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SCIENCE CITY DEVELOPMENT INITIATIVE

Science City Development Initiative

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SCIENCE CITY DEVELOPMENT INITIATIVE

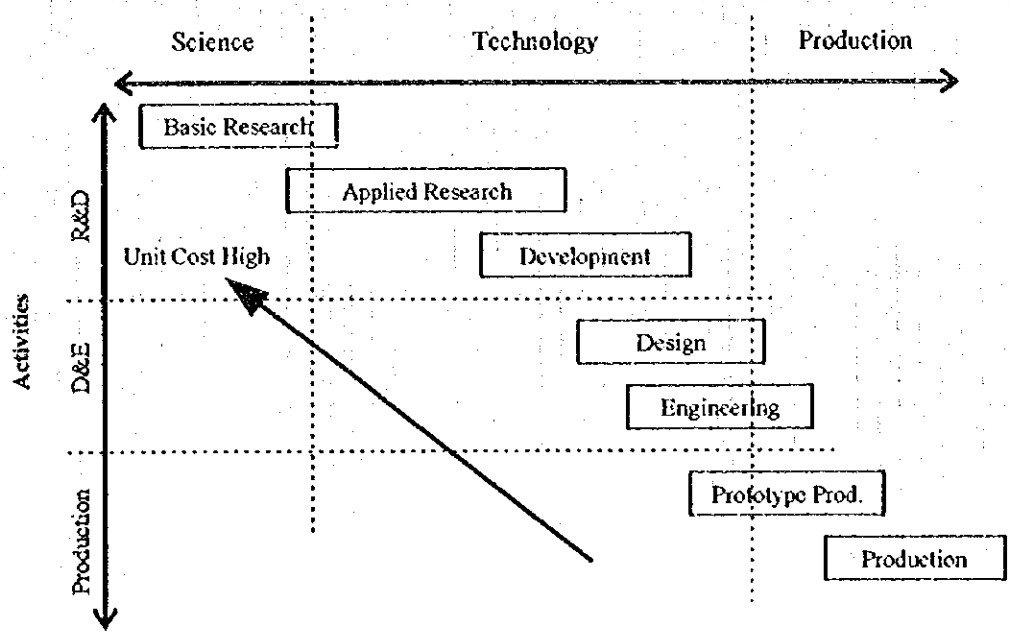
1. BACKGROUND

1.1 General

During the past decade, the Thai economy has grown at rates among the highest in the world. Major actors generating this rapid economic growth have included foreign investors, particularly in the manufacturing sector. These investors have provided not only the necessary capital but also the process technologies required for production. In recent years, Thai investors have entered new manufacturing industries, including steel and chemicals, among others, and they have directly employed foreign engineers for the technical management of projects, as well as for receiving technical assistance from their foreign partners.

Research and development (R&D) activities in the Kingdom have still remained at the pre-takeoff stage, however. In the modern industries, R&D activities constitute one of the most important factors for survival in the global market; in this case, the output of R&D activities should be considered a valuable business resource. R&D activities, however, require a certain period before they can be effectively applied in industrial production. The interrelations among the science and technology (S&T), R&D, and production is illustrated below.

Interrelations among S&T, R&D, and Production



Since industries locating in Thailand, both domestic and foreign, have to date depended on well-established production technologies, the incentives to strengthen the R&D capability in industrial firms have been inadequate. The nation's rapid industrialization and high economic growth have been generated by the labor force rather than by technological contributions, a situation that implies that investors could easily move to countries with lower labor costs. In general, the producers of mass product commodities (including certain hi-tech goods, e.g., personal computers and electronics parts and components) will look around for more advantageous locations and move their production facilities accordingly. One approach for the Government to address this tendency of manufacturers is to widen the target fields of S&T and to strengthen R&D capabilities, as mentioned in the 8th National Development Plan. Lessons from the experience of developed countries indicate that the strengthening of R&D activities and linkages between academia and industry is crucial to improve a country's economic/industrial structure. However, the current S&T and R&D activities in the Kingdom, which will be summarized in the following section, are insufficient in budget, manpower, facilities, and infrastructure.

1.2 Current Situation of R&D Activities

(1) R&D Expenditures

The total R&D expenditure in the Kingdom increased from 2,664 million Baht in 1987 to 4,473 million Baht in 1993, i.e., 1.68 times in six years, or at an average annual growth rate of 9.0 per cent. During this period, economic growth in the Kingdom increased 2.07 times, or at an average annual growth rate of 12.8 per cent. Thus, the growth of R&D expenditures has been less than that of GNP by almost 4 percentage points per annum. In the Government sector, the ratio of R&D expenditures to total Governmental

R&D Expenditures in 1987-1993

Units : millions of Baht

Fiscal year	GNP	R&D Expenditure			
		government sector *	private sector	total	% of GNP
1987	1,211,431	2,467.44	196.95	2,664.39	0.22
1989	1,752,574	2,529.52	379.43	2,908.95	0.17
1991	2,093,063	3,528.65	399.40	3,928.05	0.19
1993	2,502,265	4,163.20	310.21	4,473.41	0.18

Note: * Including Universities and non-profit activities.
Source: National Research Council of Thailand

expenditures was 0.74 per cent in 1993. If Thailand's R&D expenditures are compared with that of other Asian countries (1991, the latest year for which directly comparable data is available), R&D expenditures of Thailand are quite small as shown below. It is also noted that R&D expenditures in the Government sector represent a quite high ratio in Thailand (and Malaysia), or about 90 per cent of the total expenditures. The largest sector in terms of expenditures in 1993 was Ministries, 61.0 per cent of the total, followed by Universities at 22.7 per cent. On the other hand, private sector enterprises only accounted for 6.5 per cent of R&D expenditures in 1993. The relatively limited capability and participation of the private sector in R&D activities is a feature that public policy in Thailand should address.

R&D Expenditure in Selected Asian Countries

Country	R&D Expenditure (1991)		
	Budget (million US$)	% of GNP	Ratio of Private Sector
Korea	5,198	2.01	80
Taiwan	1,808	1.40	50
Singapore	434	1.00	59
Malaysia (1990)	293	0.80	10
Thailand	157	0.19	10

Source: Office of Policy and Planning , Ministry of Science , Technology and Environment

R&D Expenditures in Public and Private Sectors

Units: millions of Baht

Sector	R&D Expenditure					
	1989		1991		1993	
	Budget	%	Budget	%	Budget	%
Government	**1,889.23**	**64.95**	**2,735.02**	**69.63**	**3,147.78**	**70.37**
1. Ministries	1,700.19	58.45	2,565.27	65.31	2,728.89	61.00
2. Government enterprises	189.04	6.50	169.75	4.32	418.69	9.36
University	**640.23**	**22.01**	**793.63**	**20.20**	**1,015.61**	**22.70**
1. National *	634.96	21.83	711.79	18.12	-	-
2. Private	5.33	0.18	81.84	2.08	-	-
Private	**379.43**	**13.04**	**399.40**	**10.17**	**310.21**	**6.93**
1. Business	160.84	5.53	197.53	5.03	290.56	6.50
2. Nonprofit activities	218.59	7.51	201.87	5.14	19.65	0.44
Total	**2,908.95**		**3,928.05**		**4,473.40**	

Note: * Including governmental academic institutes.
Source : Office of Policy and Planning , Ministry of Science , Technology and Environment

(2) Fields of R&D Activities

The fields of R&D activities in the Kingdom have been examined by expenditures and the number of scientists and engineers. Data are available from the R&D expenditures or budget allocated to the Ministries and to the faculties of Universities as shown in the table below. In 1993, R&D expenditures of all Ministries were 2,729 million Baht or 61.0 per cent of the total national expenditures. It is notable that the budget allocated to the Ministry of Agriculture and Co-operatives (MOAC) accounted for 80.5 per cent of the total budget for the Ministries or 49 per cent of the total R&D expenditures of the Kingdom.

R&D Expenditures of The Ministries

Units: million of Baht

Ministry	R&D Expenditure					
	1989		1991		1993	
	Budget	%	Budget	%	Budget	%
Office of the Prime Minister	23.68	1.39	17.65	0.69	54.26	1.99
Ministry of Defense	30.98	1.82	43.94	1.71	89.02	3.26
Ministry of Finance	-	-	0.42	0.02	8.96	0.33
Ministry of Agriculture and Co-operatives	1,343.90	79.04	2,243.53	87.46	2,197.40	80.52
Ministry of Transport and Communications	2.3	0.14	1.12	0.04	3.24	0.12
Ministry of Commerce	2.07	0.12	1.61	0.06	1.50	0.05
Ministry of Interior	19.95	1.17	11.81	0.47	32.78	1.20
Ministry of Justice	-	-	1.02	0.04	2.73	0.10
Ministry of Science, Technology and Environment	173.13	10.18	118.84	4.63	45.66	1.67
Ministry of Education	31.2	1.83	8.84	0.34	68.75	2.52
Ministry of Public Health	54.14	3.18	81.77	3.19	195.18	7.15
Ministry of Industry	18.83	1.11	34.72	1.35	25.45	0.93
Ministry of Foreign Affairs	-	-	-	-	0.05	0.00
Ministry of Labor & Social Welfare	-	-	-	-	3.92	0.14
Total	1,700.18	100	2,565.27	100	2,728.90	100

Source : Office of Policy and Planning , Ministry of Science , Technology and Environment

The R&D expenditures of Universities were 1,015 million Baht or 22.7 per cent of the total expenditure in 1993. The budget allocated to the science and technology fields in universities was 821 million Baht or 80.8 per cent of the above budget. The engineering technology sector had the highest share (24.7 per cent), followed by agriculture and medical science (refer to the table below). It is apparent that the focal field of R&D activities in the Kingdom has been the agricultural sector including fisheries and forestry.

R&D Expenditures of Universities

Units: millions of Baht

Sector	R&D Expenditure					
	1989		1991		1993	
	Budget	%	Budget	%	Budget	%
Science and Technology	**511.88**	**79.95**	**638.18**	**80.42**	**821.06**	**80.84**
Natural Sciences	92.82	14.50	71.25	8.98	128.71	12.67
Engineering Technology	90.41	14.12	212.60	26.79	251.41	24.75
Medical Sciences	120.69	18.85	172.56	21.74	166.02	16.35
Agriculture	184.44	28.81	152.62	19.23	199.84	19.68
Environment	23.52	3.67	29.15	3.67	75.08	7.39
Social Sciences	**128.41**	**20.05**	**155.45**	**19.58**	**194.55**	**19.16**
Total	**640.29**	**100**	**793.63**	**100**	**1,015.61**	**100**

Source: Office of Policy and Planning , Ministry of Science , Technology and Environment.

Judging from the number of researchers, S&T in Thailand has been focused on agricultural science and biology, followed by medical science as shown in the table to the right. R&D in engineering and industries, which would contribute to manufacturing industries, has been rather weak both in terms of expenditures and manpower.

Number of S&T Researchers

Sector	1994	1995
Physical Sciences and Mathematics	853	942
Medical Sciences	3,911	4,101
Chemical and Pharmacy	1,138	1,214
Agricultural Sciences and Biology	4,910	5,294
Engineering and Industrial Research	1,722	1,903
Total	12,534	13,454

Source: The National Research Council of Thailand

The R&D activities are divided into three categories: Basic Research, Applied Research, and Development. In 1987, 1,506 million Baht or 56.5 per cent of the total R&D expenditures were allocated to Applied Research, followed by Basic Research (626 million Baht or 23.5 per cent). In 1993, the trend of budget allocation remained basically unchanged, with some acceleration in Applied and Basic Research. In general, the main actor of Development is private enterprises. In the Kingdom, however, R&D expenditure by the private sector has been quite small as pointed out above, and the expenditure ratio for Development remains at a low level. Development activity is closely related to production. To maintain the competitiveness of the private sector in the global market, Development activity by the private sector is essential. In higher education, the ratio and value of R&D expenditure for Basic Research decreased during the period from 1987 to 1993. The decrease in value should be carefully assessed because Basic Research activities in higher education are essential. The budget allocation to the three categories are summarized in the following table:

R&D Expenditures Classified by Types of R&D

Units: millions of Baht

		Basic Research		Applied Research		Development		Total	
Government Organizations	'87	298.72	21.63	813.16	58.88	269.16	19.49	1,381.04	100
	'93	905.07	33.17	1,474.11	54.02	349.71	12.82	2,728.89	100
Higher Education	'87	269.28	33.29	3445.48	55.04	94.61	11.69	809.37	100
	'93	233.69	23.01	653.20	64.32	128.72	12.67	1,015.61	100
State Enterprises	'87	23.99	8.66	169.35	61.13	83.69	30.21	277.03	100
	'93	25.25	6.03	295.75	70.64	97.69	23.33	418.69	100
Private Enterprises	'87	27.85	15.34	77.42	42.64	76.29	42.02	181.56	100
	'93	43.50	14.97	173.02	59.55	74.04	25.48	290.56	100
Nonprofit Organizations	'87	6.55	42.56	1.15	7.47	7.69	49.97	15.39	100
	'93	0.54	2.75	18.95	95.42	0.36	1.83	19.65	100
Total	'87	626.39	23.51	1,506.56	56.54	531.44	19.95	2,664.39	100
	'93	1,208.05	27.01	2,614.83	58.45	650.52	14.54	4,473.40	100

Source: The National Research Council of Thailand

(3) Human Resources in R&D Activities

Human Resource Development (HRD) is one of the most crucial issues for sustainable growth in the Kingdom. HRD programs are required to correspond to social needs, e.g., the demand for engineers and skilled labor by private firms, the demand for researchers and scientists by the public and private institutes. R&D activities require several occupational types, not only scientists but engineers and skilled labor or technicians. In other words, R&D activities also require supporting industries. The key, however, is the supply of scientists and engineers who have been educated in universities and/or institutes of technology. The supply of bachelor degree holders and masters and doctoral degree holders in engineering was 6,500 and 520 respectively in 1994. The capacity of supplying such degree holders, especially graduates of masters and doctoral programs, is quite low in Thailand compared to that of Korea and Taiwan, as shown in the following table:

Manpower in Science and Technology in Selected Asian Countries

Country	Korea	Taiwan	Singapore	Thailand
Bachelor graduates in Engineering per year	28,000	20,000	2,000	6,500
Bachelor graduates in Engineering per year per 1,000,000 population	700	1,000	670	110
Graduate Scientists and Engineers with Masters or Doctoral Degrees per year	20,000	6,000	n.a.	520
Scientists and Engineers per 10,000 population	90	n.a.	n.a.	24

Source: Office of Policy and Planning, Ministry of Science, Technology and Environment

The increment of researchers in S&T between 1994 and 1995 was 920 in total, including researchers in agricultural science and biology (384), medical science (190), and engineering and industrial research (181).

This shortage of manpower in R&D activities is projected to continue. For example, in 2001 the cumulative shortage of engineers and scientists with a bachelor's degree is forecast to be more than 100,000 in the industrial sector. Since some bachelor degree holders will be working in R&D in the industrial sector, such a shortage will be a serious bottleneck not only for production but also for R&D activities. The supply situation of personnel with graduate degrees in engineering or science, who are expected to be main participants in R&D activities, is forecast to be similar to that of bachelor degree holders.

(4) Institutional Situation

The National Research Council of Thailand (NRCT), chaired by the Prime Minister, is responsible for drawing up the nationwide R&D promotion policy and for supporting R&D related organizations and researchers in the whole Kingdom. The office of NRCT is set up in the Ministry of Science, Technology and Environment (MOSTE). MOSTE, therefore, acts as the administrative body under NRCT. MOSTE is also responsible for planning and execution of the comprehensive R&D programs. MOSTE has an integrated R&D institute, the Thai Institute of Scientific and Technological Research (TISTR), which executes R&D activities and provides various S&T services for the private sector. The National Science and Technology Development Agency (NSTDA), established in 1991, is another organization under MOSTE; its objectives are to cooperate with other agencies to draw up R&D policy, to support the private sector in the execution of RD&E (research, design and engineering), to execute in-house R&D activities, and to provide various S&T services through its three R&D centers to be located in the science park in Prangsit, Pathom Thani.

There were 16 state universities and 18 private universities in the Kingdom as of 1990, of which 13 universities or 105 units (i.e., number of faculties and constituent institutes) were executing R&D and related activities in science and technology. The activities of most of the 105 units may be classified as higher education and R&D related information collection and dissemination services; however, R&D activities defined as "innovative or systematic research work with the purpose of augmenting the knowledge of S&T and applying the knowledge in some new ways" was executed by only 11 units in 1990.

R&D Units in Universities

Name of University	No. of Units	R&D Activities		Location
		No. Units	S&E*	
Chiang Mai University	11	-	-	-
KMIT Tonburi	6	1	3	Bangkok
Prince of Songkhla University	10	1	16	Hat Yai
KMIT Ladkrabang	9	2	44	Bangkok
Chulalongkorn University	19	3	39	Bangkok
Kasetsart University	18	3	55	Bangkok, Nakhon Pathom
Mahidol University	8	1	20	Bangkok
Ramkhamhaeng University	3	-	-	-
Srinakharinwirat University **	7	-	-	-
Khon Kaen University	7	-	-	-
KMIT North Bangkok	4	-	-	-
Silpakorn University	2	-	-	-
Thammasat University	1	-	-	-
TOTAL	105			-

Note: * S&E is short for number of Scientists and Engineers. ** There are three campuses.
Source: Directory of Science and Technology Services in Thailand, Dec. 1990, TDRI

The major Ministries related to R&D activities are the Ministry of Public Health (MPH); Ministry of Science, Technology and Environment (MOSTE); Ministry of Agriculture and Co-operatives (MOAC); Ministry of Industry (MoI); and Ministry of Transport and Communications (MOTC). The organization of R&D activities at each Ministry is varied (e.g., semi-independent institutes, constituent institutes, divisions). The R&D units under the Ministries are summarized in the following table:

R&D Units under Ministries

Name of R&D Units	Ministries	S&E *	Fields **	Location
Department of Medical Science	MPH	521	2,3,6,7,16	Yodse, BKK
Div. of Botany & Weed Science	MOAC	38	1	Bangkhen, BKK
Div. of Entomology & Zoology	MOAC	118	1	Bangkhen, BKK
Div. of Forest Products Research	MOAC	74	10	Bangkhen, BKK
Div. of Freshwater Fisheries	MOAC	4	16	Bangkhen, BKK
Div. of Geological Survey	MoI	63	8	Phyathai, BKK
Div. of Physics	MOSTE	13	7	Bangkhen, BKK
Div. of Seed	MOAC	149	1	Bangkhen, BKK
Field Crops Research Institute	MOAC	237	1	Bangkhen, BKK
Institute of Marine Biology & Fisheries Research	MOAC	17	5,16	Muang Phuket
Kalasin Fisheries Station	MOAC	5	1,2	Muang Kalasin
National Center for Metal & Material Technology	MOSTE	6	9,10	Phyathani, BKK
National Electronics & Computer Technology Center	MOSTE	3	12	Phyathani, BKK
National Inland Fisheries Institute	MOAC	39	16	Kasetsart Univ. BKK
Phayao Inland Fisheries Station	MOAC	4	16	Muang Phayao
Thai Industrial Standards Institute	MoI	243	***	Phyathani, BKK
Thai Packaging Center	MOSTE	12	16	Bangkhen, BKK
The Communication Authority of Thailand	MTC	196	11,12,13,14	Bangkhen, BKK
The Metal-Working & Machinery Industries Development Institute	MoI	-	-	Prakhanong, BKK

Note: * S&E is short for the number of Scientists and Researchers. ***; 1,2,4,6,7,8,9,10,11,12,14,15

**; Fields of the R&D are as follows:

1: Agricultural Science 2: Biological Science & Engineering 3: Health and Medical Biology 4: Food & Nutrition 5: Environmental Science 6: Chemistry and Chemical Engineering 7: Physics 8: Geology 9: Mechanical & Mining Engineering 10: Material Science 11: Communications 12: Computer Science & Engineering 13: Data Processing 14: Electrical & Electronic Engineering 15: Instrument 16: Other Area of Expertise n.e.s.

Source: Directory of Science and Technology Services in Thailand, 1990, TDRI

(5) Spatial Distribution of S&T and R&D Facilities

According to a 1990 study by the Thailand Development Research Institute (TDRI), there were 40 units undertaking R&D activities in the Kingdom, of which 34 units or 85 per cent were located in Bangkok. Two of the remaining six units were located in the Central region (Samut Prakan and Nathan Pathom), two in the Southern region (Phuket and Hat Yai), and one each in the Northern and Northeastern regions. Consequently R&D is heavily concentrated in the Bangkok area. It is further noted that the location of R&D facilities in the Bangkok Metropolitan Area (BMA) is rather scattered; some are located in the center of the city, while others are in the outskirts of the metropolis. Due

to the traffic congestion in Bangkok, interactions or cooperation among R&D facilities is quite difficult. The R&D units have been independent even when they are under the same parent body. It should be recalled that modern R&D activities are most effective when joint or cooperative research and development is carried out with various disciplines; consider, for example, that micro devices are developed with cooperation among physics, chemistry, mechanics, and other disciplines. Therefore, "transactional" research among institutes is hardly attainable in the R&D units in the BMA.

1.3 Issues and Government Policy

(1) Issues

The results of the review and assessment of current situation in R&D activities suggest a number of issues or problems that need to be resolved for sustainable economic growth of the country. The issues identified are summarized as follows:

Budget or R&D Expenditures

- The amount of R&D expenditure is quite small.
- The R&D expenditure by the private sector is extremely small.
- The share of R&D expenditures to GNP is small, and it has been decreasing.
- Among the three R&D categories (Basic Research, Applied Research, and Development), the expenditure on Development is particularly small.
- The allocation of R&D budget is biased toward the agricultural sector. To secure the competitiveness of the industrial sector, the sector's allocation of R&D should be reconsidered.

Manpower

- A severe shortage in personnel with higher education is apparent.
- The capacity of manpower supply in engineering and science is limited.
- There is a shortage of teachers and/or instructors in engineering and science.
- Scientists and/or researchers in the public sector tend to job-hop to the private sector. This movement, however, has not resulted in a strengthening of R&D capabilities in the private sector.

Spatial Distribution

- The institutions related to the R&D activities are excessively concentrated in the BMA.

- Some universities have plans to relocate away from the central part of Bangkok, but their planned new locations are on the outskirts of the BMA.
- Because most of the existing R&D organizations under Ministries are located in the vicinity of their parent bodies in the inner city, the atmosphere for the R&D activities is less optimal.
- Because of the traffic conditions in Bangkok and the scattered location of the R&D institutions, they are quite isolated and unable to attain agglomeration of various R&D organizations.

(2) Government Policy

Most of the issues described above have been recognized by the Royal Thai Government. Both "Thailand Vision 2020" and the 8th National Economic and Social Development Plan, for example, emphasize that R&D should be strategically promoted through human resource development in both quality and quantity. The major targets of the 8th Plan regarding R&D promotion are summarized below:

- To increase the ratio of R&D expenditures to GNP to 0.75 per cent (it was 0.18 per cent in 1993);
- To increase the number of scientists and engineers by more than 15 per cent annually;
- To promote R&D activities in the both public and private sectors;
- To establish regional technology centers to cooperate with regional universities;
- To improve the efficiency of providing and improving production technology to strengthen industrial science and technology capability;
- To support R&D activities in the private sector by providing financial incentives; and
- To develop state institutions to become centers of technical excellence.

In the 8th National Plan period, the first science park will be developed by NSTDA under MOSTE. This science park has been planned in the BMA with scheduled completion in 1998. Emphasis in this park is put on RD&E (Research, Development and Engineering) activities in biotechnology, metal and material technology, and electronics and computer technology. The purpose of this science park is to follow the R&D policy under the 8th National Plan. However, this science park is located in the BMA and it will not contribute to decentralization, which is another policy of the Government.

2. SCIENCE CITY DEVELOPMENT PROGRAM

2.1 Needs for a Science City

Most R&D organizations, both public and private, are currently concentrated in the BMA. The need to relocate these facilities away from the BMA has been recognized, because it would be beneficial not only for the personnel engaged in research activities but also for the alleviation of excessive concentration in the Bangkok area. Since the siting of multiple institutions in the same area will certainly strengthen collaborative research among institutions, a project targeting such relocation should include not only science park functions but other functions and amenities as well. The Science City proposed here, therefore, requires a wider scope than that of a science park; in other words, the science park will be served by many functions within a Science City. The objective of the proposed Science City is not only to address the issues related to R&D activities (described above) but also to accelerate implementation of the Government's decentralization policy.

2.2 Position of the Central WSB Region

The proposed Science City has been conceived and planned as one of several major initiatives for the integrated regional development of the Western Seaboard (WSB) region. The Science City is planned to meet the dictates of the 8th National Plan that research staff and facilities be increased and strengthened, that decentralization of research facilities and laboratories be promoted, and that the R&D activities be integrated into the development of the WSB region.

The Central WSB region is proposed as an Amenity Zone and is already serving as a tourism center (Cha Am and Hua Hin). The ecological conditions in the zone, which includes three national parks (Khao Sam Rio Yol, HD Wanakorn, and Namtok Huai Yang) are excellent and should therefore be preserved to the maximum extent. Accordingly, this zone offers favorable conditions for the location of the Science City.

Petchaburi province is proposed as the location of the Science City for the following reasons:

- The site is located within a distance such that a one-day round trip to/from the BMA is possible.
- The site is close to the existing resort areas in Cha Am and Hua Hin, and favorable amenities and recreational facilities are available.

- The site is in a zone in which knowledge-based industries and intellectual infrastructure are proposed to be promoted under the WSB spatial development plan.
- The site is close to the Rajabhat Institute, Petchaburi, which is proposed to function as an academic center.
- Four vocational colleges (Petchaburi Technical Collage, Petchaburi Provincial Vocational College, Petchaburi Agricultural College, and Petchaburi business school) and two undergraduate colleges (Petchaburi Teacher College and Phra Jom Glaw Nursing College) are located in Petchaburi.
- Petchaburi province is located in Zone 3 (i.e., the most favored zone) under the BOI promotional scheme, and investments in the province have been increasing.

2.3 Objectives of the Science City in Petchaburi

The objectives of the Science City are summarized as follows:

- To promote research and development (R&D) activities to contribute to the objectives and goals of "Thailand Vision 2020," the 8th National Plan, and future plans for economic and social development of Thailand;
- To promote decentralization of R&D functions particularly from the BMA and to strengthen the R&D capability of each institute;
- To encourage collaborative research activities among the institutes locating in the Science City, particularly interdisciplinary R&D activities; and
- To integrate the Science City into the regional development of the WSB as a core development initiative, and to promote social, economic, and intellectual development of the region.

2.4 Concept and Rationale

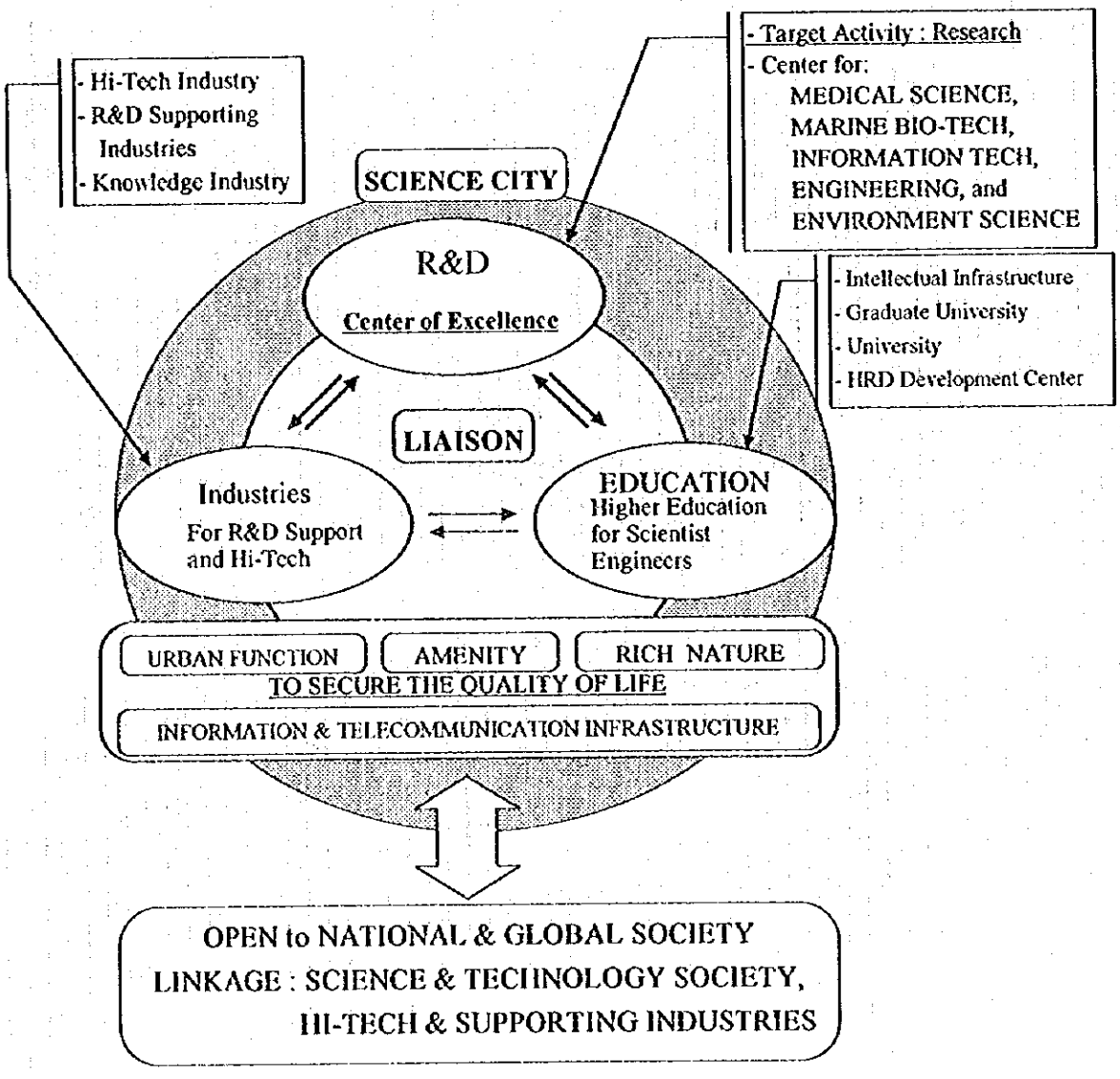
The Science City in Petchaburi is planned as a "Center of Excellence" for S&T and R&D activities. It must therefore be attractive for Thai and foreign scientists and researchers. The Science City also must attract both domestic and foreign companies to undertake R&D activities.

The basic concept of the Science City is that it will be an attractive urban area with a rich natural environment (Symbiosis), open to domestic and global endeavors (Openness), linked by human and academic/research networks using IT (information) technologies (Networking), and suitable for collaborative research among academia, and public and private institutions (Interdisciplinary).

4 Key Words for the Science City
- **Symbiosis**
- **Openness**
- **Networking**
- **Interdisciplinary**

Under this basic concept, the functions of the proposed Science City are summarized as illustrated below.

Basic Concept of Science City



Information technology (IT) will be applied to the maximum extent in the proposed Science City. To this end, the Science City will be equipped with facilities for telecommunications and network connections including both an Intranet and the global Internet.

The Science City will also have facilities for exhibitions, seminars, and information dissemination, and facilities for training and dissemination of information, as well as R&D institutions. All the functions and facilities proposed above will be integrated and operated as a Science City and R&D center. Also, the development of a new city is planned with appropriate urban facilities, urban infrastructure, and urban amenities. Some of urban infrastructure will serve not only the Science City but also nearby urban centers. A convention center will be included in the urban plan, together with hotels and other facilities to be promoted by the private sector.

2.5 Strategies for the Science City in Petchaburi

1) It is proposed that the major laboratories and R&D functions of the Government and public institutions now located in the BMA be strongly encouraged to relocate to the proposed Science City in Petchaburi. Such laboratories would include, but not be limited to, medical, engineering, agro-aqua, environmental, scientific, IT, and other research centers.

2) Private laboratories and R&D centers would be requested to relocate from the BMA to the proposed Science City; incentives would be granted for such relocation by the private sector.

3) It is proposed that a new graduate school for related disciplines be established in the Science City to cooperate with the state universities, including Rajabhat Institute.

4) The Science City would incorporate testing-measurement-calibration facilities, training facilities, and information/network facilities to execute the functions proposed above.

5) The Science City would be equipped with complete urban facilities and amenities, including education, health, housing, and urban amenities/ infrastructure. Urban facilities of the Science City could be supported by existing urban facilities, which are located nearby in the Petchaburi, Hua Hin, and Cha Am urban centers.

6) The Science City in Petchaburi will tie up with other R&D centers in the WSB and the BMA, including a center to be set up by the King Mongkut's Institute of Technology in Chumphon.

7) The Science City will also tie up with the resort/amenity zone as well as the commercial centers and the academic and vocational colleges in Cha Am and Hua Hin.

3. FRAMEWORK OF SCIENCE CITY DEVELOPMENT

3.1 Socioeconomic Framework

(1) Target Population Size of Petchaburi Science City

Target Population (Nighttime Population): 20,000 persons (approximate)

(2) Employment Structure

(i) Scientists, researchers, engineers, and technicians
(ii) Employment in the hi-tech industries (including the software industry)
(iii) University and graduate school faculties, students, and administrative staff
(iv) Employment in business, commercial, and public services
(v) Family members of the above

(3) Living Environment

(i) High level of social services (e.g., water supply, garbage collection, electricity, telecommunications)
(ii) Health care facilities
(iii) Public facilities (e.g., banks, libraries, bookstores)
(iv) Education facilities (e.g., elementary, junior high, senior high, vocational, international school)
(v) Amenity facilities (e.g., playground, theaters, movies, community center, supporting facilities, shopping center)
(vi) Accessibility to the other urban areas (e.g., expressway, railway, airport)

(4) Working Environment

(i) Accessibility to people and information

The activity at these industrial facilities relies heavily on available human resources and information. Commuting and business trips and the transmission of information should be undertaken smoothly.

(ii) Creative atmosphere

The R&D or knowledge-oriented facilities require a working environment conducive to creative work; an innovative design, with an attractive interior and excellent illumination will be used to offer an ideal atmosphere inside the buildings. A typical approach for providing a creative environment is to carefully incorporate greenery, water, and parkland to provide attractive scenery so that employees will be able to relax and feel refreshed.

(iii) Good support facilities

Special equipment such as large mainframe computers and analytical instruments should be shared by a number of users to provide cost economies. In many cases, the support facilities may be provided by industries located either inside or close to the City and which will be established to provide easy access to such equipment.

3.2 Alternative Sites

Three alternative sites for the Science City in Petchaburi province have been identified. One is in the Nong Ya Plong area located 26.5 km west by northwest of Petchaburi City about 15 km from Route 4 and 200 m above sea level. The second alternative site is Khao Den located about 18 km west of Petchaburi City; this alternative site, which covers 80,000 rai, is under the Royal Forestry Department and designated as an economic forest. This area may be subdivided into two parts, with the eastern part only 5 m above sea level and the western part on a tableland at 60-120 m above sea level. The third alternative site is located in the south of the province, 8 km west of Cha Am on the outskirts of the Khao Nam Yot. At the fringes of this third site are paddy fields and pilot agricultural projects. The features of the three alternative sites are summarized below:

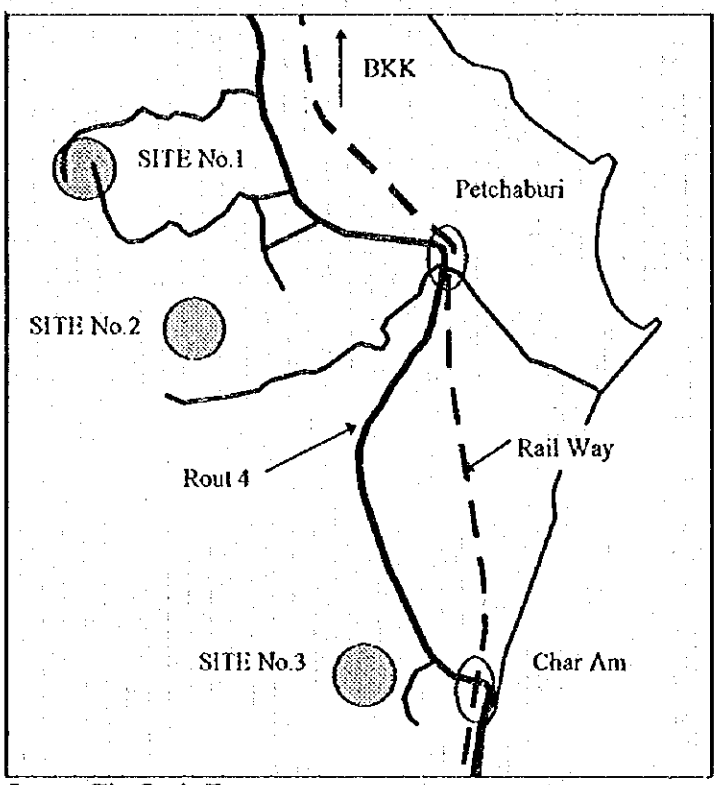
Salient Features of the Alternative Sites

	Nong Ya Plong	Khao Den	Khao Phra Rop
Location (On map below)	1	2	3
Topography	Basin, 200m height	Level, Tableland	Level
Distance from Petchaburi	26.5 km	18 km	36 km
from Cha Am	46.5 km	35.5 km	7.5 km
from Trunk Road	15 km	10 km	6 km
Ease of Land Acquisition	Difficult	Easy	Moderate
Current Land Use	-	Economic Forest	Paddy Field
Advantages/Disadvantages	Living Pop.: Large	Rajabhat Inst. Near Living Pop.:Small	Near Cha Am Agro-projects

Source: The Study Team

Through field reconnaissance, it appears that the alternative site at Khao Den (No. 2) may be most favorable because (i) a sizable area of land under the custody of the Royal Forestry Department is available; and (ii) Rajabhat Institute, Petchaburi has decided to relocate its campus to this site. It is therefore proposed that the Science City would be located at this site.

Alternative Sites of Science City



Source: The Study Team

3.3 Land Use Plan for Science City Development

(1) Scale of Development

The proposed Science City is expected to have an area of 2,400 hectares, which will include residential neighborhoods, educational, commercial, and office buildings, and national testing and research institutes. The Science City may be broadly divided into a research and academic zone and a peripheral development zone. The research and academic zone will be occupied by government and private research organs and academic institutions such as universities, commercial and business facilities including hotels, a center building with a public hall, shopping centers, a bus terminal, and other facilities. The residential zone, which will occupy about 400 hectares, will be home to approximately 20,000 persons.

Scale of the Science City in Petchaburi (Tentative)

Science City in Petchaburi	
I. Research and academic zone	*700 ha*
(1) Educational Unit (300 ha/University x 2 units)	500 ha
(2) Research and Development Unit	150 ha
(3) Hi-tech, Software Industrial Unit	100 ha
II. City Zone	*700 ha*
(1) Housing Unit (Proposed Night-time Residential Population - 20,000 population. 50 persons/ha including Schools, Public Facilities areas)	400 ha
(2) Business & Commercial Unit	50 ha
(3) Recreational Unit	250 ha
Core Area of Petchaburi Science City (I + II)	*1,400 ha*
III. Peripheral Environmental Protection and Buffer Areas	*1,000 ha*
Planned Area of Science City Petchaburi (I+II+III)	*2,400 ha*

Source: The Study Team

(2) Land Use Concept

The following will be key elements of the land use plan for the Science City:

1) Basic elements

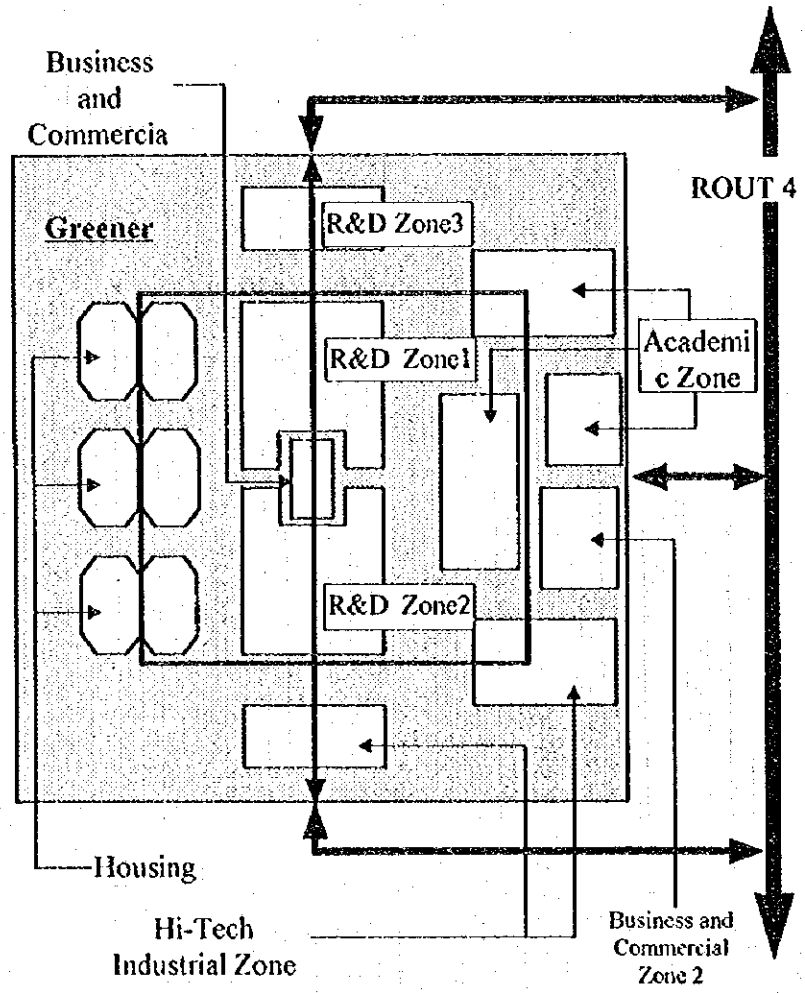
Land for R&D facilities, land for hi-tech industry, roads, parks and greenbelts, service facilities (centers), utility and processing facilities (e.g., drainage ponds, reservoirs, contaminated water processing, electric power supply equipment, waste disposal facilities).

2) Supplementary elements

Schools, housing, community facilities, sports facilities, shopping centers, etc.

A Conceptual Land Use Plan of the Science City is shown overleaf.

Conceptual Land Use Plan of Petchaburi Science City



3.4 Estimated Cost

The Science City project, with a total development area of 2,400 hectares, should be implemented step by step. The project will be divided into three phases: short term (1997-2001), medium term (2002-2006), and long term (2007-2011). The basic concept of the phasing is to set up the higher education function at first, then to relocate governmental organizations, which will then be followed by private sector enterprises.

Other basic components will be developed along with development of the above facilities. The development cost by each phase is estimated as follows:

Estimated Cost of the Science City (Tentative)

Units: millions of

Component / Target Year	2001	2006	2011	Total
I. Research and academic zone				
(1) Educational Unit (2 units)	200	200	-	400
(2) Research and Development Unit	20	60	40	120
(3) High-tech, Software Industrial Unit	-	28	-	28
II. City Zone				
(1) Housing Unit	160	480	320	960
(2) Business & Commercial Unit	32	80	48	160
(3) Recreational Unit	20	40	40	200
Sub Total (I+II)	532	888	448	1,868
III. Related Utility Development Cost	108	176	88	372
TOTAL	**640**	**1,064**	**536**	**2,240**

Source: The Study Team

3.5 Institutional Setting

The Science City project will involve the various sectors (e.g., academia, Government, private sectors) with stage-by-stage participation. The major candidate organs to take part in the main components are summarized in the table below. Some of the candidate sectors would join at the planning stage, others at implementation stage. To facilitate the smooth implementation of the Science City project, the establishment of a single development and management body is recommended. Since the Science City is consistent with the WSB regional development plan, as well as with the national R&D policy, such a development and management body should maintain a close relationship with the proposed WSB Development Management Office.

Candidate Sectors for the Science City (Tentative)

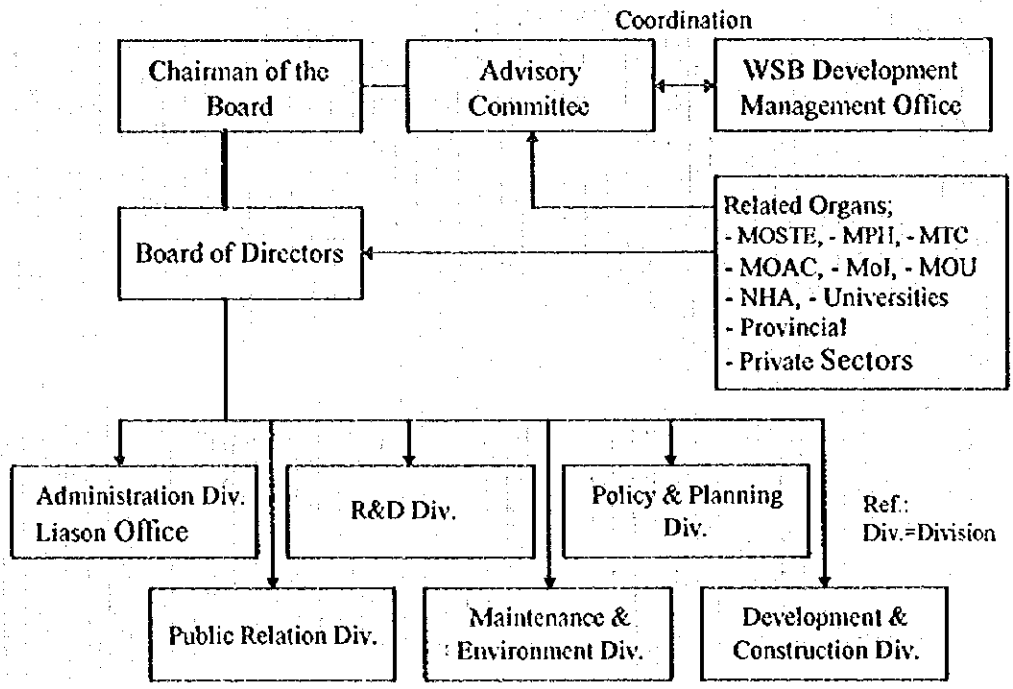
Components	Candidate Sectors
I. Research and academic zone	
(1) Educational Unit	State Universities
(2) Research and Development Unit	Government R&D units, Private Sector
(3) High-tech, Software Industrial Unit	Private Sector
II. City Zone	
(1) Housing Unit	NHA, Private Sector, Science City Corp.
(2) Business & Commercial Unit	Private Sector, J/V Private and Public
(3) Recreational Unit	Private Sector
III. Future Expansion and Buffer Areas	Managed and maintenance by the Science City Corp.

It is proposed that the development and maintenance of the Science City be pursued by a single corporatized body, provisionally called "the Science City Corporation." The tasks of the Corporation will include:

- To work out the Science City plan as a whole so as to be consistent with the WSB Regional Development Plan and the National R&D Policy;
- To develop/construct all components involved in the plan under close cooperation between the public and private sectors;
- To promote investment;
- To coordinate the activities executed in the City to strengthen the R&D capabilities; and
- To maintain the City's facilities, particularly utilities.

In order to achieve these tasks a tentative structure of the Science City Corporation is proposed as shown below.

Science City Corporation (Tentative)



3.6 Initial Environmental Examination (IEE)

The proposed site of Science City is located in relatively flat terrain about 18 km west of Petchaburi municipality. There are some lowland trees in the Project area. The area is governed by the Royal Forest Department with its forest classification of "Economic Forest" and there are some 20 households in the southernmost area. The Project area's location near a mountain range would create a potential risk of flood problems. It is believed that there are no important aesthetic, archeological, or historical resources except a cemetery located in the southern edge of the Project area.

Implementation of the Project might cause some adverse impacts on infrastructure along with facility construction-associated noise and air pollution and domestic waste discharged from dining and accommodation facilities.

It can be concluded that the Project will not result in any significant environmental impacts. However, some adverse impacts are anticipated as mentioned above, requiring appropriate preventive measures. A full-scale EIA is not considered necessary for the Project. It is desirable, however, that a study assessing probable noise and air pollution, and domestic wastes problems be conducted in the next stage of the study. Summary IEE table and IEE checklist are herein attached.

4. RECOMMENDED ACTIONS

It is proposed that the feasibility study of the Science City project be executed as early as possible. Until the WSB Development Corporation is set up (as proposed in this master plan study for the integrated regional development of the WSB), it is proposed that NESDB act as the executing agency during the feasibility stage. However, it would be beneficial if NSTDA were to cooperate in the planning and study of the proposed Science City.

Development incentives are expected to be introduced for the Science City. To induce companies and institutions to relocate or to be newly installed, financial assistance should be provided for the construction of their facilities. It is desirable that the following tax incentives and subsidies be offered to firms and organizations that move to the Science City development area.

i) Relocation incentive tax exemptions

Special relocation incentive tax exemptions or depreciation for the replacement of business assets (equipment) required to relocate from the over-concentrated BMA should be considered.

ii) Low-interest loans

Low-interest loans are desired to finance relocation and construction costs borne by companies and organizations/institutions moving from the BMA.

iii) Financial assistance for the Science City Corporation

Investment and financial assistance should be considered for the Science City Corporation, which will provide research and development support, provide guarantees, and conduct personnel resources development and information dissemination functions.

Initial Environmental Examination (IEE) for Science City Development Initiative

A. Description of Environment	
1. Physical Resources	1. The Project area is located in relatively flat terrain about 20 km west of Petchaburi municipality.
2. Ecological Resources	2. There are some lowland trees in the Project area. The area is governed by the Royal Forest Department with its forest classification of "Economic Forest".
3. Human Use Values	3. There are no significant agricultural or commercial activities.
4. Quality of Life Values	4. There are no important aesthetic, archeological, or historical resources except a cemetery located in the southern edge of the planned Project area. There also found some 20 households in the southernmost area.
B. Screening of Potential Environmental Impacts	
1. Environmental Impacts Caused by Project Location	1.The Project area's location near a mountain range would create a potential risk of flood problems.
2. Environmental Impacts Associated with Construction Stage	2. Infrastructure and facility development would result in an increased level of noise and air pollution; however these impacts are considered minimal as it is believed that very few people or wildlife inhabit in the Project area.
3. Environmental Impacts Resulting from Project Operations	3. There would be no significant adverse environmental impacts caused by the Project operation. Only potential impact is domestic waste discharged from dining and accommodation facilities.
C. Environmental Mitigation Measures	Provision of appropriate flood protection measures on the mountain slope, careful selection of facility sites to avoid the cemetery and existing residents, the setting up of machinery maintenance areas and construction camps away from the water bodies, and installation of a household waste treatment system would be efficient means to prevent potential environmental quality degradation.
D. Conclusion	The Project will not result in any significant environmental impacts.

Checklist of Initial Environmental Examination (Science City Development Initiative)

Environmental Parameters Affected by the Project Implementation	Impacts on the Environment	Recommended Feasible Mitigation Measures	Magnitude of Impacts			
			No Significant Effect	Significant Effect		
				Small	Moderate	Major
1. Air and Noise Pollution	1. Nuisances and health hazards to neighbors and wildlife.	1. Usage of low air and noise emission construction equipment; selection of proper times for land clearing and facility construction.		x		
2. Terrestrial Ecology and Flooding	2. Alteration of wildlife habitats, loss of biodiversity, and potential risk of flooding from tree cutting.	2. Minimization of the amount of tree cutting, replanting precious vegetation, and providing slope/flood prevention measures.			x	
3. Water Quality and Sanitary Condition	3. Water pollution caused by facility construction works, and untreated domestic waste water and/or solid wastes discharged from facilities to be established in the science city.	3. Setting up machinery maintenance areas and construction camps away from the water bodies, and proper measures to treat domestic waste water and solid wastes generated from the facilities.		x		
4. Historical/Cultural Properties	4. Loss of historical/cultural properties.	4. Investigation of these properties and provision of appropriate preservation measures.	x			
5. Human Resettlement	5. Relocation of residents.	5. Consideration of alternative site selection and adequate compensation for affected residents.		x