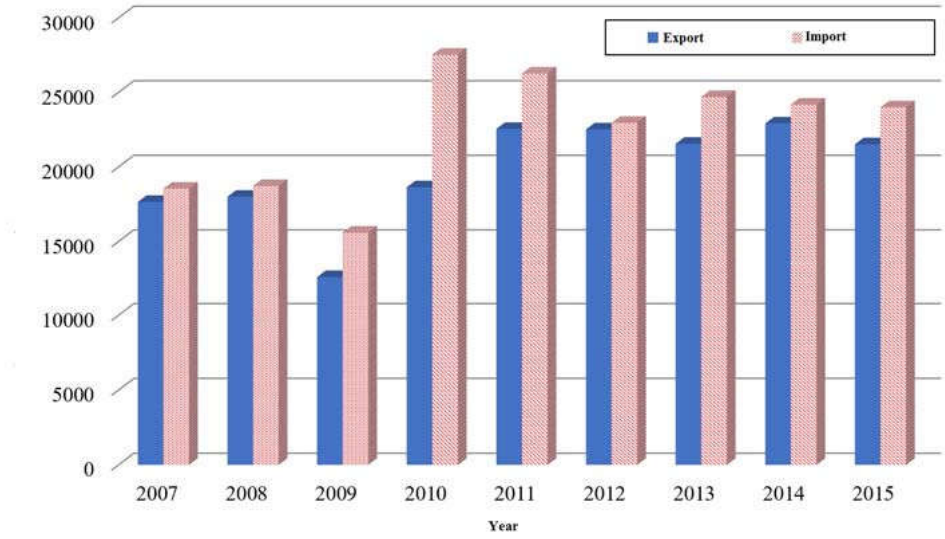
**Figure 3:** Import-Export of machines and mechanical engineering technologies of Taiwan of two years 1972 and 1992

Fig. 3 exhibits the comparison of import-export values of mechanical engineering machines and technologies of two years 1972 and 1992 which reflect well the promotion of import of mechanical engineering machines and technologies and, at the same time, the expansion of export markets of Taiwanese mechanical engineering sector to the world. Taiwan also issued policies of discrimination nature toward FDI companies where the FDI sources would be blocked for the sectors under technological control by domestic companies. Inversely, for the sectors where domestic companies are technologically weak they get stimulations for foreign companies to enter. This move targets the diffusion of technologies and to enhance capacities of domestic companies. The typical case was the development of CNC machine tools where producing enterprises respond well to new

technologies by using control systems and integrating micro-electronic components in their machines all being provided from external supply sources. Almost all the machine tool producers were successful in turning their products to CNC tools with supports from Japanese suppliers of digital control devices during 1980s *(Liang-Chih Chen, 2009)*. Also for purpose to enhance capacities of machine tools, ITRI had made the technological transfer of high speed main axe engine from Switzerland and then Taiwan could manufacture successfully this engine for the first time by 1994 *(Trade Office of Swiss Industries (TOSI), 2013)*. However, majority of CNC machine tools were developed by using the "doing through learning" model which mean, by other words, the learning by imitating and decoding of technologies. It is worth to note the process of import of technologies for development of machine tools was conducted in parallel with the process of import of technologies and development of technologies of Taiwanese electronic industry. The period is the pre-condition for the period of high techs afterwards.

*c) 1996-now period*

With accumulated experiences and imported technologies from previous periods, the industrial sector in general and the mechanical engineering sector in particular of Taiwan entered fast into the stage of back investments for local R&D activities. At this stage, Taiwan focuses efforts for development of high tech based industrial sectors. However, they do not halt activities in promotion of import of technologies.




*Source: Collected and built up by the author from data presented by Liang-Chih Chen, 2009*

**Figure 4:** Import-Export values of machines by Taiwan from 2007 to 2015

During 1990-2000 periods, Taiwan held 0.31% of GDP for import of technologies with the share of mechanical engineering sector of about 40% which is second to electronic sector. Particularly, since early 2000s the electronic industry and high tech sector of Taiwan soared then required the corresponding development of supporting sectors including mechanical engineering one. Therefore, the import values of machines and technologies increased faster than the previous periods, particularly from 2010 to now (Fig. 4). The activities of import of technologies were conducted on basis of global linkages.

Finally, the policies were issued for shifting of production linkages through transfer of technological rights, OEM and ODM (Original Design Manufacturing). The transfer of technological rights is the feasible choice for mechanical engineering enterprises of Taiwan when they need advanced technologies. When Taiwanese enterprises get successful in copying mechanical engineering products made by advanced nations such as Germany, Italy, Japan and US many mechanical engineering enterprises over the world proactively contact Taiwanese enterprises for transfer of technological rights and then the Taiwanese enterprises become their producing partners in the system of OEM and ODM.

Therefore, Taiwan had developed very early and consistently a strategy for import of technologies. At the beginning, the Taiwanese Government decided the orientation and the selection of import technologies which were started by the licensing of use rights. Taiwan also set up a very tough policy for selection of import technologies. Despite of certain priorities for investments by FDI enterprises, Taiwan issued regulations for selection of import technologies in mechanical engineering sector which were based on the systems of standards for evaluation of technological level and quality of import machines and equipment. They decided to select advanced technologies for acceleration of the process of industrialization. Taiwan, in the initial stages, imported technologies through FDI channels and then focused efforts for import of technologies under licensing forms. With this selection, Taiwan advanced proactively to R&D activities, directly exploiting, mastering and creating new technologies.

### *2.3. Experiences from Thailand*

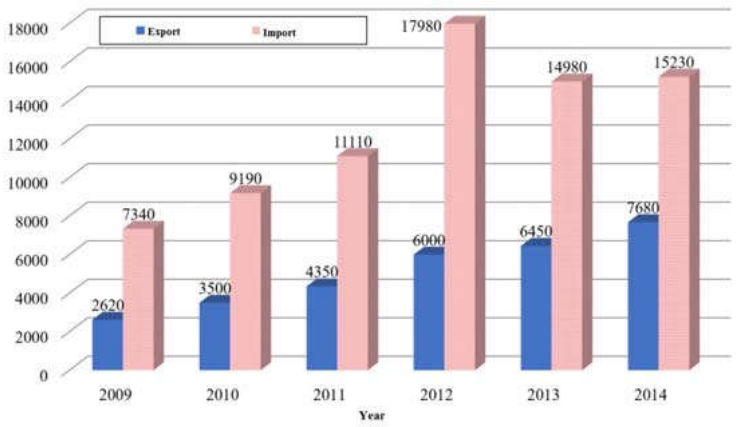
Thailand is a country which has the geographic location and the process of socio-economic development similar to the one of Vietnam in many aspects. However, Thailand passes over Vietnam in some aspects of industrial development. Before 1960, the industry of Thailand was segmented and had mainly private enterprises and some public enterprises of medium size. After 1960, Thailand changed both the visions and growth

policies while shifting to rich capital investments and high techs to replace low cost labors. They did not use the strategy to produce products to replace imported commodities but made orientations directly to export products *(Shafiq Dhanani, Philippe Scholtès, 2002)*. Thanks to open policies for investments, Thailand was successful in attraction of investments from foreign corporations. In addition to that, Thailand focused to build up complete supporting industries. When the domestic supporting industries get extended many other producing activities get developed also which turn Thailand to a key center of production and export of the world.

The mechanical engineering sector play important roles in the process of economic development in general and industrial development in particular. For the mechanical engineering sector only, the growth rate during 1980-1990 periods was in range of 5-15% per year. This rate remained during the first half of 1990s (about 11% per year). During 1996-2000 periods, the growth rate gets down to 2-3% per year under impacts from the world's economic crisis. The important driving force for development of mechanical engineering sector of Thailand is export products. The illustration for that is the automobile industry which is the leading mechanical engineering industry of Thailand. During the initial stage, 1960-1990 periods, Thailand focused attentions on development strategies to replace gradually imported products. The Thailand Government encouraged producers to make investments to build up plants through import tax measures and applied regulations to push up production of parts. Initially, Thailand issued policies to support foreign enterprises which made investments for assembling cars. Gradually, policies were changed and then banned the import of complete modules for purpose to stimulate domestic production of parts. Since 1990, Thailand conducted the localization of automobile industry and shifted the production targets from consumption in local markets to export markets. Only for two year 2012 and 2013, the export excess values of Thailand automobile industries were over 30%. Keeping pace with and serving the domestic industries including automobile industry, the mechanical engineering sector made the corresponding development in terms of technologies and production scale.

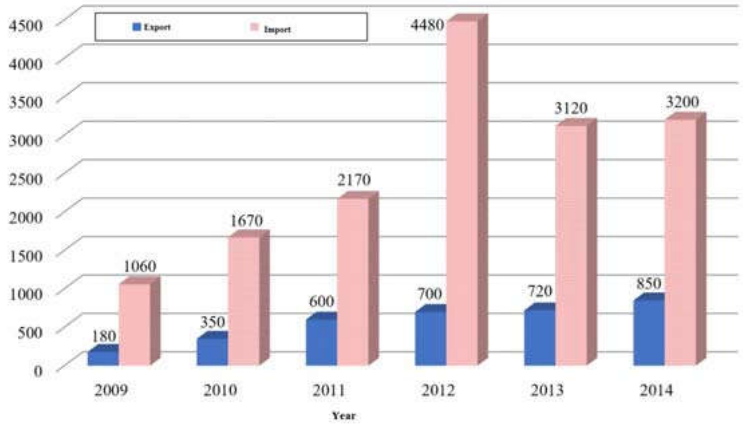
For achieving the high production level in mechanical engineering sector while the starting point was an agricultural country, the fastest way for Thailand was the import of machines and manufacturing technologies from advanced countries. Similarly to many other countries in the similar context, Thailand did it and imported technologies to push up development of local technological level. It is seen clearly through increasing values of import of machine and parts during 2009-2014 periods (Fig. 5) where the import values were twice of the export ones. Particularly, the mechanical engineering sector, with import-export of machine tools and parts, keeps the

large shares (Fig. 6) in the total values of global machinery sectors (Fig. 5). The import values of machine tools and parts increased 200% from 2009 to 2014 to the volume of USD3.2 billion. The volume includes USD2.99 billion from import of machine tools and USD206 million from import of portable tools. The leading positions are the import of molding boxes for metals, metal machining segments (forging, bending, folding and cutting) and lathes.




*Source: Machinery information data collection unit, Thailand Institute of Steels*

**Figure 5:** Import-Export of machinery sectors of Thailand, 2009-2014 periods



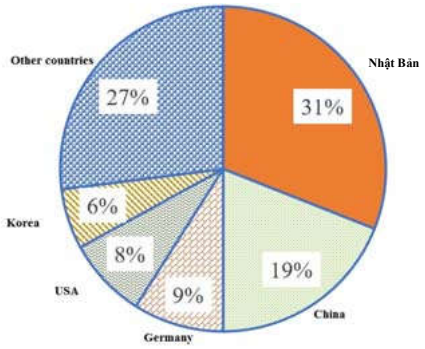

*Source: Machinery information data collection unit, Thailand Institute of Steels*

**Figure 6:** Import-Export of machine tools and machine parts of Thailand, 2009-2014 periods

Together with the high valued import of machines and parts in mechanical engineering sector the import of technologies in the sector also keeps pace

with. Fig. 5 and Fig. 6 show well large changes of the values of import of machines in Thailand. The post-2012 development shows well the impacts from orientations of policies for industrial development which lead to needs of import of new technologies to meet requirements of the stage. The development of automobile sector and electronic sector is the important factor to accelerate the needs of modern machine tools. Another reason leading to high import values of machines in mechanical engineering sector is the large gap in development between various sectors and the low development of production capacities in high tech machinery sector of Thailand.

Machines and technologies were imported mainly through FDI channels where Japan hold the top position. Fig. 7 shows the share of machine import sources, mainly from Japan (31.5%), then China (19.2%) and Germany (9%) *(Thailand Board of Investment, Thailand's Machinery Industry)*. The figures show Thailand had defined the orientation of import sources of machines in this sector from certain markets. Despite of the main lines issued by the Government to guide import markets for advanced machines, equipment and technological chains, Thailand remained the destination of old equipment and technologies. However, since Thailand defined clearly the orientation and development strategies which get flexibly adjusted to contexts of short term stages, the import technologies were selected according to orientations guided by the Government. Therefore, Thailand can proactively control the import and transfer of technologies.




*Source: Machinery information data collection unit, Thailand Institute of Steels*

**Figure 7:** Shares of import sources of machines and parts of Thailand, 2014

The above provided analysis shows the policies for development of industrial sectors of Thailand are mainly based on FDI sources including tax and non-tax motivated policies, stimulation for development of high techs, R&D activities, strong promotion of training to meet advanced

technologies and development of SMEs. Thailand offers particular favours for FDI activities in industrial zones in the global programs of national economic development plans. These policies of Thailand lead to fast development of mechanical engineering sector on basis of imports of selected technologies and then turn Thailand to a nation with advanced industries in the ASEAN region.

## 3. Lessons from experiences and solutions for Vietnam

### *3.1. Brief view of the actual status of Vietnam mechanical engineering sector*

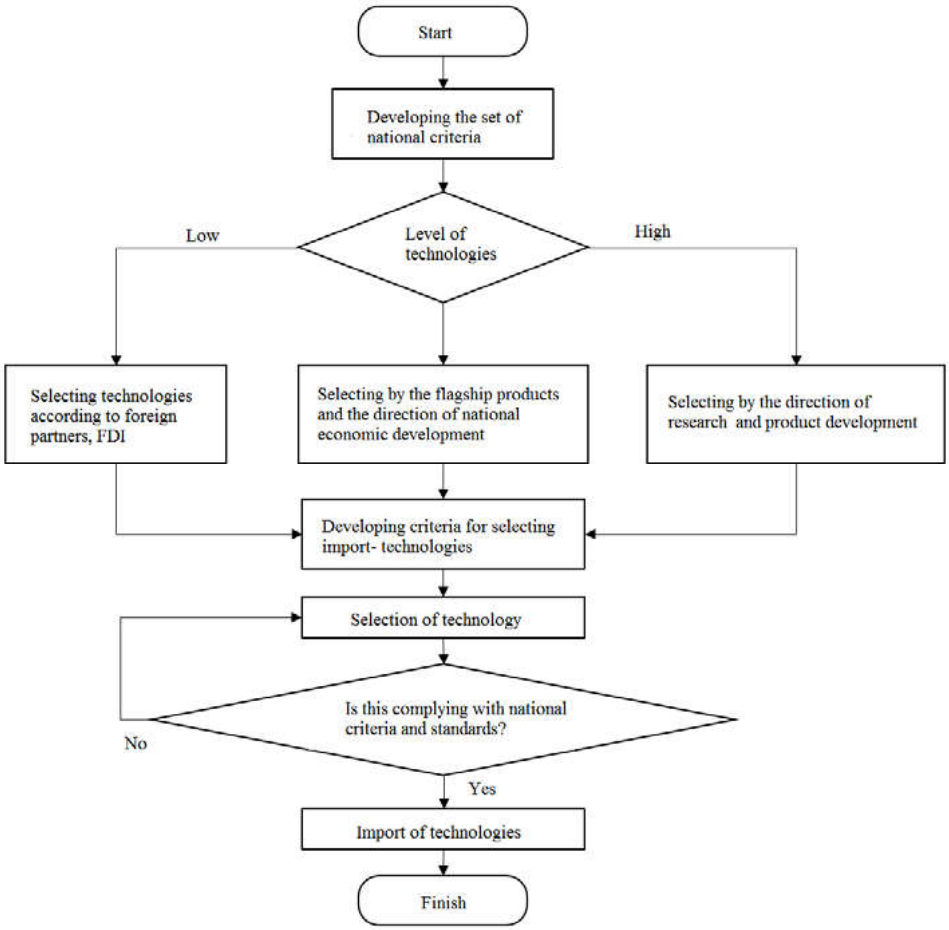
Actually Vietnam has about 53,000 mechanical workshops and enterprises where an estimation of 50% of them are manufacturing and assembling facilities and the remaining part are reparation workshops. The total capitals of the State owned facilities are about USD370 million and the total capitals of foreign investments are about USD2.1 billion *(National Statistics Office, 2013)*. The total industrial production values of 2013 is about USD12.6 billion (a growth of 10.5% in comparison to the values of 2012 and 6 times of the values of 2000). Despite of annual growing trends the mechanical engineering sector can meet only 32% of domestic needs - a very low capacity. The technological level of mechanical engineering sector is evaluated as low and out-dated with 48.2% of enterprises of low technological level and 39.3% of enterprises of medium technological level *(National Statistics Office, 2013)*. In majority of cases, the technologies in use now in mechanical engineering sector have the age of 30 years and production chains are low integrated. Then, they are difficult to provide machining works which require high precision level and stable quality of products. A closer consideration of basic working segments shows that the research and design segment achieves the upper medium level of the region, the semi-fabrication segment (molding, forging, punching, beating, welding) remains out-dated, surface processing segment is the most out-dated state in the chain of machining works of enterprises in mechanical engineering sector. New technology based equipment almost is not applied yet in Vietnam except some laboratories and foreign JV enterprises. Other segments such as complete assembling and tests, control of quality of materials and finished products are evaluated as out-dated in comparison to the general level of the countries in the region.

The selection of import technologies remains a difficult topic. Actually, research organizations and mechanical enterprises in Vietnam cannot give clearly defined orientations, right starting points and focused targets of the sector. The most recently issued strategies for development of mechanical

engineering industries indicate only sectors to be developed *(Decision No. 319/QD-TTg on 15th March 2018)* without, however, indicating clearly the types of technologies to be developed, the technological level to be achieved and the industrial sectors to be served. These questions should be considered and added to close future agendas.

### *3.2. Lessons of experiences and solutions*

The lessons from the development process of mechanical engineering industries of the nations as presented above show certain similarities which can be summarized in the scheme of Fig. 8. According to that, every nation when starting the selection and import of technologies needs to build up the set of national standards. Further, the methodology applied in selection of technologies depends on the actual development level of the nation.




*Source: Collected and built up by the authors*

**Figure 8:** Scheme of selection of import technologies on basis of international lessons and experiences

The lessons from Korea showed that during 1960-1980 periods where the technological level remained low they did the selection of technologies fully relying on foreign partners and FDI enterprises. It was also the ways Taiwan and Thailand followed in the before-1990 time. When the technological level achieves the medium level these nations defined the national key products which target export markets. These products then lead to the selection and import of technologies suitable for production of the key products. This concept was applied by Korea from 1980 to 2000 for mechanical engineering sector with its key products to serve electronic sector. Taiwan and Thailand just passed the stage of medium level technologies. They are conducting the selection of technologies for their key products: machine tools for Taiwan and cars for Thailand. Actually, Korea has achieved the high technological level and then selects technologies in direction of research and development of products. On this basis, they build up the set of indicators to decide technologies to be imported. This set of indicators and the set of national standards will help to select technologies to be imported.

The experiences of the nations as analysed above would help us to have global views on selection and import of technologies for development of mechanical engineering sector which lead to some recommendations and solutions for Vietnam.

- ***First,*** during this period, the selection of import technologies in mechanical engineering sector (when the technological level is low) should rely on foreign partners and FDI enterprises. Really, during the recent 10 years, Vietnam is successful in calling many foreign investors to build up plants in Vietnam which make come in many companies of supporting industries. Here, a big number of mechanical engineering companies of Vietnam have chances to participate in the chains of supporting services for FDI enterprises. However, it is necessary to get concrete policies from the Government to force FDI enterprises to transfer technological rights or to support Vietnam enterprises to raise the technological level on basis of requirements to register the localization rate of output products according to a suitable time road map. At the same time, it is necessary to issue policies to stimulate foreign companies to bring in technologies where domestic companies remain weak. This measure would help diffuse technologies where Vietnam companies have chances to access and to enhance their technological level.

- ***Second,*** it is necessary to build up and to add law regulations for the system of national standards for evaluation, monitoring, examination and approval of the types of import technologies for industrial sectors in general and for mechanical engineering sector in particular. This measure would

secure to follow up closely the development targets of the sectors and the national economy. The preparation and the set up of the system of standards should be assigned to Ministry of Science-Technology (MOST) to chair and to administer. The building up and the addition of law regulations for the system of standards would help mechanical engineering sector select advanced and suitable import technologies, to avoid the import of old and out-dated technologies which cause bad impacts to socio-economic development and environment.

- ***Third,*** it is necessary to build up a system of rules to limit the import of machines which could be produced locally (for example, rules to restrict sizes) and, at the same time, to shift the direction of import of machines, equipment and technologies on basis of joint R&D activities with foreign partners. Policies should be issued to reduce taxes for import of equipment and machines with rich contents of high techs and to shift gradually to production linkages based on transfer of technological rights, OEM and ODM. It is a feasible selection for enterprises in mechanical engineering sector when they need advanced technologies.

- ***Fourth,*** it is necessary to focus resources on purchase and absorption the world's most advanced machines and technologies from advanced countries such as US, Japan, Korea and others. The technologies in mechanical engineering sector which are imported now need to be in close relations with the level of materials, designs and management skills for high tech based products. At the same time, Vietnam needs to identify clearly national key products for mechanical engineering sector for the present stage then to set up orientations for the set of indicators to import technologies to meet the system of national standards.

- ***Fifth,*** it is necessary to build up the system for registration of private research institutes which should be exempted of taxes during 5 to 10 years and reduction of taxes related to activities of search, research and development of technologies, particularly advanced ones. It is necessary to implement the establishment and investments for research institutes abroad for better access to the newest technologies of the world as well as to exploit import technologies and then to master and to create technologies.

- ***Sixth,*** the import of technologies is found to be adequate measures in certain stage of development of the country, and for that stage we need special support policies by the Government and then they need to be adjusted flexibly such as long term loans from external sources, attraction of FDI capitals, orientation of import technologies to meet the economic development orientation of the country, supports for establishment of intermediate organizations, set up and completion of industrial standards, training of human resource and etc.

## Conclusion

The above made presentation is the essential research outcomes of the team of authors after a series of studies of practical experiences from some nations on selection of import technologies in mechanical engineering sector and policies related to import of technologies. Every nation naturally has its specific particularities. But the made studies and provided analysis find out some focal points common for all of them where Vietnam can learn through the 6 lessons and solutions as presented above. Policies need to be adjusted flexibly to fit the situation of socio-economic development of each stage. There is no requirements to be bound toughly to or to follow strictly any models. This approach would let to have dynamic movements not only in the S&T sectors but many other socio-economic fields./.

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