The Nanosafety and Ethics Strategic Plan (2017 – 2021)

Executive Summary

The Nanosafety and Ethics Strategic Plan (2017 – 2021) is the second edition of the first Strategic Plan 2012-2016 by the Office of the National Science, Technology and Innovation Board (STI) together with the National Nanotechnology Center (NANOTEC), National Science and Technology Development Agency (NSTDA), and Ministry of Science and Technology. It is designed to ensure continuous monitoring and management of safety and ethics in national nanotechnology development.

As a result of past performances, various organizations and institutions have realized the importance of safety and ethics of nanotechnology. This can be seen from the fact that various organizations have created database of knowledge, safety and ethics, nanotechnology and nanotechnology products that are accessible to all sectors such as 1) nanotechnology information and knowledge centers and 2) nanotechnology safety manual for consumers, industry and academics, as well as regulatory and regulatory measures and measures for instance 1) guidelines for health care practitioners and 2) notification by the Ministry of Industry for the 7 industrial nanotechnology standards.

This strategic plan is based on the Strategic Plan for Safety and Ethics of Nanotechnology 2012 - 2016 in which the working group have analyzed, evaluated and elaborated the strategic plan so that it is in line with current situation of nanotechnology development in Thailand. The plan focuses on the involvement of relevant agencies and the process of creating ownership of this strategic plan, at the same time demonstrating the direction and approaches that will lead to "sustainable nanotechnology for national development" that aims at achieving health safety, environment and security for national research and development, production and distribution process, and ethical use of nanotechnology and nanotechnology products. The 3 strategies to achieve the vision and goals of this plan are: 1) the creation and management of knowledge, 2) the development and strengthening of measures and mechanisms for supervision and enforcement, and 3) the strengthening and promotion of public participation.

The strategic plan should be implemented as a guideline for creating action plans by relevant agencies which will also include reviewing and updating the action plan on yearly bases in order to provide updates, monitoring, and flexibility to achieve its goals. Information from the review and monitoring process will help when it is time to renew the plan.

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Chapter 1

Introduction

Current applications of nanotechnology can be seen in many products and industries for the purpose of adding value to wide range of products especially the textile, cosmetics, food, agriculture and medical industries. Nanoparticles are very small and have more surface area which makes it obtain special properties and can react efficiently. However the size of the nanoparticles is causing concerns as nanoparticles can be absorb through the human skin and may cause harm. Both domestic and international research on the dangers of nano-products to health and the environment is limited, particularly in long-term toxicity. Because toxicity studies are incomplete it is difficult to measure the amount of exposure or exposure to nanomaterials. Current releases also show that nanoparticle materials tend to be more toxic than larger materials. That does not mean that all nanotech products are more toxic or dangerous than products containing larger materials. Toxicity of nanoparticles depends on many factors such as the physical and chemical properties of nanoparticles. The amount of nanoparticles received and the duration of exposure.

Currently in Thailand, the government and industry are applying nanotechnology to improve the quality or value of products, but at the same time not overlooking the risks and dangers it may arise. It has emerged as a collaboration between various agencies such as:

The Food and Drugs Administration (FDA) has responsibility to control the nanoproducts for health such as food, drug, medical equipment, cosmetic and hazardous material for household or sanitary products. FDA applies the high level of the measure of health products standard to control the standard of nanoproducts for health with concerning in risks, hazardous and usage, including the problems of public health.

National Nanotechnology Center (NANOTEC) has responsibility in research and development, innovation and engineering, and applying on nanotechnology to bring about the excellent and knowledge

transferring to the industrial sector including improvement the performance to compete in the international market and upgrading the quality of life under concerning in the eco-life and environment.

Thai Industrial Standards Institute (TISI) has collaboration with National Nanotechnology Center (NANOTEC) and National Science and Technology Development Agency to draft the standard of industrial products, NANOTECH completed seven issues of the standard to announce in the government gazette.

Nanotechnology No.1	How to specify nanomaterial from production
Nanotechnology No.2	How to identify specification of nanomaterial from production
Nanotechnology No.3	Safety for manage and eliminate nanomaterial
Nanotechnology No.4	How to analyze the specification of physical-chemical for toxicity of nanoproducts
Nanotechnology No.5	How to evaluate risks of nanomaterial
Nanotechnology No.6	Analyst the particle size by technology of dynamic tyndall
Nanotechnology No.7	Guideline about health and safe for nanotechnology worker

Department of Disease Control, a general department of the Ministry of Public Health, has responsibility to develop the education of disease and threaten control in Communicable disease, non-communicable disease, Occupational and environment disease, Emerging Disease to react to the emergency of disease epidemic with Thai law and the International Convention by providing the education, research, development, knowledge and technology transfer, control and development the standards and regulation to monitor, prevent, control and diagnose the disease which may threaten the human health. Moreover, the organization provides and develops the monitoring mechanism to control disease and support the patient delivery especially in tertiary level of critical illness and Infectious disease, and restriction of Dangerous disease to comply with the International Agreement including to support between the nation and international to monitoring, prevention and control disease which may threaten on health.

Department of Health, a general department of the Ministry of Public Health, has responsibility to promote the public health, and process in the education, analysist, research, development instruction the knowledge and technology including establishing and developing the standard of public health, managing

risks for health and environment health, and evaluating the health impact. Moreover, the organization develops the system, mechanism and follows the regulation of Public Health and others agencies which support, coordinate, promote and coordinate with all networks in Thailand and international in the purpose of promoting the public health and managing the environment health and improving people knowledge and skill to support themselves, family and community to be healthy.

Department of Medical Services, a general department under The Ministry of Public Health, has responsibility to develop the knowledge of treatment and rehabilitation on physical medical, procedure of studying, analyzing, researching and development the knowledge and technology on special medical science. The department manages and develops the standard of specialized medical treatment, knowledge transferring and technology to the medical center of government and public sectors. Moreover, the department has responsibility to evaluate the usage of medical technology on medical center to be proper and worth, provide services to support the delivery of specialized disease patient, give knowledge and skills on the medical treatment and related knowledge to both government and public medical practitioners, and develop system and mechanism to follow the regulation, including manage and coordinate with other related sectors in Thailand and international.

Department of Industrial Works, a department of The Ministry of Industry, has responsibility to develop industrial business by monitoring and supporting the industrial, to motivate the industrial to be perform in market competition, sustainability in development and acceptable in the international market, especially in manufacturing technology, environment, safety, power safety, hazardous material and chemical, and to comply with the regulation and International Agreement which are under the law of Industrial regulation, Hazardous Substances Act, regulation of Emergency Decree on Prevention Against Abuse Using of Volatile Substances, Machine Registration Act, The Operation of the Organization for the Prohibition of Chemical Weapons, Regulation of the office of prime minister on procurement of Service point of investment and other related law, regulations and International Agreements.

Nanotechnology Association of Thailand has intention to promote the NanoQ label to certify the nanoproducts which contains with nanomaterial that qualification has been changed from normal products, as well as unleaded the impact to human and environment. In the present, NanoQ label has certified in 3 types of products; garment, paint and coat of household products while it is on process in cosmetic. Once

nanoproducts in Thailand are increasing, NanoQ label will be important factor to motivate the manufacturer to produce their products to be confidence to the consumers.

Application of nanotechnology in Thailand

Based on the results of the survey of nanotechnology status of the private sector 2014-2015 (Appendix A) by the Office of Science Policy. The objective of this project is to explore the status of nanotechnology in Thailand and to gather ideas for analysis. It also serves as a policy guide for promoting and supporting research development and innovation in nanotechnology. The surveyed groups were divided into 3 groups: 1) government agencies and research institutes, 2) educational institutes and 3) private sector conducted surveys in the form of questionnaires. Brainstorming and interviewing questionnaire shows that research and development cooperation between private agencies and other agencies is largely non-targeted. Lack of direction and clear policy on what to develop together in what direction and which. At the same time, there are increase collaborative projects with the government and universities. The major factor that the private sector sees as a conducive to the implementation of nanotechnology research with other organizations is that the private sector intends to develop products and services that are consistent with consumers' needs. The key problem to limiting private sector research collaboration with government and universities relation is that they have to take the financial risks if the project is not successful as plan.

Nanotechnology Testing Laboratory in Thailand

The first Strategic Plan 2012-2016 was developed to strengthen and advanced regulatory measures that will enhance health safety, environment, and national security of relevant processes. At the same time, Thai society has become more open and more active in the awareness of nanotechnology. As a result, the role of nanotechnology testing has become increasingly important (Appendix B). There are many testing laboratories and tools that can be used to monitor and test nanoparticles. Government agencies also have the infrastructure required to facilitate the standardization of testing related to nanotechnology safety. It should accelerate the cooperation between the public and private sectors and push for standards in nanotechnology-related safety analysis both nationally and internationally.

Nanotechnology safety situation abroad

Over the years, the industry has introduced information and knowledge about nanomaterials and applied nanotechnology to products that can add value and enhance market competitiveness. This results in some fake products being sold claiming special properties beyond reality. Based on this information, academics and government agencies responsible for product oversight are increasingly aware of the safety of nanotech products for health and the environment. Many countries are starting to be more active in overseeing nanotech products and issuing legal and regulatory measures for nano-health products, such as the European Union and the United States (Annex C).

Table 1.1 Details of the international policy to monitoring and control nanoproducts (October 2018)

	Cosmetic	Foods	Drugs & Medical	Biocidal Product
EU European Commission	Nano-Specific Provisions Definition Labeling Notification/ Approval	Nano-Specific Provisions Definition Labeling Notification/ Approval	Existing Regulation	Nano-Specific Provisions Definition Labeling Approval
USA	Existing Regulation + (Draft) Guidance	Existing Regulation + (Draft) Guidance	Existing Regulation	Existing Regulation
China **Taiwan** **Korean**	Certification system for Nano-related products E.g. NanoMark			

The Nanosafety and Ethics Strategic Plan (2012-2016), approved by the Cabinet on September 11, 2012 to promote understanding, regulating, overseeing, monitoring and managing the safety and ethics related to nanotechnology.

Assessment of the performance of the Nanosafety and Ethics Strategic Plan (2012-2016) (Appendix D) found that the strategy 1) Establishing and implementing knowledge management in nanosafety and

ethics and nanoproducts and 2) Developing and reinforcing measures and monitoring mechanisms have been completed with key performance indicators and enforcement, while 3) Strengthening and promoting public engagement activities have been completed in some points. However, in the beginning of implementation of the strategic plan, every departments related with nanotechnology have awareness to create knowledge management and basic standards to apply. Once the standards are appropriated development, this will bring about the awareness and public engagement on nanosafety.

According to the above performance analysis, Thailand has consistently manage the promotion of Nanosafety and Ethics Strategic Plan to establish the knowledge of nanosafety, control and express awareness in the public sectors continuously and effectively. In which case the National Nanotechnology Center (NANOTEC) has consultation with the National Science Technology and Innovation Policy Office (STI) to appoint the committees to create the strategies and policy and control nanoproducts in Thailand (Appendix E and F)

SWOT Analysis of Nanosafety and Ethics

A workshop on "SWOT Analysis for Nanotechnology Safety in Thailand" was organized by the Naresuan University of Technology, Phitsanulok on October 5, 2019 at the Park Hotel Century Park in Bangkok with funding from Thailand Research Fund (TRF) to analyze the strengths, weaknesses and opportunities and threats under the Strategic Action Plan focusing on 4 sectors: 1) people sector 2) government sector 3) education sector 4) Industry (For details, see Appendix G).

Important process are required in the implementation of the strategic plan which will also need to take into consideration various factors. The results of this SWOT analysis will be used only as a guideline for the implementation of nanotechnology development in Thailand to achieve the objective goal and proceed in the right directions according to the roles of relevant agencies. Following are details of the SWOT analysis:

Strength

- Thailand has a strategic plan for nanosafety and ethics which will help guide the direction and control of nanotechnology safety by government agencies, industry, education and public sector. The strategic plan has a clear definition of strengthening and participation of the people.
- Thailand has the Chemical Usage Control Acts and the Promotion and Conservation of National Environmental Quality Acts to control the production, inspection, and pollution from chemical as well as nanomaterial.
- Nanotechnology is widely accepted by the government and private sectors, and the main driving force responsible for nanotechnology development is the National Nanotechnology Center.
- The government and the education sectors have continuous develop information on nanosafety for public access and is sufficient for promoting public awareness activities.
- Public and private agencies are keen to participate in nanosafety campaign, monitoring, and there are pilot activities being implemented by many government agencies.
- The government sector do have safety testing equipment for the industrial sectors but there are still room for additional equipment required.
- Most universities have education in nanotechnology and have adequate researchers in the field.
- There are nanotechnology laboratories and equipment for testing and inspection of nanomaterial and nanoproducts however, many do not cover the area of nanosafety.
- There are agencies that support funding of nanotechnology research.
- The industrial organizations in Thailand such as the Department of Industrial Works, The Federal of Thai Industry emphasis participation of nanotechnology and nanosafety.
- Government agencies and industry are keen to participate in monitoring nanotechnology safety.
- Thailand has the Chemical Control Act and the National Environmental Quality Promotion/ Protection Act, which covers the production process and pollution control to protect the public.
- Thailand launched NanoQ label and FDA label for consumer protection in nanoproducts.

Weakness

- Lack of public relations on the Nanosafety and Ethics Strategic Plan.
- Government agencies lack laws that can be used to control safety of nanotechnology including law that will cover production, importation and exportation of nanomaterials. This include the treatment and removal of waste from nanoparticles.
- Inspection, controlling and monitoring of nanosafety is not the responsibility and routine tasks of government sectors.
- Lack of knowledge and communication of nanotechnology among government sectors.
- Lack of synergy among government agencies to support information, working relations, inspection, monitoring and controlling of technology.
- Lack of laboratory equipment, measurement and inspection standards.
- Few nanotechnology testing laboratory to analyze and inspect nanomaterial, and need to enhance development capacity of existing nano laboratories.
- There are many nanotechnology researchers but few in nanosafety specific.
- Lack of testing laboratory and special equipment in the education sectors to support nanosafety researching including toxicology.
- Limited research funding to develop knowledge of nanosafety in comparison to speed of innovation.
- Lack of funding support to creation of specialized research centers on nanosafety in higher education sector
- Lack of public relations to emphasis the necessity of nanosafety awareness for consumer protection.
- Information on nanotoxicology is not clear and manufactruers do not see the need for awareness of nanosafety.
- There are no standards and safety testing related to nanomaterials that will promote protection in industries

- Lack of supporting and promotion for industrial sectors that do manage to implement nanosafety for consumer protection.
- Strategic plan lack the means to create public participation, building knowledge, and communicate to the public their freedom of choice for nanotechnology products to ensure nanosafety.
- People are unaware of the pros and cons of nanotechnology application towards both health and environmental impact.
- Lack of consumer protection in nanoproducts where nanomaterial may access into the food chain.
- NanoQ label does not cover all range of nano properties only for Water Repellent and Anti-Bacteria properties.
- Lack of monitoring, controlling and inspection of nanosafety for imported nanomaterial.
- Lack of comprehensive legislation on the production, import or export of nanomaterials, including safety issues in all aspects of nanotechnology.
- Society still lack correct knowledge about nanotechnology. In addition knowledge of nanosafety is still limited.

Opportunity

- Facilitation of infrastructure by government agencies to facilitate standardization of testing related to nanosafety.
- Need to expand the opportunity to form and expand the collaboration between government and public sectors to push for testing of nanomaterials.
- Establish standards and strategy of nanosafety testing both at national and international level.
- Establish research collaboration with overseas institutions to gain knowledge.
- Researcher from many universities have close collaboration with the industrial sectors to create innovations.
- Nanotechnology research has increase rapidly while research in nanosafety has not progress as much as it should be.

- Relationship between universities and secondary school are close therefore more opportunities for transfer of knowledge in nanotechnology and nanosafety.
- Universities can help to promote engagement of awareness, monitoring and inspection of nanomaterial to the community and society.
- There is increase concerns by the global community on the issues of emerging nanotechnology, safety, risks and ethics.
- Government sector and universities have established public engagement on the awareness, monitoring, and inspection concerning absorption of nanomaterial from nanoproducts.
- There is increase consumers awareness to information on nanomaterial, nanotechnology, are more acceptable to engage in monitoring of nanosafety.
- Thailand has conducted research on nanosafety and have transferred knowledge to help protect the public and build awareness.
- The government through the local administration contributed to the transferring of knowledge to public community.
- Integrating public-private partnerships helps build rural knowledge of nanotechnology research project.

Threats

- Thailand is the gateway for exporters of nanoproducts as there are weak regulations and public knowledge on nanosafety is still limited.
- Thailand has limited registration on imported nanomaterial, nanoproducts and nano-chemical to control imports.
- Safety standards on nanoproducts from manufacture and imported nanoproducts are not covered in the registration, inspection and control procedures.
- Bureaucratic processes cause's gaps between government agencies, in addition private sectors are unwilling to share information due to confidentiality clause, causing vague information on nanotechnology.

- Limitation in receiving up-to-date and insight information on nanosafety.
- Private sector tends not to share nanosafety information due to confidential commercial data.
- Information on nanosafety and ethics is essential but unclear, possible cause for misunderstanding to the society.
- Limited exchanges of technical information and collaboration with overseas institutions resulting in limited nanotechnology specialist.
- Researchers tends to have less awareness of safety protection for nanotechnology innovations.
- Limited collaboration between researchers and industrial sectors to establish knowledge of nanosafety, including the study on toxicity and inspection for safe nanoproducts.
- Lack of knowledge transfer on safety of nanotechnology to consumers.
- No standards and measurement to control nanosafety and enforce in the industrial sectors.
- The government sectors have not done enough public releations to promoted genuine nanoproducts, therefore there is an increase in the level of faked imported nanoproducts in the market.
- No department to provide support on the analysis and inspection of nanoproducts.
- There is limited government support to researcher for funding of research in nanotechnology.
- Research documents are difficult to understand by the public.
- Limited extensive social media to communicate on the topic of nanotechnology by the government sector.
- Limited public hearing sessions on nanotechnology.

Chapter 2

Vision, Objective, and Key Performance Indicators of the Strategic Plan

1. Vision

"Safe-nano for Thailand's sustainable development"

The vision is to bring about social development in many aspects of health, education, environment and economy. Main activities related to nanotechnology include:

1) Research and Development: To conduct and manage nanotechnology knowledge for effective and sustainable implementations.
2) Production, Import, Export and Marketing: To create opportunities to the public for choosing safe and beneficial nanoproducts, ensure safety and good health for employees, and boost Thailand's economics by exporting nanoproducts.
3) Proper utilization / application of nanotechnology, nanomaterials and nanoproducts used in products and services leading to social benefits and better understanding for the public.

This activities operates under the safe and appropriate transportation and storage process according to Thai society, strong regulatory, and enforcement mechanisms. There is also appropriate disposal procedures without causing pollution to health and the environment.

2. Objective

To enhance health, and environment safety as well as promote social security through ethical, sustainable and proper engagement in Research and Development, production, distribution and nanotechnology and nanoproducts usage.

3. Key Performance Indicators and Targets

At the end of the Nanosafety and Ethics Strategic Plan (2017-2021), key indicators and targets to be met are as follows (sub-indicators, see Chapter 3).

1) Thailand has an effective management system of nanosafety and ethics, with related to all sectors' operating

2) Nanoproducts in Thailand market have label displaying nanomaterials components and safety information based on scientific evidence.

3) The public has knowledge, understanding and awareness of nanosafety and risk to be able to select, store, and handle nanoproducts by themselves.

4. Strategies

To achieve the vision and objective of the Nanosafety and Ethics Strategic Plan (2017-2021), three strategies below have been determined to build involvement and integrity of all sectors.

Strategies 1: Establishing and implementing knowledge management in nanosafety and ethics and nanoproducts

Strategies 2: Developing and reinforcing measures and monitoring mechanisms and enforcement

Strategies 3: Strengthening and promoting public engagement activities.

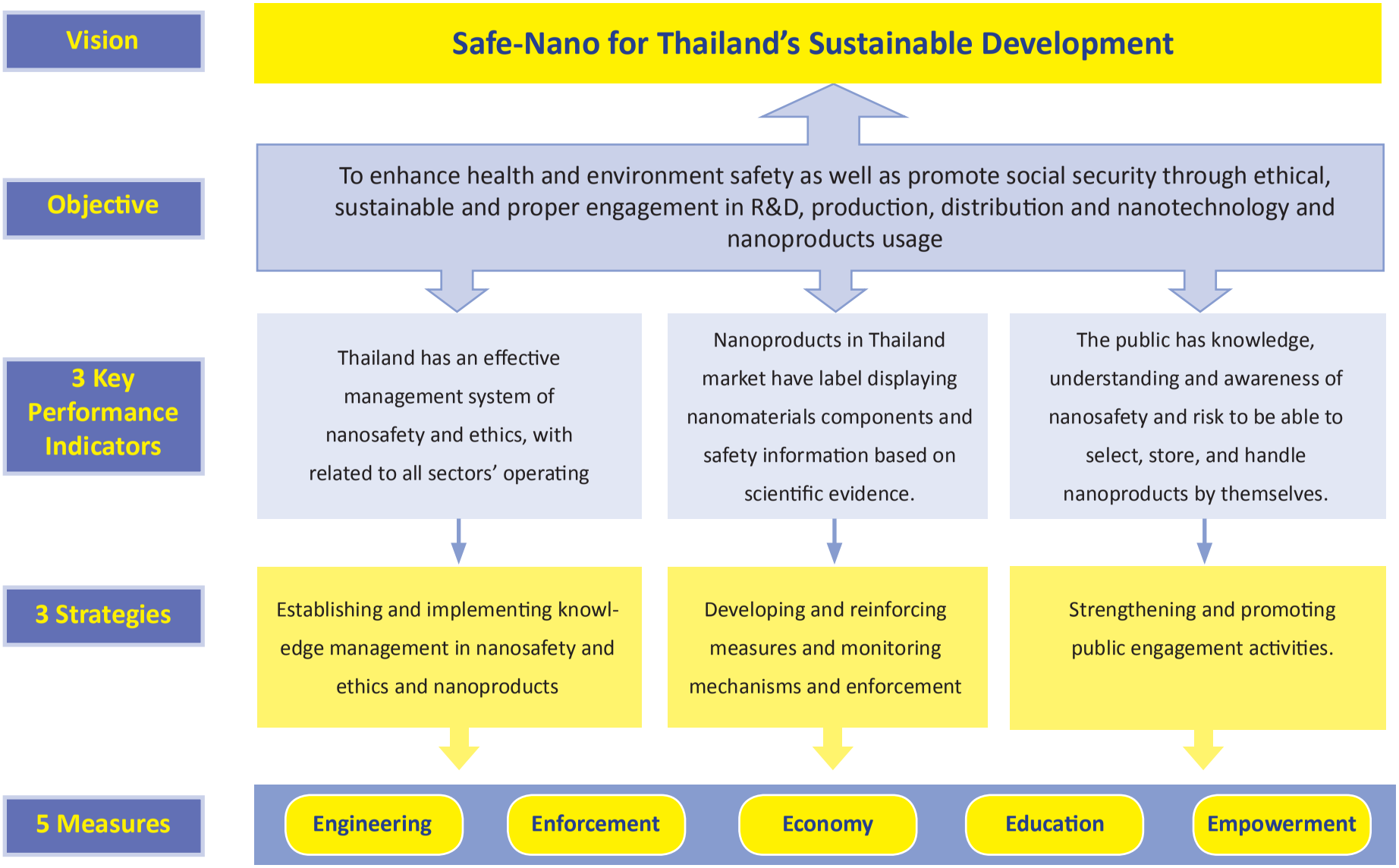
These three strategies are outlined from Thailand's SWOT analysis for nanosafety and ethics. Moreover, the passive and active strategies, objective, and indicators are framed to develop knowledge management for nanotechnology, conduct safety measures, implements safety regulation on health, environment and nation security, including supporting the sustainable public participation in the Nanosafety and Ethics Strategic Plan.

For the strategies to involve all sectors, the Nanosafety and Ethics Strategic Plan shall cover five working fields as follows:

1. Engineering
2. Enforcement
3. Economy and Finance
4. Education and Knowledge Management
5. Empowerment

The linkages of vision, goals, and key indicators are summarized in Figure 2.1. Chapter 3

Figure 2.1 Diagram of the relationship between vision, objective, indicators, strategies and measure of the National Nanosafety and Ethics (2017-2021)



Chapter 3

Nanosafety and Ethics Strategic Plan

Strategy 1:

Establishing and implementing knowledge management in nanosafety and ethics, and nanoproducts

Objectives

1. To establish and manage information on nanotechnology and nanoproducts' safety and ethics in a reliable, systematic, and holistic manner.
2. To promote a connecting network for information on nanotechnology and nanoproducts' safety and ethics in national and international level.

   The aim of this objectives is that all sectors have knowledge and awareness in nanotechnology and nanoproducts' safety and usage.

Strategic Goals

Knowledge on nanotechnology and nanoproducts' safety and ethics will be systematically created and managed. The information network on nanosafety and ethics will be integrated from all related parties as well as ready for distribution to the public.

Key Performance Indicators and Targets

1. Creating and developing the knowledge on nanosafety and ethics.
2. Having database system on nanosafety and ethics which is accessible to the public.
3. Having knowledge management process which can be integrated by every sector leading to effective and sustainable implementation.

Measures

Enforcement

1. Develop nanotechnology and nanoproducts' safety and ethics measures which involve working condition, usage, research, development, and production as well as the impacts on health, environment and national security.

Education and Knowledge Management

2. Develop safety usage of nanotechnology and nanoproducts and procedure for the industry, laboratory and user level.
3. Develop a center of nanotechnology and nanoproducts' safety and ethics information center, linking nationally and internationally, in order to build and accessible gateway for academics, manufacturers, and the public.

Economy and Finance

4. Promote, support, motivate, and ensure sufficient budget, at least 10% of research budget, for knowledge and reliable processes on nanosafety and the effects of nanomaterials and nanoproducts which may pose impact on health, environment, and national safety.

Empowerment

5. Create networks for both national and international researchers and organizations in order to link all nanotechnology knowledge.

Strategy 2:

Developing and reinforcing measures and monitoring mechanisms and enforcement

Objectives

1. To develop and reinforce nanosafety and ethics regulations which are efficient in monitoring nanotechnology and nanoproducts in every aspects.
2. To develop an effective and complete national management system for nanotechnology and nanoproducts.

3. To integrate national and international measures as well as every sectors' operation involving nanosafety and ethics monitoring and enforcement in order to create and unified concept.

Strategic Goals

To establish nanosafety and ethics management system which integrate national and international measures as well as operation of all sectors.

Key Performance Indicators and Targets

1. Having nanosafety and ethics measures which involve all related parties and cover every sector's operations.
2. Having effective mechanisms to support, monitoring, and enforcement in nanosafety and ethics measures.
3. Nanoproducts in Thailand's market have labels displaying nanomaterials components and safety information based on scientific evidence.
4. Having agencies and organizations which provide services on analysis, testing, calibrating and certifying nano label for nanoproducts.
5. Having agencies or surveillance and warning systems for nanosafety which coordinate with authorized agencies to determine measures as well as recalls, discontinue sales in the market, and eliminated the lower quality nanoproducts.
6. Having controls and guidelines on advertising.

Measures

Enforcement

1. Develop nanosafety and ethics measures and reporting systems which involve working condition covering research and development, production and storage, logistics and disposal as well as the impacts on health, environment and national security.
2. Analysis of laws and measures both on national and international level, in order to improve and develop Thailand's nanosafety and ethics laws, regulation and rules.

3. Establish standards or measures for controlling, regulating. And monitoring nanosafety and ethics, including the advertisement and promotions of nanoproducts in order to properly optimize beneficial and safety usages.
4. Develop a national mechanism to determine the direction suggestion or consultation on the policies to support, monitor, and enforce nanosafety and ethics measures, as well as provide in cases wherein consumers are affected by nanoproducts.

Engineering

1. Develop and enhance laboratories' capabilities in analyzing and testing nanoproducts and nanomaterials so as to study the effects of manufactured nanomaterials on health and environment.

Strategy 3:

Strengthening and promoting public engagement activities

Objectives

1. To promote public engagement in the process of public policy as well as nanotechnology and nanosafety and ethics management at all levels
2. To conduct a learning society to promote knowledge, understanding, and awareness in all relevant subjects of nanosafety through the educational system and simple learning material for every levels in the society.

Strategic Goals

The public has knowledge, understanding and awareness in nanotechnology and nanosafety. Moreover, are capable of safe and appropriate usage of nanoproducts and are able to engage in the process of developing and establishing policy concerning nanosafety and ethics management, surveillance and monitoring.

Key Performance Indicators and Targets

1. The public and consumer network has knowledge, understanding and are capable of participating in the process of policy development for nanotechnology and nanosafety management.
2. Information and risks of nanotechnology, nanosafety is accessible and the public is awareness and can utilize them appropriately and promptly.

3. Having appropriate nanotechnology and nanosafety materials in regional education centers both in the formal and informal education system.

Measures

Education and Knowledge Management

1. Establish and develop participation, comprehension, and continuality in the public network for nanotechnology and nanosafety and ethics knowledge and understanding.
2. Strengthen and connect public network as well as develop academics on nanotechnology to exchange, strengthen and expand knowledge into communities and societies.
3. Promote public awareness and learning on the benefits and potential risks of nanotechnology in various aspects through a variety of media and channels which are appropriate to each audience.

Engineering

4. Support the network for public and private nanotechnology laboratories that are eligible for certifying "NanoQ" label to verify nanoproducts advertisement.

Empowerment

5. Campaign to the public network, community, and local government organization for attentiveness and awareness of shared responsibility in protecting and solving problems from nanotechnology and nanoproducts.
6. Grant urban and rural communities easy and equal access of information on nanoproducts by distributing simple academic data. This will act as an attempt to provide opportunity for consumer and their communities' safety on nanoproducts selection.
7. Assign responsible and relevant agencies to develop activities for strengthening and promoting public participation.

From the above Key Performance Indicators and Targets, and Measures of Nanosafety and Ethics Strategic Plan, the responsibility has assigned to primary agencies and supporting agencies as in Table 3.1.

Table 3.1 Key Performance Indicators, targets, primary responsible agencies, primary responsible agencies, and supporting agencies for the Nanosafety and Ethics Strategic Plan.

Strategy	Key Performance Indicators and Targets	Primary responsible agencies	Supporting agencies on data and network
1. Establishing and implementing knowledge management in nanosafety and ethics and nanoproducts	1. Having a database system on nanosafety and ethics which is accessible to the public.	- Nanosafety Information Center of Thailand (NICT)	- National Nanotechnology Center - The Federation of Thai Industries - Office of the National Research Council of Thailand - Ministry of Industry - Ministry of Agriculture and Cooperatives - Ministry of Public Health
	2. Having a knowledge management process which can be integrated by every sector leading to and effective and sustainable implementation.	- National Nanotechnology Center - Nanosafety Information Center of Thailand (NICT)	- The Federation of Thai Industries - Office of the National Research Council of Thailand - Ministry of Industry - Ministry of Agriculture and Cooperatives - Ministry of Public Health

Strategy	Key Performance Indicators and Targets	Primary responsible agencies	Supporting agencies on data and network
2. Developing and reinforcing measures and monitoring mechanisms and enforcement	1. Having Nanosafety and ethics measures which involve all related parties and cover the operations of all sectors	- National Nanotechnology Center - National Science Technology and Innovation Policy Office - Food and Drug Administration - National Bureau of agriculture Commodity and Food Standards - Department of Agriculture - Department of Fisheries - Department of Livestock Development - The Customs Department - The Fiscal Policy Office - The Industrial Standards Institute - Department of Industrial Works - Pollution Control Department - Department of Environment Quality Promotion - Occupation Safety and Health Bureau - Department of Labour Protection and Welfare - Office of the Consumer Protection Board	- Center of Excellence in Nanotechnology of Higher Education Institutions - Ministry of Science - Department of Science Service - National Institute of Metrology (Thailand) - Department of Medical Sciences - Consumer Organization - Consumer Protection Police Division - The Federation of Thai Industries - The Thai Chamber of Commerce and Board of Trade of Thailand (Bangkok)

Strategy	Key Performance Indicators and Targets	Primary responsible agencies	Supporting agencies on data and network
2. Developing and reinforcing measures and monitoring mechanisms and enforcement	2. Having effective mechanisms to support, monitor, and enforce nanosafety and ethics measures.	- National Nanotechnology Center - National Science Technology and Innovation Policy Office - Food and Drug Administration - National Bureau of agriculture Commodity and Food Standards - Department of Agriculture - Department of Fisheries - Department of Livestock Development - The Customs Department - The Fiscal Policy Office - The Industrial Standards Institute - Department of Industrial Works - Pollution Control Department - Department of Environment Quality Promotion - Occupation Safety and Health Bureau - Department of Labour Protection and Welfare - Office of the Consumer Protection Board	- Center of Excellence in Nanotechnology of Higher Education Institutions - Department of Science Service - National Institute of Metrology (Thailand) - Department of Medical Sciences - Consumer Organization - Consumer Protection Police Division - The Federation of Thai Industries - The Thai Chamber of Commerce and Board of Trade of Thailand (Bangkok)

Strategy	Key Performance Indicators and Targets	Primary responsible agencies	Supporting agencies on data and network
2. Developing and reinforcing measures and monitoring mechanisms and enforcement	3. Nanoproducts in Thailand's market have labels displaying nanomaterials components and safety information based on scientific evidence	- Office of the Consumer Protection Board - Food and Drug Administration - The Industrial Standards Institute - National Bureau of Agriculture Commodity and Food Standards	- Center of Excellence in Nanotechnology of Higher Education Institutions - Nanotechnology Association of Thailand - The Federation of Thai Industries - The Thai Chamber of Commerce and Board of Trade of Thailand (Bangkok) - Department of Science and Service - National Institute of Metrology (Thailand) - Department of Medical Sciences - Consumer Organization - Royal Thai Police - Department of Industrial Works - Ministry of Commerce - The Customs Department

Strategy	Key Performance Indicators and Targets	Primary responsible agencies	Supporting agencies on data and network
2. Developing and reinforcing measures and monitoring mechanisms and enforcement	4. Having agencies and organization which provide services on analysis, testing, calibrating, and certifying nano-label for nanoproducts	- National Nanotechnology Center - Department of Science Service - Department of Medical Sciences - Thailand Textile Institute - Thailand Institute of Scientific and Technological Research - Center of Excellence in Nanotechnology of Higher Education Institutions	- Center Laboratory - National Institute of Metrology (Thailand)
	5. Having agencies or surveillance and warning systems for nanosafety which coordinate with authorized agencies to determine measures as well as recalls, discontinue sales in the market, and eliminated the lower quality nanoproducts.	- National Nanotechnology Center - Office of the Consumer Protection Board	- Royal Thai Police - Nanotechnology Association of Thailand

Strategy	Key Performance Indicators and Targets	Primary responsible agencies	Supporting agencies on data and network
2. Developing and reinforcing measures and monitoring mechanisms and enforcement	6. Having controls and guidelines on nanoproducts advertising.	- Office of Consumer Protection Board	- The Government of Public Relations Department
3. Strengthening and promoting public engagement activities	1. Public and consumer network has knowledge, understanding and are capable of participating in the process of policy development for nanotechnology and nanosafety management.	- National Nanotechnology Center - Foundation for Consumers - Bangkok's Consumer Protection Association	- Food and Drug Administration - National Bureau of Agriculture Commodity and Food Standards - Department of Agriculture - Department of Fisheries - Department of Livestock Development - The Customs Department - The Fiscal Policy Office - The Industrial Standards Institute - Department of Industrial Works - Pollution Control Department - Department of Environment Quality Promotion - Occupation Safety and Health Bureau

Strategy	Key Performance Indicators and Targets	Primary responsible agencies	Supporting agencies on data and network
3. Strengthening and promoting public engagement activities	2. Information on nanotechnology, nanosafety and risks are accessible and the public is awareness and can utilize them appropriately and promptly.	- Nanosafety Information Center of Thailand (NICT) - Thai Journalists Association - The Press Association of Thailand - Thai Broadcast Journalist Association - The Government Public Relations Department - Ministry of Education - Department of Academic Affair - Office of the Basic Education Commission of Thailand	- National Nanotechnology Center - The Federation of Thai Industry - Office if the National Research Council of Thailand - Ministry of Industry - Ministry of Agriculture and Cooperatives - Ministry of Public Health - National Nanotechnology Center - Nanosafety Information and Knowledge Management Center - Center of Excellence in Nanotechnology of Higher Education Institutions

Chapter 4

Mechanisms on Implementation and Evaluation of the Strategic Plan

Implementation of the Strategic Plan is a significant process. Therefore, it requires synergy teamwork, proper technology, vivid target and a unified objective. Moreover, for each sector to embrace the Strategic Plan in the annual implementation plan requires conformation of both the national nanotechnology as well as other development situation. Therefore, creating and implementation plan along with reviewing and improving the annual implementation plan is a significant process which will bring about flexibility in implementation. In turn, this will support each sector to pursue their roles and goals efficiently. The procedures can be described as follows:

1) Related parties shall establish work plans, projects and activity plans which conform to the objectives, goals and measures stated in the Strategic Plan.
2) Each sector shall prioritize, by importance and urgency. The implementation of the Strategic Plan which can be done by determining control mechanisms and setting key performance indicators in both short and long terms.
3) Each sector shall integrate their implementation plan with the National Economic and Social Development Plan, government policies, national agendas, international standards, international treaties and Thailand's role in the international stage.
4) Each sector shall determine work plans, projects and activity plans which conform to the Strategic Plan. Also, each shall allocate budgets to promote efficient operation.
5) Support the primary, supporting and related agencies with a unified direction conforming to the strategic plan by promoting clear and unified objective, integrating operations while aiming to eradicate redundancy.

4.1 Strategic in Implementing the Strategic Plan

Implementing the Strategic Plan requires synergy teamwork, proper technology, vivid target and unified objective with strategies as per below:

1) **Operation by Focusing on Every Sector's Engagement:** Set clear goals and share responsibilities in order to enhance efficiency. Moreover, establish in mechanism wherein beneficiaries and affected parties involve in analyzing, planning and making decisions in every process.
2) **Reinforce Knowledge and Understanding to the Public:** The Strategic Plan emphasizes that each sector needs to establish work plans, projects and activity plans which conform to the national policy and strategy. Nanosafety development should be a national policy to able to communicate to the public and related parties on how to manage and develop the Strategic Plan. Enhancing understanding of nanosafety as well as create engagement in the monitoring process and awareness on the potential risks and unexpected outcomes that may occur within the community and society in necessary.
3) **Adapt Work Plans, Projects and Activity Plans to Fit Budget Approval Practice:** Each sector must concern in the work plans, projects and activity plans with the time frame of the Strategic Plan as well as the vision, policy, public needs and the country's development situation.
4) **Public Engagement:** For the policy and operation of the Strategic Plan to be fully effective, the plan shall also include strategies on public engagement with the private sector on nanosafety management. Several measures include 1) strengthen communities' awareness and monitoring of nanomaterials manufacturing process, 2) promote learning on the advantages of nanomaterials and nanosafety, 3) increase coordination in the community and different sectors aiming to produce concrete operational outcomes.
5) **Utilizing the Mechanism of the Nanosafety and Risk Management Committee, Leading to Implementation:** The process should involve the National Nanotechnology Center, representatives from the Ministry of Health, Ministry of Labor, Ministry of Industry, Ministry of Agriculture and Cooperatives, related parties from both the public and private sectors, and the academic sectors.

This is bring about integration which results in collaboration, co-ordination and leads to financial support for operations concerning the nanosafety and risk management in Thailand.

4.2 Implementing the Strategic Plan

In the initial stage, structuring the organization chart with clear roles and missions of each sector shall lead to implementation as follow:

1) Organization structure leading to implementation. Beginning from the cabinet level to the local operating level (As per figure 4.1)
2) Integration of the financial support. Nanosafety will involve several ministries and sectors; therefore, implementation needs to be unified by determining a strategy which integrate nanotechnology safety operations and the national financial plan as follows:

   2.1) Determining primary responsible agencies to work as a coordinator of the implementation plan.

   2.2) Process of establishing the implementation plan needs to emphasize engagement of ministries, sectors and networks.

   2.3) Budget submitting process of ministries and different sectors needs to include an annual implementation plan which conforms to each sector's roles and missions.

   2.4) The Nanosafety and Risk Management Committee coordinates, pushes forward and promotes financial support in cases of emergencies or important issues wherein different sectors must work together.

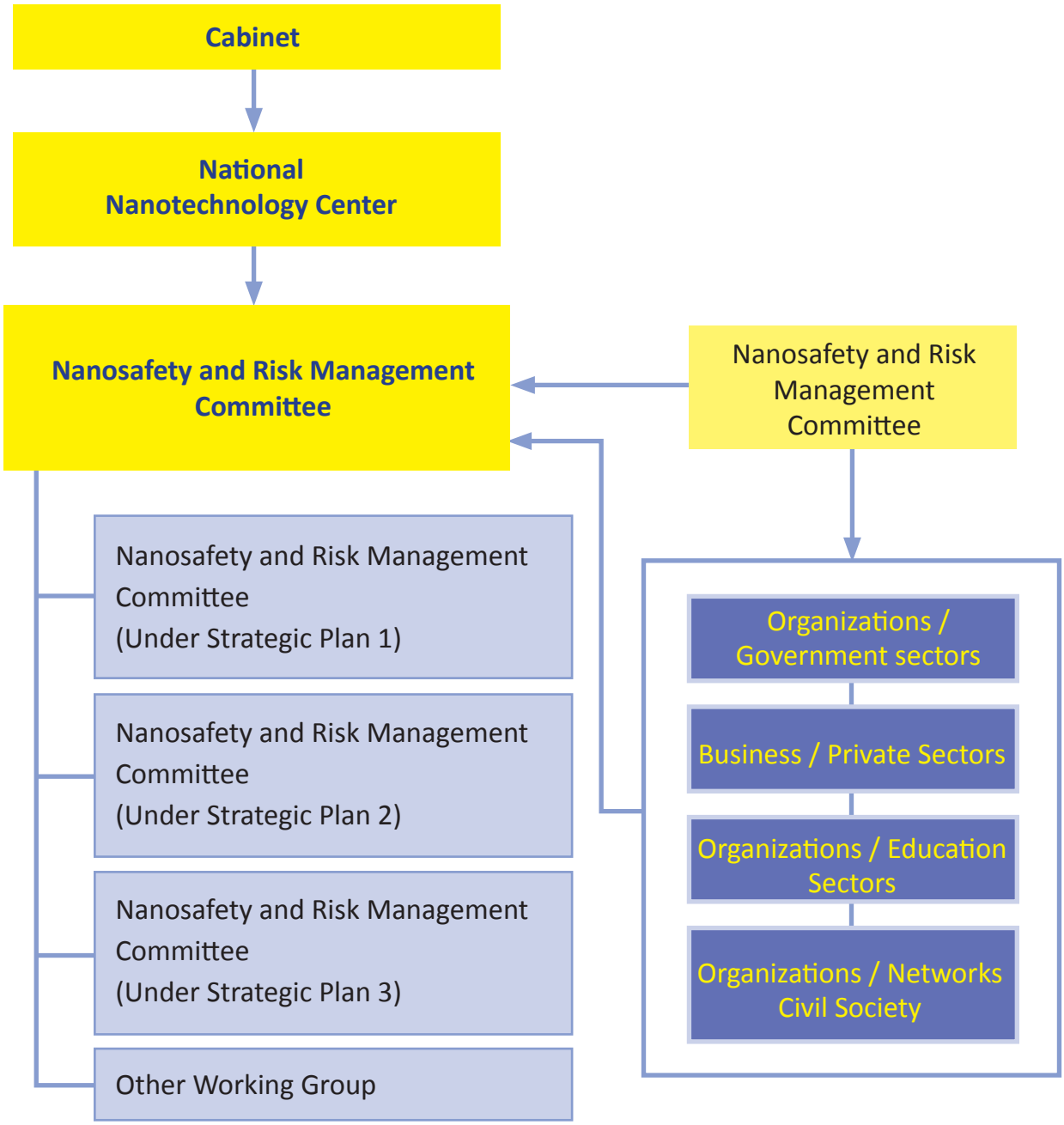


Figure 4.1 Organization Chart for Implementation

4.3 Monitoring and Evaluation

Monitoring and evaluation must follow the framework of public administration in a result-oriented approach with the concept of monitoring and evaluating the key success indicators in different dimensions as follows:

1) Designate a monitoring and evaluating committee which involves representatives from related parties who continuously evaluate and compile past performance at least once a year. The result will then be used by the Nanosafety and Risk Management Committee to efficiently follow up and speed up the implementation plan.
2) Determine regular assessment and improvement by reviewing and developing the implementation plan annually utilizing the committee's mechanism.
3) Develop key success indicators following the progress of the result oriented operation.
4) Determine regular reviews and improvement of the implementation plan to generate flexibility of the operation. Flexibility will encourage each sector to pursue the roles and missions as well as aim to achieve the goals together. The implementation plan assessment and development shall be done annually via the committee or working group's mechanism in order to efficiently unify the operation and coordinate cross functional work.

Appendix

Appendix A

Study Result on the situation of Nanotechnology on Private sector (2014-2015)

Studied By: Thailand Innovative Administration Consultancy Institute (TIA)

Data By: National Science Technology and Innovation Policy Office (STI)

Nanotechnology is used for adjustment of level of product characteristic from very small to atom level. Nanotechnology can change the primary matter characteristic, so nanotechnology brings about development and usage in several manufactures. Nanotechnology is a key success factor to be able to change the future. In the present, Nanotechnology has been applied widely and all necessary step of manufacturer industrial value chain.

The study of nanotechnology status in Thailand is important to bring about the direction and trend as well as receiving useful information for government and public sectors. The study of Nanotechnology in Thailand (2014-2015) can be brought for establish the policy to promote and support the enhancement of research and development, and innovation of nanotechnology in Thailand.

Remark: This report is only study on current situation of nanotechnology from private sectors.

Objective:

1. To study the status of nanotechnology in Thailand (2014-2015).
2. To collect the opinions on nanotechnology, analyze for supported measures and create the policy to promote and support enhancement of research and development, and innovation of nanotechnology.

Target Groups:

This study has been categorized the sample groups into 3 groups:

1) Government sector and research center (both internal and external of the Ministry of Science and Technology)

2) Education Sector

3) Private Sector

The Method

The Study is from 3 channels: Answer the questionnaire (from all sectors), Brainstorming meeting (Government sector), and Interview (Education sector and private sector).

The questionnaire has been sent to target groups in paper and e-documents, which is contents 14 questions in 29 pages with the guidelines of questions and vocabulary of nanotechnology including individual interview and group interview as additional.

The respondence

Target Group	Number of Target Group	Number of respondence
Government sectors and Research center	47	41 (87%)
Education Sectors	20	16 (80%)
Private Sectors *	183	132 (72%)
Total	**250**	**189 (76%)**

The result from Private sectors / Industrial sectors

1. Financial / Budget / Investment

- Less reply with estimated data because no system to record the nanotechnology information in private sectors as well as the answers are only from subdivision data.
- The proportion of expenses on each organization is difference, some organization concern in investment, operation expenses or human resources.

2. Activities / Cooperation / Operating to support nanotechnology frameworks

- The private sectors need more establish the cooperation projects with government sectors and education sectors but concern in financial risks where the research projects or product expansion have not success as expectation.
- The private sector has continuously process on research and development with both government and education sectors but not obvious in directions and subjects. Moreover, the private sector does not know information about interested projects, research, subjects from the government, so the information will be brought from previous or on going activities on nanotechnology which has cooperation with national nanotechnology center.
- To consider the connection between private sector and the common national policy framework of nanotechnology, found that the private sector does not know the framework, the framework is difficult to understand and some issues are duplicated. However, there are some strategies are related to the their organizations;
    1) To promote the research and development on nanotechnology to apply for commercial side.
    2) To initiate the knowledge of nanotechnology and increase value chain.
    3) To establish the cooperation and mechanisms between government sectors, education sectors, private sectors and public sectors.

3. Research and Development, Cooperation with other agencies

- Most of research and development projects from private sectors have not direct objectives. The important factor that the private sectors express the research and development on nanotechnology with other agencies is aim to develop and improve their products and services to meet their customer needs as well as increasing value added.
- From 132 private sectors' answers, there are only 7 laboratories from 10 laboratories to support the nanotechnology inspectors.
- The reasons that the private sectors have cooperation research with overseas:
    1) Lake of researchers in necessary subjects

2) Lack of centers, materials, tools and equipment to support the research and development activities.

3) There are existing cooperated projects with agencies from overseas.

4) The private sectors have intension to hire overseas organizations to do research and development.

5) The private sectors have intension to do internal research and development.

- There are more patent registration and certification on private sector than government sector and education sector because the private sector has more budgets to support, while most of government sectors register on petty patent and product design registration.

4. Research and development in nanotechnology and others areas : Report of plans/projects/activities

Research and Development Areas	Completed Plans / Projects / Activities (2012-2014)	On process Plans / Projects / Activities	Total
Nanotechnology	10	7	17
Other (Non Nanotechnology)	1	0	1
Total	**11**	**7**	**18**

5. Human resource on nanotechnology

- There are only 15 organizations from 132 private sectors' answer gave the information about human resources that they hire foreigner staffs more than other organization increasing every years.
- Most of the private sectors hire the permanent employments and increasing every year. Most of the researchers, research assistance and supporters graduated in nanotechnology science while less of others positions such as management graduated in nanotechnology science. The problem is not about lacking staffs but it is about high cost of hiring employee who graduated in nanotechnology science while they have high cost of investment on laboratory, material and equipment of nanotechnology without guarantee to success the projects.

- The private sectors purchase nanomaterial from overseas in purpose of guarantee in result and for advertisement that their products are made by nanotechnology from overseas. Moreover this may safe the cost of investment in the infrastructure incase own produce.

6. Recommendation

- The direction of nanotechnology should be the collaboration between government sectors, education sectors and private sectors to determine the proper and possible objective plan, including monitoring and flexibility to change. Moreover, the plan may have the responsibility committee, specific timeline, key performance indicators and solution to solve the problems, and the agency to support, coordinator to adjust the limitation of budget, personnel, material, equipment, regulation and standards to motivate in the researching and strategies for commercial purpose.
- In the private sector, there are less specialists and investment in research and development for industrial and distribution in commercial purpose because of unpredictable profit and result. Moreover, the result may be difference from the research from laboratory. To recommend, the government should have the development plan on nanotechnology, compare the information with international level and express the research to the commercial part.

Appendix B

Laboratory on nanotechnology in Thailand

Department	Testing Analysis			Remark
	Measurement in Nanoparticles	Inspection of Characteristic of Nanotechnology	Safety and Toxicology testing on Nanomaterial	
The National Nanotechnology Center (NANOTEC)	√	1. Anti-Bacterial 2. Water refection	√	SEM and DLS technique : Certified by ISO/IEC 17025
Thailand Textile Institute (THTI)	-	1. Anti-Bacterial 2. Water refection	-	SEM and DLS technique : Certified by ISO/IEC 17025
Scientific and Technology Research Equipment Center, Chulalongkorn University (STREC)	√	1. Anti-Bacterial	-	SEM and DLS technique : Certified by ISO/IEC 17025
Center of Nanoscience and Nanotechnology (NANO)	√	-	-	SEM and DLS technique : Certified by ISO/IEC 17025
Department of Medical Science	-	1. Anti-Bacterial	-	

Department	Testing Analysis			Remark
	Measurement in Nanoparticles	Inspection of Characteristic of Nanotechnology	Safety and Toxicology testing on Nanomaterial	
Center of Excellence in Nanotechnology under Chulalongkorn University (NANOTEC-CU-CoE)	√	1. Anti-Bacterial	-	
Center of Nanotechnology, Advance Nanomaterial for energy production and storage, Khonkhsen University (NANOTEC-KKU-CoE)	√	1. Electrical Conductivity	-	
College of Nanotechnology on Nanoelectronic Devices, King Mongkut's Institute of Technology Ladkrabang (NANOTEC-KMITL-CoE)	√	1. Electrical Conductivity 2. Magnetism	-	
KMUTT-Center of Excellence on Hybrid Nanomaterial for Alternative Energy (NANOTEC-KMUTT-CoE)	√	1. Electrical Conductivity	-	

Department	Testing Analysis			Remark
	Measurement in Nanoparticles	Inspection of Nanotechnology Characteristic	Safety and Toxicology testing on Nanomaterial	
Center of Nanotechnology on Nanoscale materials for Green Nanotechnology, Kasetsart University (NANOTEC-KU-CoE)	√	-	-	
Center of Nanoscience and Nanotechnology, Cancer Nanotechnology, Mahidol University (NANOTEC-MU-CoE (Siriraj))	-	-	-	
Center of Nanoscience and Nanotechnology, Intelligence Material and Systems, Mahidol University (NANOTEC-MU-CoE)	√	1. Anti-Bacteria	√	
Center of Excellent in Nanotechnology under the Southern Thailand Science Park, Drug Delivery Systems (NANOTEC-PSUL-CoE)	√	-	-	

Department	Testing Analysis			Remark
	Measurement in Nanoparticles	Inspection of Nanotechnology Characteristic	Safety and Toxicology testing on Nanomaterial	
Center of Excellence on Advanced Functional Nanomaterial, Suranari University (NANOTEC-SUT-CoE)	√	1. Electrical Conductivity 2. Magnetism	-	

Appendix C

Global Status of Nanosafety

Dr. Chaiporn Pumkam, FDA Thailand

October 20, 2015

USA

The National Nanotechnology Initiative (NNI) is a United States federal government programs for the science, engineering, and technology research and development for nanoscale projects. The NNI serves as the central point of communication, cooperation, and collaboration for all federal agencies engaged in nanotechnology research, bringing together the expertise needed to advance this broad and complex field.

The President's 2017 Budget provides $1.4 billion for the NNI, with a cumulative total of nearly $24 billion since the inception of the NNI in 2001 (including the 2017 request), affirming the important role that nanotechnology continues to play in the Administration's innovation agenda. The President's 2017 Budget supports nanoscale science, engineering, and technology R&D at 11 agencies. Another 9 agencies have nanotechnology-related mission interests or regulatory responsibilities.

The NNI participating agencies, the White House Office of Science and Technology Policy (OSTP), and the National Nanotechnology Coordination Office (NNCO) have charted the directions of the NNI to emphasize on promoting commercialization and increasing education and outreach efforts to the broader nanotechnology community.

As part of this effort, and in keeping with recommendations from the President's Council of Advisors for Science and Technology, the NNI has been working to establish Nanotechnology-Inspired Grand Challenges, ambitious but achievable goals that will harness nanotechnology to solve National or global problems and that have the potential to capture the public's imagination. Based upon inputs from NNI agencies and the broader community, the first Nanotechnology-Inspired Grand Challenge was announced by OSTP on October 20,2015, calling for a collaborative effort to create a new type of computer that can proactively interpret and learn from data, solve unfamiliar problems using what it has learned, and operate with the energy efficiency of the human brain.

Also in the USA, the Environmental Protection Agency (EPA) has, under the Toxic Substances Control Act (TSCA – the US regulatory provision for chemical substances), a dedicated activity on the regulation of nanomaterials. TSCA provides EPA with authority to require reporting, record-keeping and testing requirements, and restrictions relating to chemical substances and/or mixtures. Certain substances are generally excluded from TSCA, including, among others, food, drugs, cosmetics and pesticides. TSCA addresses the production, importation, use, and disposal of specific chemicals including polychlorinated biphenyls (PCBs), asbestos, radon and lead-based paint.

A very basic difference with respect to the EU approach, is that under the TSCA the burden of proof about the safety of a substance is on the regulatory authority (and not on the manufacturer, as with REACH).

As in other regulations, nanomaterials are not explicitly mentioned in the statute. However, a series of actions have been put in place in the last years to ensure notification and registration of nanomaterials. In particular, "Significant new use rules (SNUR)", a notification asked to companies in case of any significant new use of existing chemicals, have been issued for some specific nanomaterials (mainly carbon nanotubes and fullerenes). EPA is planning to adopt such procedures on a regular basis for a number of nanomaterials, in order to gather detailed information about the use, characteristics and safety issues before the nanomaterials are put on the market.

The National Institute for Occupational Safety and Health (NIOSH) updates on a regular basis a series of authoritative guidance on OHS issues of nanomaterials.

A joint commitment between USA and EU to promote transatlantic cooperation in regulation and safety issues related to nanotechnologies has been recently established and led to the establishment of bilateral research activities on these matters as well as a series of bilateral meetings between US and EU authorities

EU states

The current EU regulations provide the most important framework for activities in this field at national level by the EU Member States. In general, national regulatory agencies must align with EU regulations, with the possibility to implement specific (more detailed or tighter) regulations at a national level.

In addition, many European Countries, in particular those more active in nanotechnologies, have also started their own activities on regulation of nanotechnologies/nanomaterials. These are mainly in relation to occupational safety and health aspects, chemicals, and foods.

Research on Environment, Health, and Safety (EHS) issues and regulatory aspects are included as priority in all countries having a nanotechnologies development strategy/plan. Among them, the most active are France, Germany, Switzerland, the Netherlands, and the UK.

Almost all other countries surveyed2 have at least some initiatives on these matters, and are linked to activities at EU level through participation in working groups at the institutional level (such as different technical Committees of Member States authorities, the OECD WPMNs, the Nanosafety Hub of the European Commission). In particular, regarding Occupational Safety and Health issues (OSH), those countries that have working groups at the institutional level, are developing guidelines and support specific research activities on the matter.

Regarding chemicals, the way nanomaterials are considered in REACH will strongly influence regulatory actions at national level, in particular in countries such as France, Germany, Austria, Belgium, and Italy that are considering introducing notification and registration mechanisms for nanomaterials (though they would generally prefer to avoid any kind of duplication of REACH procedures).

On this issue, relevant initiatives have been lately undertaken by France, which is moving forward with a compulsory reporting scheme (declaration) of nanomaterials. The scheme will be devoted to specific types of nanomaterials and requires a declaration of identity, quantity and use of these substances. A public consultation on the decree issued on the matter by the Environmental Ministry ended on February 2011. A definitive version of the decree is expected soon.

France is also publishing a series of technical guidance documents related to nanotechnologies (OSH aspects of nanomaterials in general, including a recently published control banding tool; carbon nanotubes; medicinal products, medical devices.

In **Germany**, in the Nano Action Plan 2011-2015 promoted by the Federal Government, the need to develop appropriate regulation and standards for nanotechnologies is include as a priority. In September 2010, the

German NanoKommission Dialogue Initiative (involving more than 100 key nanotech stakeholders) provided to the German Government an analysis about EU/national regulation and the concrete application of the precautionary principle, as well as considerations about a definition of nanomaterials and the creation of a nanoproducts register.

The report suggested a series of amendments aiming to explicitly include nanomaterials in existing regulatory provisions, though stressing the need for a coherent approach between German and EU regulation.

Several documents and guidance have been published in the last years by German authorities and stakeholders on EHS issues and nanotechnologies3, and the German Federal Institute for Occupational Safety and Health is running a second survey (the first was in 2006) on worker protection in the production/handing of nanomaterials.

In terms of regulation, the **United Kingdom** supports EU initiatives, however is promoting a 'case-by-case' approach to assess the risk and suitable use of individual nanomaterials in food and food contract materials. The UK Food Standards Agency monitors on a regular basis the regular basis the regulatory situation of these products.

The UK Government has confirmed its commitment toward EHS research, with new studies on safety issues of specific nanomaterials (in particular on nanosilver, carbon nanotubes, iron nanomaterials) and, among others, a bilateral call for research projects on environmental issues with the USA. The British Standards Institution will publish three new standards documents on nanotech (including a guide for SMEs on nano regulation).

The **Netherlands** has a clear commitment towards responsible innovation, and the principles of precaution, inclusiveness, transparency, risk/benefit balance are clearly set out in its nanotech development strategy.

Various guidance materials are being developed on issues such as regulations, the precautionary principle, risk management, information sharing, consumer information (among them an inventory of consumer nano-related products in the EU) and societal dialogue. Research on safety issues is considered a priority, with relevant funding allocated (and required) in national nanotech research activities. In response to the EC

recommendation on a Code of Conduct for nanotechnologies, the **Netherlands** is now introducing a contractual obligation to comply with this Code in its national funding schemes for nanotech (implementation is still at an early stage). As planned in the Action plan on risk assessment and risk management of synthetic nanomaterials, **Switzerland** continues to closely monitor the regulatory situation and provide technical guidelines to support implementation of existing regulation as well as consumer's and stakeholders' awareness on safety issues.

Key challenges that are considered common in the EU are available tools for the assessment of the safety of Engineered Nano Materials are often inappropriate, or so laborious that adequate safety assessment remains highly problematic. Current resources or test methods are not likely to enable safety assessment of the numerous novel nanomaterials that are emerging at an ever increasing pace. This means that new safety assessment paradigms need to be developed in order to solve this problem.

The EU also feels that it is important to support regulators and the nanotechnology industry so that prosperity is maintained and current products are made safe for citizens in Europe and elsewhere. This situation calls for rapid identification of research priorities and of a roadmap for nanosafety.

Several cross-cutting issues that need to be addressed in order to promote growth of the nanotechnology industry are identified in this document. There cross-cutting issues include: 1) the regulatory framework for ENM and nanotechnologies, coupled to the important issue of standardization to promote good practice and to facilitate communication; 2) the innovation/value chain for environmental health and safety and innovation and means to 'unblock' the value chain; 3) the development of infrastructures for nanosafety to promote research, education, and innovation; 4) international collaboration and global dialogue, with a view towards a global research area in nanosafety, along with 5) communication and dissemination of research to key stakeholders beyond the research community, including industry, regulatory bodies, and others.

EU research needs and priorities for the coming years in four main thematic areas: 1) nanomaterial identification and classification; 2) nanomaterial exposure and transformation; 3) hazard mechanisms related to efforts on human health and environment; and 4) tools for the predictive risk assessment and management including databased and ontologies. A set of research priorities that is required in order to reach the goals of the roadmap. Ultimately, the successful and timely implementation of this roadmap-which is subject to further refinements as new research priorities emerge – will lead to the development of a nano

EHS (Environment, Health and Safety) tool box for exposure assessment, for hazard prediction, and for risk assessment and prediction as well as management that will allow the sustainable implementation of nanotechnologies.

Canada and Australia

In Canada and Australis, EHS and regulatory issues are receiving increasing resources within their national strategies for nanotechnologies, and the need to adopt a precautionary approach is explicitly stated. There is a growing involvement of authorities in different sectors that are working to develop regulatory, product-specific guidance documents for nanomaterials.

Australia and Canada have similar risk assessment programs for industrial chemicals: Identify substance by CAS #, and name and both require tests to properties, toxicity, description of use and exposure. Key issues that are common in both countries are harmonized definition of nanomaterials, and differentiation between nanomaterials from 'ordinary' chemicals?

Health Canada (one of the two main regulatory authorities, the other is Environment Canada) announced the adoption of the Interim Policy Statement on Health Canada's Working Definition for Nanomaterials and its posting on the Health Canada website. The Interim Policy is effective immediately and comments on this policy statement are being collected so that it may be updated as necessary.

Currently, the Acts and Regulations administered by Health Canada have no explicit reference to nanomaterial. Among four key objectives, this policy statement establishes a transparent working means of identifying nanomaterials. It will also provide Health Canada with a consistent set of approaches across the department and a trigger to request information. Given the range of nanomaterial-related regulatory responsibilities at Health Canada, the working definition is intentionally broad and will be applied more specifically in each regulatory program area.

In preparing the Interim Policy Statement on Health Canada's Working Definition for Nanomaterials, Health Canada sought the informal feedback of some international stakeholders, industry trade groups, standards associations, and other Canadian federal departments.

Canada's regulatory systems for food, health and consumer products have served Canadians well over the years. However, recent trends such as advances in science and technology, globalization and changing consumer demands are driving the need for regulatory modernization in Canada and around the world.

Australia

In Australia, the National Industrial Chemicals Notification and Assessment Scheme (NICNAS), has developed a specific strategy for the regulation of nanomaterials, supported by an in depth stakeholder consultation ("Proposal for regulatory Reform of Industrial Nanomaterials"). Based on this consultation a working definition for "industrial nanomaterials", has been agreed with stakeholder and officially adopted (it may be further changed in the future, also in view of international harmonization). A series of amendments have been introduced into the existing chemical regulation, ensuring pre-market evaluation of new nanomaterials. These requirements have since been in force since January 2011, accompanied by guidance documentation, and monitoring of concrete implementation is currently ongoing.

An intense activity on nanoregulation is ongoing also from other Australian authorities, to review existing regulation and increase the knowledge base through specific research programmers. In particular, Safe Work Australia has launched a "Nanotechnology Work Health and Safety Program" to develop appropriate tools and methods related to occupational and health issues. These include the "Work health and safety assessment tool for handling engineered nanomaterials" and a draft guidance nanomaterial into Safety Data Sheets and labeling procedures.

Asia

It seems Japan, Korea, Taiwan, and Thailand are not planning specific regulatory actions for nanotechnologies, but are looking at legislation developed in Europe and USA as a benchmark for the development of their own. They pay particular attention to the debate on REACH and nanomaterials. Nevertheless, the countries mentioned are quite active in the field of standardization and all have initiatives and research programs at institutional level on nanomaterials, in particular regarding Occupational Safety and Health (OSH) aspects.

Japan

Unlike the EU, which has introduced labeling rules for cosmetics containing nanomaterials and has published a regulatory definition of the term "nanomaterials", Japan has not yet developed any similar

labelling requirements or definition. Currently, it has no jurisdictional framework specifically designed to address them, nor regulations containing provisions defining the size of chemicals. Sookie Hong of 3E Company looks at how three ministries are tackling nanomaterials from their own perspectives.

Nanomaterials have been used in Japan for some time in products such as home appliances, food, food containers, cosmetics, automobile parts, pharmaceuticals, paints and inks, and textiles. Recognizing that they must move fast to provide effective regulations on nanomaterials hazard and risk management, Japanese ministries have been promoting safety measures and guidelines, and developing toxicity testing and risk assessment on nanomaterials.

The 3 main regulatory authorities are Ministry of Economy, Technology, and Industry (METI), Ministry of Health, Labour and Welfare's Bureau of Labor Standards, and Ministry of Environment (MoE).

METI has concentrated on hazard testing and risk assessment in order to develop effective safety measures. It has published reports which provided general safety measures for prevention of exposure to nanomaterials in the workplace, and urged industry to conduct voluntary safety surveys and share information in the supply chain. The ministry also initiated the Nanomaterial Information Collection and Communication Program to urge manufactures to share hazard information six substances as major nanomaterials: carbon nanotubes, carbon black, titanium dioxide, fullerenes, zinc oxide, and silicon dioxide. The report reviewed each substance's characteristics, production volume and major use in Japan, and exposure and emission prevention measures.

In order to increase scientific knowledge on the risks posed by nanomaterials, Meti is implementing project on the research and development of nanoparticle characterization methods with the New Energy and Industrial Technology Development Organization. The focus of the research is on developing risk assessment of nanomaterials and proposing a risk management policy. The project produced detailed risk assessment of three nanomaterials (titanium dioxide, fullerenes and carbon nanotubes), a report on toxicity testing of manufactured nanomaterials, and guidelines for hazard assessment testing of industrial nanomaterials in animals by respiratory exposures.

The ministry also established the Nanomaterials Safety Management Committee to focus on exposure to nanomaterials in products, and to develop appropriate management procedures from the perspective of

usage and life cycles. Various meeting discussion reports have been published outlining three principal areas of discussion: hazard exposure and risk assessment; risk management; and definition and technological measurement.

Korea

The Republic of Korea is developing the "National Nano-safety Strategic Plan (2011-2015)" and will publish in 2011 a "Guidance on safe management of nanotechnology based product". Moreover, a specific "Risk management platform technology for nanoproducts (2009-2013)" is in development, aiming to provide a certification system for nano-related products. Several research programs on EHS and ELSA are in progress.

Taiwan

In Taiwan, within the framework of their Strategic Plan for Responsible Nanotechnology (2009-2014), the Nanomark Certification System (coordinated by ITRI, the Industrial Technology Research Institute) has been active since 2004. This is a voluntary reporting and certification scheme that aims to increase public confidence in nanotechnology products.

Thailand

The National Nanotechnology Center (NANOTEC) under NSTDA is the focal point for nanotechnology research, development, communication, and collaboration activities. Since its establishment in 2003, NANOTEC's direction has been to work on research and development which is considered of national importance, established international excellence, and promote global visibility of research' capabilities.

The nanosafety aspects of its operation began to come of age in late 2011 when senior management began to push for the government to establish the country's first Nanosafety and Ethics Strategic Plan which was finally endorse in 2011 clearing the way for the publication of the Nanosafety and Ethics Strategic Plan 2012-2016.

The new plan which will run from 2016-2021 is currently under review and is expected to be completed and approved by end of 2016. The plan will continue to focus on strategies related to knowledge management, monitoring, and public engagement.

Also working hand-in hand with NANOTEC is the Nanotechnology Association of Thailand which launched in 2011 the industrial standards certification for nanotechnologies related products call NanoQ. This is also the first national voluntary certification program and the association is urging companies in the paint, ceramics, textile, and household plastic industries to make inquiries on the possibilities of obtaining NanoQ label for their product. Doing so will give their customers a sense of assurance that the product they are purchasing does have nano particles with specific characteristics as stated by the company. In addition, NanoQ label also helps to rid the market of fake nano products. To date, 5 NanoQ labels have been awarded to companies in the paint, textile, and plastic sectors. Despite the fact that nanosafety is not the main focus determining the approval process of NanoQ label, comments on nanosafety can be recommended to the private sector during industrial visits and production process. Nanosafety comment have been issued on several occasions and have been noted in consumer' manual.

NANOTEC is also working closely with the Teacher Trainers of Nanotechnology (TTN) and the Nanoplus+ Center members to implement activities that promote awareness of nanosafety in schools and universities. Several workshops and science project activities have been initiated.

Appendix D

The report of Nanosafety and Ethics Strategic Plan (2012-2016)

The Nanosafety and Ethics Strategic Plan (2012-2016), approved by cabinet on September 11, 2012 , has developed from initiative of other Master Plans and Strategic Plans which is related in national and international nanosafety aim to the nanosafety and ethics management in Thailand to operate in the same direction and bring about "Safe-Nano for Thailand's sustainable development" including coordination with other organizations to determine the plan and manage the related activities along with the vision and key performance indicators in purpose of safety for health, environment and nation security from research and development, production, distribution, nanotechnology and nanoproducts usage with proper ethics and sustainability. The success factors should be complied with key performance indicators and objective within 5 years or end of the strategic plan (2012-2016). The key performance indicators and objectives are as following:

1) Thailand has the efficient and effectiveness in nanosafety and ethics system and covers all related sectors within 5 years.
2) All Nanoproducts in Thailand market has display the nanomaterial and safety information with evidences in science.
3) People have increasing knowledge and understanding in the safety and dangerous of using, storing and disposing the nanoproducts safely.

To improve and develop for efficiency operation and responsive to the nation policy on nanotechnology, National Science and Technology Development Agency by the National Nanotechnology Center, as the cooperation of strategic plan driving, arranged the conference to follow up the performance of the Nanosafety and Ethics strategic Plan (2012-2016) on 1st April, 2016 at the meeting room 303, Thailand Science Park Convention Center. The meeting aimed for cooperation between related organizations, brainstorming the ideas from main and revising visions, objectives, Key Performance Indicators and Strategies of Nanosafety and Ethics Strategic Plan (2012-2016) on the direction of the next Nanosafety and Ethics Strategic Plan. The details of each strategy performance are as following:

Strategy 1: Establishing and implementing knowledge management in nanosafety and ethics and nanoproducts

Key Performance Indicators	Result
1.1 Having a database system on nanosafety and ethics which is accessible to the public	√Completed
1.2 Having nanosafety and ethics measures which involve all related parties and cover the operations of all sectors	√ Competed

Achievements:

- Nanosafety Information Center Thailand, (www.knownano.org)

  Operated by Chulalongkorn University
- Three of nanosafety guidelines; 1) Consumers Guideline, 2) Manufacturer Guideline, and 3) Academic Professional Guideline

  Operated by the National Nanotechnology Center
- The basic of nanotechnology for industrial, Department of Industrial Work (June, 2012)

  Operated by Department of Industrial Works
- Toolkits of technical on Nanosafety for staffs, technician and entrepreneurs

  Operated by Food and Drug Administration
- Manual

  Operated by Naraesuan University and The Thailand Research Fund
- The activities to integrate the knowledge on Nanosafety with the Public relationship department activities and strengthen the awareness from the National Nanotechnology center: the nanotechnology competition (Hi-light Projects)

  Operated by the National Nanotechnology Center

Strategy 2: Developing and reinforcing measures and monitoring mechanisms and enforcement

Key Performance Indicators	Result
2.1 Having nanosafety and ethics measures which involve all related parties and cover the operations of all sectors	√ Competed
2.2 Having effective mechanisms to support, monitor, and enforce nanosafety and ethics measures	√ Competed
2.3 Nanoproducts in Thailand's market have labels displaying nanomaterials components and safety information based on scientific evidence	√ Competed
2.4 Having agencies and organizations which provide services on analysis, testing, calibrating, and certifying nano label for nanoproducts	√ Competed
2.5 Having agencies or monitoring and warning systems on nanosafety, coordinates with authorized agencies to determine measures as well as make recalls, discontinue sales in the market, and eliminated under standard nanoproducts	√ Competed
2.6 Having controls advertising establish advertising guideline for nanoproducts	√ Competed

Achievements:

- Determination the standard of manufacturing by the announcement from Thai Industrial Standards Institute has announcement about 7 subjects of Standards of nanotechnology industrial
    1) The standard of nanomaterial from manufacturing
    2) The method of analytical on nanomaterial from manufacturing
    3) The standard of manage and dispose nanomaterial safety
    4) The standard of physical and chemical characteristic inspection on toxicology of nanomaterial from manufacturing
    5) Risks evaluation of nanomaterial
    6) Measurement of nanoparticles by dynamic of light scattering

7) How to manage the health and safety for human who is related with nanotechnology

Operated by Thai Industrial Standard Institute and the National Nanotechnology

- Improvement and implementation the regulation to monitor, control the effectiveness and safety on nanoproducts for health, and establish “The guideline for nanoproducts for health for entrepreneur” as public information.

  Operated by: Food and Drugs Administration (FDA)

- Establishment documents of “Safety Data Sheet : SDS” and leading to use in related organizations as following:

  1) Documents from Department of Labor Protection and Welfare: Hazardous of product form, which is related to SDS and closely to the proposed documents from Nanotechnology center as a law enforcement that the organization should comply with.

  2) Department of Industrial Works lists the controlled chemical, follow Hazardous Substances Act which is enforce to all manufacturers, importers, exporters and storage. In case of the National Nanotechnology Center intend to enforce as the law, the nanomaterials should be list Toxic products.

  3) The notification of Department of Industrial Works about the system of classification and communication the hazards 2012.

  4) The regulation of Department of Industrial Works as Entrepreneurship Law especially in the manufacturer that the manufacturer of chemical usage needs to report the SDS for the chemical in production.

- FS : NanoMARKS has coordination with Nanotechnology Association in Thailand to determine the objective of NanoQ label.

  Operated by the National Nanotechnology Center

- NanoQ projects

  Operated by Nanotechnology Association in Thailand

- Cooperation with Office of The Consumer Protection Board to determine the direction of “NanoQ label” that Office of The Consumer Protection Board has announcement about “products label”

and the regulation of responsibility and control hazardous of product, but this is covered some of nanoproducts in market.

- Office of The Consumer Protection Board has announcement of The Consumers Protection Act (1979) and The National Nanotechnology Center should prepare the testing process by request the cases issues from Office of The Consumer Protection Board to support.

Strategy 3 : Strengthening and promoting public engagement activities

Key Performance Indicators	Result
3.1 The public and consumer network has knowledge, understanding and are capable of participating in the process of policy development for nanotechnology and nanosafety management.	On Process
3.2 Information on nanotechnology, nanosafety and risks are accessible and the public is awareness and can utilize them appropriately and promptly.	√ Competed
3.3 Having appropriate nanotechnology and nanosafety materials in regional education centers both in the formal and informal education system.	√ Competed

Achievement:

- Insert knowledge on nanosafety and awareness on nanotechnology

  Operated by the National Nanotechnology Center
- Training on knowledge and information on nanotechnology including nanoproducts to the Nanoplus network (TTN) staffs.
- Establish the knowledge management on nanosafety and nanoproducts to public.

  Operated by the National Nanotechnology Center

From the report in 2012-2016, we found that the Strategy 1 : Establishing and implementing knowledge management in nanosafety and ethics and nanoproducts and Strategy 2 : Developing and reinforcing measures and monitoring mechanisms and enforcement has been completed with Key Performance Indicators since the beginning of Strategic Plan, the organizations has prioritize to establish and set knowledge management, including the basic of measurement and enforcement. Once the knowledge and standards has been complied with people then the awareness and public accessibility on nanosafety will be occur. The report from some parts of Strategy 3 : Strengthening and promoting public engagement activities

shows that the operation to comply with the nanosafety and ethics strategic plan (2012-2016) can be demonstrated as follow points: the process to complete the objectives of strategic plan should be initiated with giving knowledge and establish standards to enforce. Then apply the knowledge and standards to promote the awareness and public engagement that the result should be followed with the strategic plan's objectives such safety for health, environment and nation security by the procedure of research and development, production, distribution and usage of nanotechnology and nanoproducts with ethics in proper, sustainability and accessibility.

Appendix E

Nanosafety and Ethics Strategic Plan (2017-2021) Committee

1.	Dr. Suwit Wibulpolprasert	Consultant
2.	Dr. Yupin Lawanprasert	Consultant
3.	Prof. Sirirug Songsivilai	President
4.	Dr. Sirasak Teparkum	Vice President
5.	Ms. Sumalee Pornkitprasan	Committee
6.	Ms. Chanathip Pharino	Committee
7.	Dr. Tipicha Posayanon	Committee
8.	Ms. Petcharat Eksangkuk	Committee
9.	Ms. Nalinee Sripaung	Committee
10.	Ms. Pornpit Sikavute	Committee
11.	Representative of Pollution Control Department	Committee
12.	Representative of Thai Industrial Standards Institute	Committee
13.	Representative of Office of The Consumer Protection Board	Committee
14.	Representative of Department of Industrial Works	Committee
15.	Representative of Department of Medical Sciences	Committee
16.	Representative of National Bureau of Agricultural Commodity and Food Standards	Committee
17.	Mr. Wathanyoo Techapunyong	Committee
18.	Mr. Aungkarn Wongdeethai	Committee and Secretary
19.	Mr. Ramjitti Intraraprasert	Committee and Secretary
20.	Ms. Narisa Bunyongworapinit	Committee and Secretary Assistant
21.	Ms. Thitima Jantanasot	Committee and Secretary Assistant

Appendix F

The procedure of the Nanosafety and Ethics Strategic Plan

The Procedure of the Nanosafety and Ethics Strategic Plan (2017-2021)

1) The National Science Technology and Innovation Policy Office (STI) appointed the Nanosafety and Ethics Strategic Plan (2017-2021) committees from related agencies to have responsibility to process the "Nanosafety and Ethics Strategic Plan (2017-2021)" to be conformed the government policy and national Policy. This is objected to conduct the knowledge and understanding, control and manage the safety and ethics on nanotechnology, as well as develop the nanotechnology in Thailand, prevent and solve the impact from nanotechnology.
2) Draft of Nanosafety and Ethics Strategic Plan (2017-2021) was established on April, 2016 by starting from workshop with related agencies to follow up the Nanosafety and Ethics Strategic Plan (2012-2016). The objectives of the workshop was about brainstorming from primary agencies and supported agencies, revising the vision, objectives, key performance indicators and measures, and scoping the Nanosafety and Ethics Strategic Plan (2017-2021).
3) To ensure the procedure of the Nanosafety and Ethics Strategic Plan (2017-2021) has related and integrated with related agencies operations, the draft of strategic plan was initiated as follow meeting: (See in Figure F-1)

   There are 5 meetings of the Nanosafety and Ethics Strategic Plan (2017-2021) Committee

   1. On 26 July 2016, at National Science Technology and Innovation Policy Office
   2. On 31 August 2016, at National Science Technology and Innovation Policy Office
   3. On 30 September 2016, at National Science Technology and Innovation Policy Office
   4. On 9 November 2016, at National Science Technology and Innovation Policy Office
   5. On 24 February 2017, at National Science Technology and Innovation Policy Office

Moreover, there is a brainstorming meeting on the Nanosafety and Ethics Strategic Plan (2017-2021) on 22 December, 2016 at National Science and Technology Development Agency.

Figure F-1 : Procedure of the Nanosafety and Ethics Strategic Plan (2017-2021)

Appendix G

SWOT Analysis of Nanosafety and Ethics

Source of Information

- Workshop "Performance of Nanosafety and Ethics Strategic Plan (2012-2016)" by National Nanotechnology, 1st April, 2018 at The National Science and Technology Development Agency, Pathumthani
- Workshop "SWOT Analysis for driving nanotechnology in Thailand" by Naraesuan University and supported by The Thailand Research Fund, 5th October, 2016 at Century Park Hotel, Bangkok
- Survey of 12 nanoproducts manufacturers, by The Nanosafety and Ethics Strategic Plan Committee
- Survey of 13 people of academic personnel in 15 universities where has education and research in nanotechnology, by the Nanosafety and Ethics Strategic Plan committee

The mechanism of SWOT Analysis of Nanosafety and Ethics

The SWOT Analysis of Nanosafety and Ethics will be categorized and evaluated in 4 sectors; 1) Public sector, 2) Government sector, 3) Education Sector, and 4) Industrial sector, and compared with SWOT Analysis of Nanosafety and Ethics in 2012 result.

The details of SWOT Analysis from all sectors as follow;

Government sector

Strength	Weakness
• Thailand has the Nanosafety and Ethics Strategic Plan, the direction to control nanosafety in government, industrial, education and public sectors, and to establish strengthening and promote public engagement activities. • Thailand has Chemical Usage Control Acts and Promotion and Conversation of National Environmental Quality Acts. • The government and education sectors have continuous develop and present the nanosafety guidance for working. • The government and public sectors have awareness to control the safety on nanotechnology and create engagement activities. • The government sector has safety testing equipment for the industrial sectors but not enough.	• Lack of conversation in the Nanosafety and Ethics Strategic Plan to the government, education, industrial and public sectors, and inappropriate setting the responsibility and process to follow the plan. • Lack of law and regulation to control the nanosafety on production, import and export nanomaterial including treatment and waste disposal the nanomaterial as well as all issues of safety on nanotechnology. • Lack of standard of safety control in nanoproducts even though there is related Acts to support. • The inspection, controlling and monitoring in nanosafety is not responsibility and tasks of government sectors. • Lack of proper knowledge and communication about nanotechnology in the government sectors. • Lack of networking from the government to support the information of working, inspection, monitoring and controlling the safety. • Lack of equipment, measurement and inspection standards in the industrial and laboratory. • Less of nanotechnology laboratory to analyze and inspect nanomaterial, and need more implementation and development performance.

Government Sector (Continue)

Opportunity	Threats
• The government supports to establish the standards, testing and inspection on nanotechnology. • There are information and collaboration in international level to exchange the knowledge of nanosafety. • Opportunity to form and expand the collaboration between government and public sectors for nanosafety but it still has limitation. • Encouragement to establish the standards and strategy of nanosafety inspection in Thailand and international level.	• Thailand is a source of purchasing on nanoproducts from overseas because Thailand has not strong regulation to control from the government sectors and lack of conversation in the knowledge to public in the risks of nanoproducts. • Thailand has not registration on imported nanomaterial, nanoproducts and nano-chemical, so no control to cover all products. • Lack of standards to control the safety on nanoproducts from manufacture and import, by registration, inspection, control and standards. • The gap between the each department in government sectors and the government is not ready to support nanoproducts usage while the public sectors keep secret on the production information which may impact to business market, so the information on nanotechnology is ambiguous on government and private sectors. • No public hearing on nanotechnology.

Education sector

Strength	Weakness
• Thailand has the Nanosafety and Ethics Strategic Plan, the direction to control nanosafety in government, industrial, education and public sectors, and to establish strengthening and promote public engagement activities. • The government and education sectors have continuous develop and present the nanosafety guideline for working. • There are lot of researchers, mostly in educational levels and universities where support the nanotechnology research. • There are the nanotechnology laboratory and equipment for testing and inspection the nanomaterial and nonoproducts but not cover in nanosafety. • There are organizations to support fund and budget in nanotechnology research.	• Lack of conversation in the Nanosafety and Ethics Strategic Plan to the government, education, industrial and public sectors, and inappropriate setting the responsibility and process to follow the plan. • There are lots of researchers in nanotechnology, but still lacking in nanosafety. • Lack of laboratory and special equipment in the education sectors to support researching on nanosafety, toxic of nanomaterial and innovation of nanotechnology. • Limit and lack of research funding to develop the knowledge on nanosafety as quick as nanotechnology innovation. • Lack of investment and supporting the nanosafety research center in the university and specialist to create the knowledge and innovation on nanotechnology in Thailand.

Education sector (Continue)

Opportunity	Threats
• The researchers has collaboration with the international university and overseas to establish nanotechnology knowledge. • The researcher from many universities has closely collaborated with the industrial sectors to create the innovation. • The research in nanotechnology has increasing rapidly while research in nanosafety has limited. • The relationship between universities and secondary school has closure, so the knowledge of nanosafety is easily to transfer to school level. • Universities build up the engagement of awareness, monitoring and inspection on nanomaterial to the community and society about absorption of nanomaterial from nanoproducts.	• The information exchanging, the collaboration, and information transferring on nanosafety from overseas to Thailand have limited due to lack of specialist on nanotechnology in Thailand. • The researchers on nanotechnology have less awareness on safety protection of the nanotechnology innovation. • There are less collaboration between researchers and industrial sectors to establish the knowledge of safety on nanotechnology innovation, including studying in toxicity and inspection the safety on nanoproducts. • Education and researching in university level have not enough knowledge and information about safety on nanotechnology even there are lots of nanotechnology researches. • Lack of knowledge transferring in the safety of nanotechnology, especially giving to the consumers in school and social community level.

Industrial sector

Strength	Weakness
• Thailand has the Nanosafety and Ethics Strategic Plan, the direction to control nanosafety in government, industrial, education and public sectors, and to establish strengthening and promote public engagement activities. • The nanotechnology is widely acceptance in the government and private sectors, and driving in all activities by the Nation Nanotechnology Center as the main organization. • The industrial organizations in Thailand such as the Department of Industrial Works, The Federal of Thai Industry are emphasis and execute in the nanosafety. • The government and industrial sectors have emphasis in nanotechnology control. • There are the nanotechnology laboratory and equipment for testing and inspection the nanomaterial and nonoproducts but not cover in nanosafety.	• Lack of conversation in the Nanosafety and Ethics Strategic Plan to the government, education, industrial and public sectors, and inappropriate setting the responsibility and process to follow the plan. • Lack of equipment, measurement and inspection standards in the industrial and laboratory. • Less of nanotechnology laboratory to analyze and inspect nanomaterial, and need more implementation and development performance. • Lack of conversation to emphasis the necessary nanosafety for consumer protection. • Unclear of knowledge and information of toxic in nanoproducts, so the manufacturers have not emphasized to inspect the safety on nanomaterial. • Lack of testing standards to control nanotechnology and nanosafety in the industrial sectors. • Lack of supporting in industrial sectors to manage the nanosafety for consumer protection.

Industrial sector (Continue)

Opportunity	Threats
• Universities build up the engagement of awareness, monitoring and inspection on nanomaterial to the community and society about absorption of nanomaterial from nanoproducts. • The national community has more concern on the issues of emerging nanotechnology, safety, risks and ethics. • The researcher from many universities has closely collaboration with the industrial sectors to create the innovation. • Encouragement to establish the standards and strategy of nanosafety inspection in Thailand and international level.	• Thailand is a source of purchasing on nanoproducts from overseas because Thailand has not strong regulation to control from the government sectors and lack of conversation in the knowledge to public about the dangerous of nanoproducts. • Thailand has not registration on imported nanomaterial, nanoproducts and nano-chemical, so the control has not cover in all products. • The standards of safety on nanoproducts from manufacture and imported nanoproducts have not covered in registration, inspection, controlling and standards. • No standards and measurement to control nanosafety and enforce to the industrial sectors. • The government sectors has less promoted on the genuine nanoproducts to the industrial sector, so the faked nanoproducts has been expanded in the market. Moreover, the consumers have less knowledge to consume the products. • The private company and manufacturer have not share the nanosafety information due to their confidential data. • There are less collaboration between researchers and industrial sectors to establish the knowledge of safety on nanotechnology innovation, including studying in toxicity and inspection the safety on nanoproducts. • No department to support on analysis and inspection on nanoproducts.

Public sector

Strength	Weakness
• Thailand has the Nanosafety and Ethics Strategic Plan, the direction to control nanosafety in government, industrial, education and public sectors, and to establish strengthening and promote public engagement activities. • The strategic plan has establishment on strengthen and public engagement activities explicitly. • Thailand has Chemical Usage Control Acts and Promotion and Conversation of National Environmental Quality Acts to control the production, inspection, and pollution from the chemical as well as nanomaterial. • Thailand launch NanoQ label and FDA label for consumer protection in nanoproducts.	• Lack of conversation in the Nanosafety and Ethics Strategic Plan to the government, education, industrial and public sectors, and inappropriate setting the responsibility and process to follow the plan. • Lack of process to support engagement activities, knowledge management and transferring to public in safety of nanoproducts usage. • Unclear role of agencies that have direct coordination with public sector such as Provincial Public Health Office, Local Administration, etc. • Lack of knowledge in good and bad impact to health and residue in the environment. • Lack of consumer protection in nanoproducts where nanomaterial may access into the food chain. • NanoQ has inspected and covered only in Water reflection and Anti-Bacteria but not covered to all nanoproducts, as well as inspection of nanoproducts in market. • Lack of monitoring, controlling and inspection the safety on imported nanomaterial. • Lack of law to control the manufacture, imported and exported nanomaterial, including all issues of safety on nanotechnology. • Limitation of knowledge on nanotechnology and information of nanosafety in the society.

Public sector (Continue)

Opportunity	Threats
• The government sector and universities establish the engagement of awareness, monitoring and inspection to the community and society about absorption of nanomaterial from nanoproducts. • The relationship between universities and secondary school has closure, so the knowledge of nanosafety is easily to transfer to school level. • The consumers have awareness to receive the information of nanomaterial and nanotechnology and engage to monitor on nanosafety. • Thailand has researches on nanosafety to help protect the public and the researchers transfer the knowledge and build the awareness to the public. • The government and local government structure contribute the knowledge transferring from the government sectors to public community. • The innovation brings about the collaboration between government and public sector to merge the knowledge from research with the local wisdom for the innovation on nanotechnology.	• The government has less support the researcher and fund to research in nanotechnology. • The research has written in academic language, so it may difficult to understand in local community level. • The government sector should have measurement to control, protect and give warning to people for making the understanding on nanotechnology. • The channels, such as Website or URL to conversation about nanotechnology to public, accessible into the information are limited. • No public hearing in nanotechnology. • The operation on safety protection has not been continuing, and less of collaboration has been caused of uncover and incomplete information. • The project management and studying on nanosafety and nanotechnology has not been reached to the public sectors. • Less communication on the toxic and dangerous of nanomaterial.