# The Nanosafety and Ethics Strategic Plan

## (2012 – 2016)

National Nanotechnology Center

National Science and Technology Development Agency

# Executive Summary

Thailand has recently introduced nanotechnology to the various industries and demonstrated the improved properties of nano-functions and added value to various products, especially in the industries that play a significant role in Thailand's economy, for example, textiles, food, and cosmetics. However, knowledge on the regulations of nanotechnology, particularly nanomaterials, regarding health and the environment, both directly and indirectly, are neglected and procedures are still uncertain. Currently, Thailand is continually developing institutions, both in the public and private sector, to exclusively monitor and control nanotechnology. Also, Thailand views the need to establish a Nanosafety and Ethics Strategic Plan. This plan shall work parallel with nanotechnology development in preventing and preparing to minimize the potential risks of nanomaterials and nanotechnology that might occur from the growth of nanotechnology application.

The Nanosafety and Ethics Strategic Plan (2012-2016) originated by integrating various model schemes and strategic plans regarding to the national and international chemical safety measures, which also relates to the Thai governmental policies. It aims to manage unity and define the directions for nanotechnology precautions and ethics in order for each institution to synergize and compliance with the strategic plan and pursue in the same direction.

The Strategic Plan endeavors to involve every sector to prevent redundancy and improve the procedure as well as aim to embrace every aspect concerning Thailand's nanotechnology safety and ethics. Furthermore, to completely manage, it aims to promote the role of public engagement. The plan is initiated from NANOTEC's Board of Directors deploying the Nanosafety and Risk Management Committee to form the Nanosafety and Ethics Strategic Plan. Procedures include past-situation analysis, SWOT analysis, brainstorming, public assembly, and Nanosafety and Ethic Committee meetings which carefully reviewed the strategic plan.

The Strategic Plan demonstrates the directions and guides Thailand to a "Safe-Nano for Thailand's sustainable development". The contents are as follows:

Chapter 1: Nanosafety Situation

Chapter 2: Procedures in Establishing the Strategic Plan

Chapter 3: Vision, Objective, and Key Performance Indicators of the Strategic Plan

Chapter 4: Nanosafety and Ethics Strategies

**The three strategies are as follows:**

- **Establishing and implementing knowledge management in nanosafety and ethics and nanoproducts**
- **Developing and reinforcing measures and monitoring mechanisms and enforcement**
- **Strengthening and promoting public engagement activities**

Chapter 5: Mechanisms on Implementation and Evaluation of the Strategic Plan

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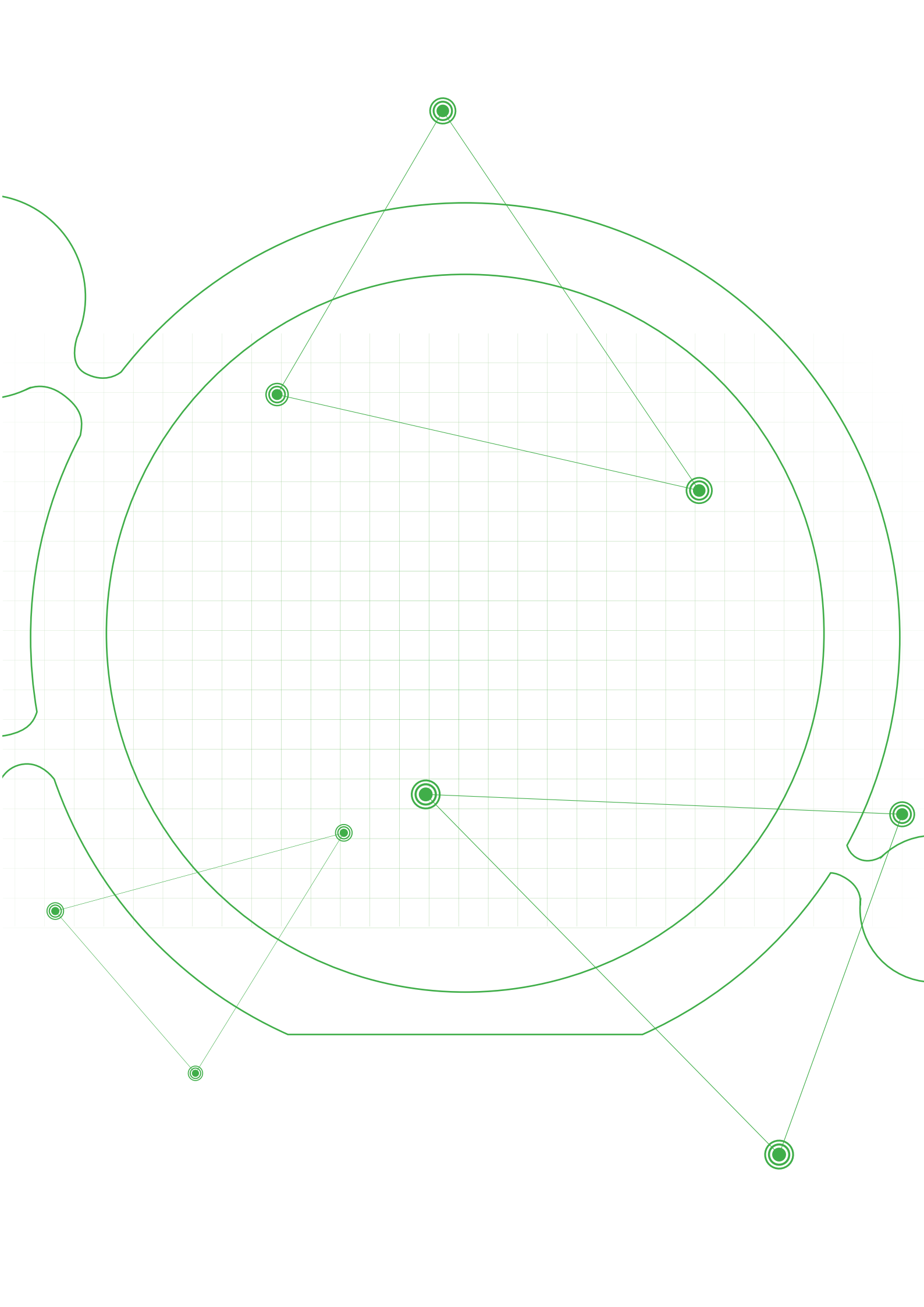


# Chapter 1

# Nanosafety Situation

## 1. Current Situation

For sustainable development and competitiveness, Thailand realized the crucial role of utilizing nanotechnology to improve properties and add value to textile, food, agricultural products, cosmetics, and to the medical industries. Some examples of adding value to products using nanotechnology to develop of water repellent clothes, antibacterial coated textiles, the encapsulated vitamin and nutrition, nanoemulsion anti-aging cream, smart packaging for prolonging food shelf-life, nanosensors for agricultural and food products, nanomedicine to decrease side effects, drug-target delivery, nanocatalysts for new alternative energy, nanomaterials for stronger and lighter weight, and smart nanomaterials for anti-pollution, as well as other potential benefits. Nevertheless, the understandings of direct and indirect effects of nanomaterials and nanoproducts, to health and environment are still limited. At present, there are no conclusions or clear guideline; therefore, regulation and safety guideline are needed to minimize the potential risks of nanomaterials.

As a consequence, Thailand has initiated the "Nanosafety and Ethics Strategic Plan" to educate, regulate, monitor, and manage nanosafety and ethics issues along with the promotion of nanotechnology to sustain nanotechnology development in the country.

## 2. Terminology and Definitions

"Nanotechnology" is often defined in different aspects. In the scope of policy or strategic planning, it is crucial to clearly comprehend the differences between nanotechnology (knowledge or technology), nanomaterials (emphasizing materials), and nanoproducts. The definitions below are provided for common understanding.

2.1 "Nanotechnology" is the process of construction, synthesis, control, modification, and characterization of materials in an atomic or molecular scale, or other structures possessing at least one dimension sized from 1 to 100 nanometres.

2.2 "Nanomaterials" are materials possessing surface structures or porosities or at least one dimension sized on the nanoscale. In brief, nanomaterials are materials with morphological features on the nanoscale or materials containing nanostructures. Nanomaterials generally fall into 3 categories.

1. Natural nanomaterials are found in the natural environment (soil, air, atmo sphere) for example dust particles.
2. Incidental Nanomaterials are produced by chance as a by-product of a process. For example, fire and combustion particulates would be considered incidental materials. Incidental nanomaterials vary in sizes. Some are in nanoscale while some are larger.
3. Manufactured nanomaterials are intentionally produced to have specific properties and homogeneous particles sizes or shapes.

2.3 "Nanoproducts" are products containing nanomaterials or produced by nanotechnological process to have new properties or new functions and improve consumer benefits and add economical value.

2.4 "Nanosafety" is a systematic study monitoring the effects of nanomaterials in human body (including organs, tissues, and cells), and also in the environment. It is related to nanotoxicity, ecotoxicity, and genotoxicity of the nanomaterials.

## Background and Related Researches

In the past decade, there have been several studies in the effects of nanomaterials exposure to animals such as mice, rabbits, and fish which demonstrate that nanomaterials can cause lung inflammation because nanomaterials are capable of translocating from lung toward bloodstream and to body tissues. Some nanotoxicity studies have shown that titanium dioxide, silicon dioxide, and barium sulfate exposure can cause lung inflammation in mice. The inflammator potencies depend on the types and surface areas of materials. However, in the case of equal surface area of materials, inflammatory potencies depend on total mass of material accumulation.

Some manufactured nanomaterials cannot decompose in a short period of time. If such nanomaterials expose into the soil or water, they may remain active for years. Additionally, some highly active substances such as titanium dioxide, nanoparticles may affect life cycles of bacteria in the soil which might cause the change in the ecosystem. There is a chance that the leak of nanomaterials in the environment stays in the food chain and finally returns back to human.

The above issue concerns ethics in science and technology involving areas such as information access, public engagement in decision making and gap of knowledge in people with and without nanotechnology. Nanotechnology is in the initial stage and is full of potential to become society's new technology and invention. But on the other hand, it can overpower other technology. Nanotechnology may be considered as both an enabling and disrupting technology at the same time. Some social issues can be very interesting namely the image and social acceptance for nanotechnology. Nonetheless, the argument remains whether the technology creates social problems and should countries allow the use of nanotechnology in the military affairs.

From data collection of the United Nations Educational, Scientific and Cultural Organization (UNESCO), the Nano Forum of the European Union and the National Science Foundation, in the USA, have concluded 10 nanoethic concerns as follows:

1. Nanotechnology impacts on health, environment safety, consumers, and labors
2. Public confidence in nanotechnology
3. Using the precautionary measures for risk management
4. Building public awareness for better decision makings on the knowledge based
5. Social inequality and owning nanotechnology
6. International inequality
7. Human machine
8. Disease diagnosis by nanotechnology
9. Nanotechnology for military applications
10. Necessity of amending laws and creating a new system

## 3. Nanosafety and Ethics Policies, Strategic Plans, and Laws

3.1 National Nanotechnology Center: The Thai government recognized the advantages of nanotechnology; therefore, the National Nanotechnology Center (NANOTEC) was established on August 13, 2003 as an agency under the National Science and Technology Development Agency (NSTDA), Ministry of Science and Technology. NANOTEC focuses on supporting and encouraging nanotechnology development of the country through research innovations and technology transfer in order to achieve the goals in improving socio-economy of Thailand. In addition raising public awareness, understanding, and knowledge on nanotechnology as well as outlining safety and risk management principles for nanotechnology are included. In 2007, NANOTEC launched the Nanomaterials Safety program involving in NANOTEC investigating the current status of nanosafety, proposing a framework for Thailand's nanosafety and risk management, and preparing regulations and nanosafety guidelines.

3.2 Thailand's National Strategic Plan on Chemical Management: In response to the increasing health problems caused by chemicals, Thailand's Ministry of Public Health (MoPH) has joined the International Program on Chemical Safety (IPCS) with the cabinet's approval since 1985. Since April 1994, the MoPH has been appointed to be the National Focal Point for the Intergovernmental Forum on Chemical Safety (IFCS). At present, Thailand is working under Thailand's Fourth National Strategic Plan on Chemical Management (2012-2021) which comprises of three strategies: the development of a complete database system, mechanics and, chemical control tools, promoting and strengthening the capabilities in chemical management for all sectors, and reducing the risk of chemical hazards.

3.3 Related Laws: At present, there are no specific laws for nanotechnology safety and ethics in Thailand. Nevertheless, some of the Thai civil laws can be applied and categorized into 4 groups as follows:

1. Environmental safety laws: the enhancement of national environment quality act 1992, and the hazardous material act 1992
2. Occupational health and safety laws: the labor protection act 1998
3. Product safety and consumer safety laws: the consumer protection act 1979
4. Human and animal testing laws: human subject research and animal testing regulations

## 4. SWOT Analysis of Nanosafety and Ethics of Thailand

### Strengths

- Nanotechnology is extensively accepted by the government and private sectors in Thailand. NANOTEC has a major role to drive all related nanotechnology activities.
- Industrial sector recognizes the importance of nanotechnology and participates in nanosafety activities.
- Strong collaborations among working organizations.
- Adequate number of testing tools for monitoring nanosafety.
- Presence of the toxic substances control act and the environmental act for monitoring nanomaterials production and utilization.

### Weaknesses

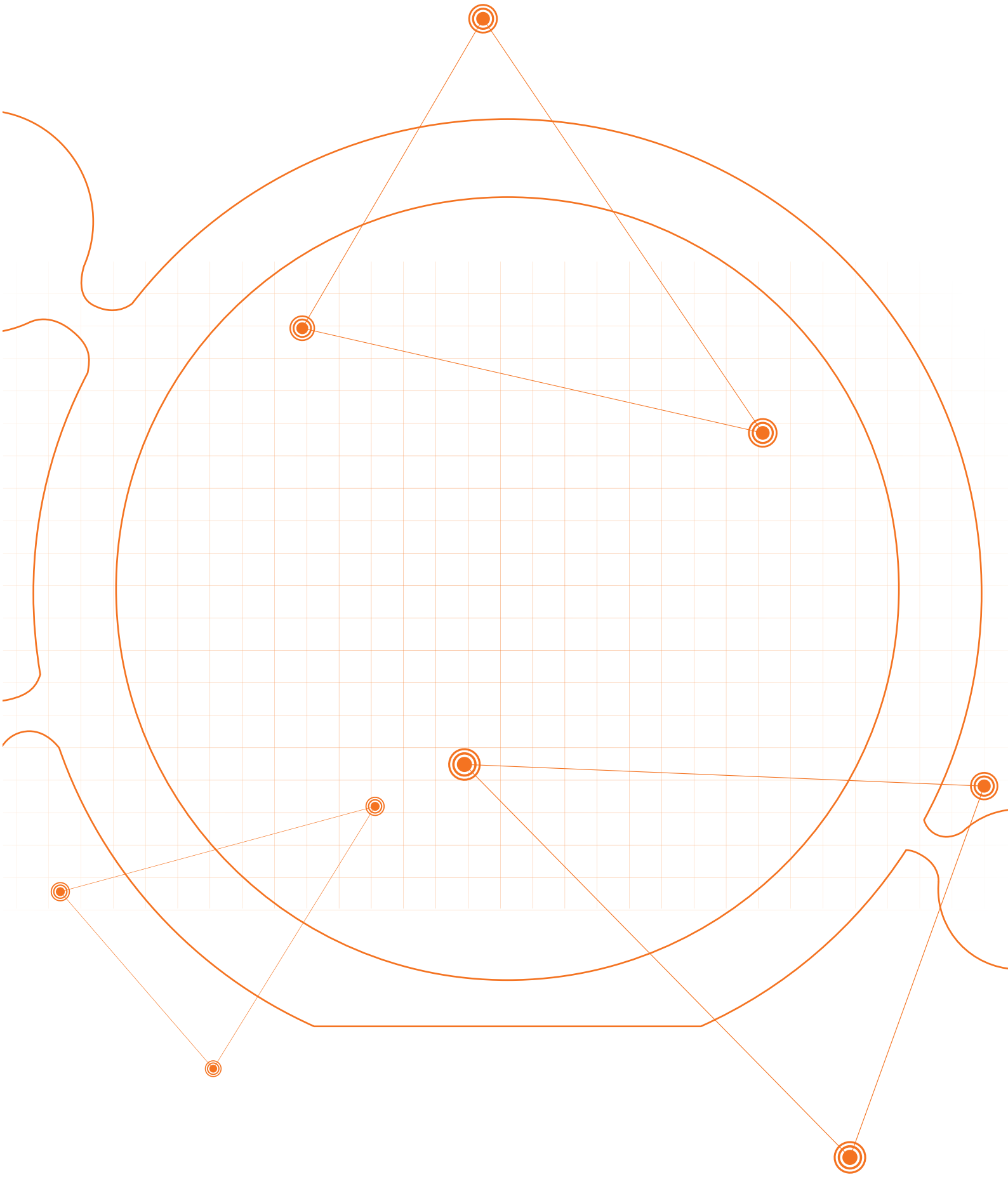
- Working organizations lack information on nanosafety.
- Lack of tools, procedures, and standards for testing nanomaterials in nanoproducts at both industrial and laboratory levels.
- No regulation on nanotechnology productions, imports, exports, and safety issues.
- The public lacks nanotechnology understanding and knowledge due to the limit availabilities of nanotechnology information.
- Lack of human resources in nanosafety R&D.

## Opportunities

- International collaborations on information and knowledge exchange of nanosafety can be conducted continuously.
- The international chemical forum recognizes nanotechnology as an emerging issue.
- Collaborations between government and private sectors to encourage nanosafety testing at both the national and international levels.
- Rapid increase of availability in nanosafety R&D at an international level.
- Awareness of pushing through national and international standardizations on nano safety testing and strategies.

## Threats

- Thailand may become the dumping ground for nanoproducts from other countries due to the lack of control measures.
- Limited access to updated and in-depth information on nanosafety.
- Restrictions on the disclosure of information regarding nanoproduct safety from com panies claiming confidentiality.
- Distortion of facts related to nanosafety at an international level.
- Nanosafety and ethics are sensitive issues and still lack explicit information which might cause public misunderstanding. This could easily lead to public misunderstanding.



# Chapter 2

# Procedures in Establishing the Strategic Plan

## The Procedures in Establishing the Nanosafety and Ethics Strategic Plan

1. The Nanosafety and Risk Management Committee appointed the Nanosafety Strategic Plan Working Group which consists of related organizations from all sectors. The tasks and responsibility of the working group is to develop the "Nanosafety and Ethics Strategic Plan (2012-2016)" in accordance with Thailand governmental policies and international regulations. The objectives are to establish the strategic plan to build knowledge and understanding, monitor and manage nanosafety and ethics, along with nanotechnology development in Thailand. The strategic plan is impl emented to minimize risks from nanotechnology applications.
2. The process of establishing the Nanosafety and Ethics Strategic Plan launched in December, 2009. Several brainstorming sessions were held to establish SWOT analysis of Thailand's nanosafety and ethics. It aimed to integrate the Nanosafety and Ethics Strategic Plan with Thailand's Fourth National Strategic Plan on Chemical Management (2012-2021), the Strategy Formulation, the Tenth National Economic and Social Development Plan, and the Strategic Approach to International Chemicals Management (SAICM). Additionally, the Strategic Plan had to comply with the nanosafety and ethics guidelines at the international level.
3. "Nanosafety and Thailand's Economic and Social situation" seminar was organized to ensure that the Nanosafety and Ethics Strategic Plan was established, and will be effectively implemented by all sectors as well as to create awareness and understanding in nanotechnology. Moreover, the goal was to gain benefits on health, environment, and national security from proper R&D and nanoproducts utilization. Three brainstorming sessions were additionally held to provide more opportunities for government networks, industrial and public sectors, as well as academics and specialists to contribute ideas and comments on the draft of the Strategic Plan in various aspects.

To ensure that the Nanosafety and Ethics Strategic Plan complies with Thailand's Fourth National Strategic Plan on Chemical Management (2012-2021), the working group and NANOTEC organized several brainstorming sessions and meetings with others organizations as shown below:

Two brainstorming sessions with the Food and Drug Administration

| | | |
|---|---|---|
| The 1st meeting: | February 17, 2010 | at Food and Drug Administration |
| The 2nd meeting: | March 10, 2010 | at NSTDA |

Six Nanosafety Strategic Plan Working Group meetings

| | | |
|---|---|---|
| The 1st meeting: | April 8, 2010 | at NSTDA |
| The 2nd meeting: | May 15, 2010 | at NSTDA |
| The 3rd meeting: | June 10, 2010 | at NSTDA |
| The 4th meeting: | July 16, 2010 | at NSTDA |

Three Sub-Working Group meetings

| | | |
|---|---|---|
| The 1st meeting: | May 3, 2010 | at NSTDA |
| The 2nd meeting: | June 2, 2010 | at NSTDA |
| The 3rd meeting: | August 23, 2010 | at NSTDA |

Three brainstorming sessions with the National Health Commission Office of Thailand

| | | |
|---|---|---|
| The 1st meeting: | October 19, 2010 | at National Health Commission Office of Thailand |
| The 2nd meeting: | November 1, 2010 | at National Health Commission Office of Thailand |
| The 3rd meeting: | November 30, 2010 | at NSTDA |

Four Nanotechnology Safety and Risk Management Committee Meetings of 2009

| | | |
|---|---|---|
| The 1st meeting: | March 5, 2009 | at NSTDA |
| The 2nd meeting: | May 26, 2009 | at NSTDA |
| The 3rd meeting: | July 24, 2009 | at NSTDA |
| The 4th meeting: | December 2, 2009 | at Century Park Hotel |

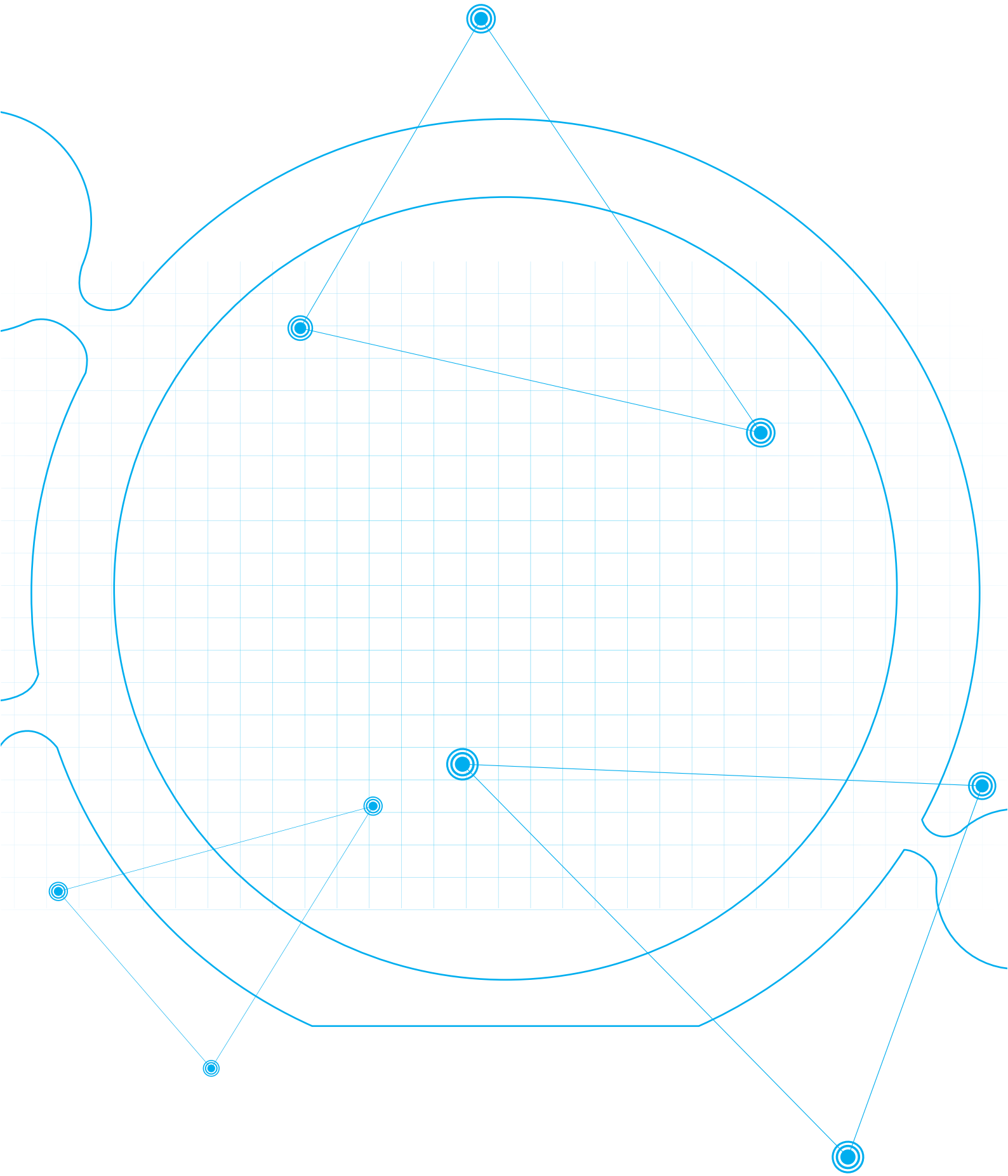
Five Nanotechnology Safety and Risk Management Committee Meetings of 2010

| | | |
|---|---|---|
| The 1st meeting: | February 10, 2010 | at NSTDA |
| The 2nd meeting: | April 20, 2010 | at NSTDA |
| The 3rd meeting: | June 15, 2010 | at NSTDA |
| The 4th meeting: | August 4, 2010 | at NSTDA |
| The 5th meeting: | August 27-28, 2010 | at Rose Garden Riverside Hotel, Nakhon Pathom |

Four seminars and brainstorming sessions

| | |
|---|---|
| The 1st meeting: | The seminar of the “Nanosafety and Thailand’s Economic and Social Situation” December 2, 2009 at Century Park Hotel |
| The 2nd meeting: | The brainstorming for “Nanotechnology Safety Strategic Plan” July 22, 2010 at Miracle Grand Hotel |
| The 3rd meeting: | The brainstorming for “Nanotechnology Safety and Ethics Strategic Plan” by the National Nanotechnology Center and the National Health Commission Office of Thailand November 20, 2010 at NSTDA, Pathumthani |
| The 4th meeting: | The issue based health assembly: “Nanotechnology Safety and Ethics Strategic Plan (2012-2016)” January 12, 2011 at Grand Ballroom, Rama Garden Hotel, Bangkok |

Figure 2.1: **Process and timeline to develop the Nanosafety and Ethics Strategic Plan**



# Chapter 3

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

The Nanosafety and Ethics Strategic Plan is developed in compliance with government policies by integrating the master plan and several nanosafety-related strategic plans both in the national and international sector. Mainly, the plan engages Thailand's Fourth National Strategic Plan on Chemical Management (2012-2021) to embrace every aspect of nanotechnology safety and ethics issues. The alignment between the Thailand's Fourth National Strategic Plan on Chemical Management (2012-2021) and the Nanosafety and Ethics Strategic Plan (2012-2016.) are shown in Figure 3.1 below

| Thailand's Fourth National Strategic Plan on Chemicals Management (2012-2021) | Nanosafety and Ethics Strategic Plan (2012-2016) |
|---|---|
| 1. Develop a complete database system, mechanics and chemical control tools | 1. Establishing and implementing knowledge mangement in nanosafety and ethics and nanoproducts |
| 2. Promote and strengthen the capabilities in chemicals management for all sectors | 2. Developing and reinforcing measures and monitoring mechanisms and enforcement |
| 3. Reducing the risk of chemical hazards | 3. Strengthening and promoting public engagement activities |

Figure 3.1: The alignment between the Thailand's Fourth National Strategic Plan on Chemical Management (2012-2021) and the Nanosafety and Ethics Strategic Plan (2012-2016).

The objective of the Nanosafety and Ethics Strategic Plan is to define the directions of safety and ethics management in order to create alignment among organizations and operate in accordance with Thailand's situation. The prospect frameworks are as follows:

## 1. Vision

"Safe-nano for Thailand's sustainable development"

The vision becomes the direction of Thailand's social development, based on nanotechnology concerning health, education, environment, and economics in a reliable and sustainable manner. The activities are as follows:

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.
4. Logistics and Storage: To conduct a safe and proper logistic and storage system for the Thai community under strict measures and regulations.
5. Disposal: To create a proper disposal system with no pollution.

## 2. Objective

To enhance health and environment safety as well as promote social security via ethical, sustainable and proper engagement in R&D, production, distribution and nanotechnology and nanoproduct usage.

## 3. Key Performance Indicators and Targets

Within 5 years, when the Nanosafety and Ethics Strategic Plan is complete, three key performance indicators and targets are to be accomplished as follows:

1. Thailand has an effective management system of nanosafety and ethics, with related sectors' operating within 5 years.
2. Nanoproducts in Thailand market have labels displaying nanomaterials components and safety information based on scientific evidence.
3. The public has knowledge, understanding, and awareness of nanosafety and risk and are able to select, store, and handle nanoproducts by themselves.

## 4. Strategies

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

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

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

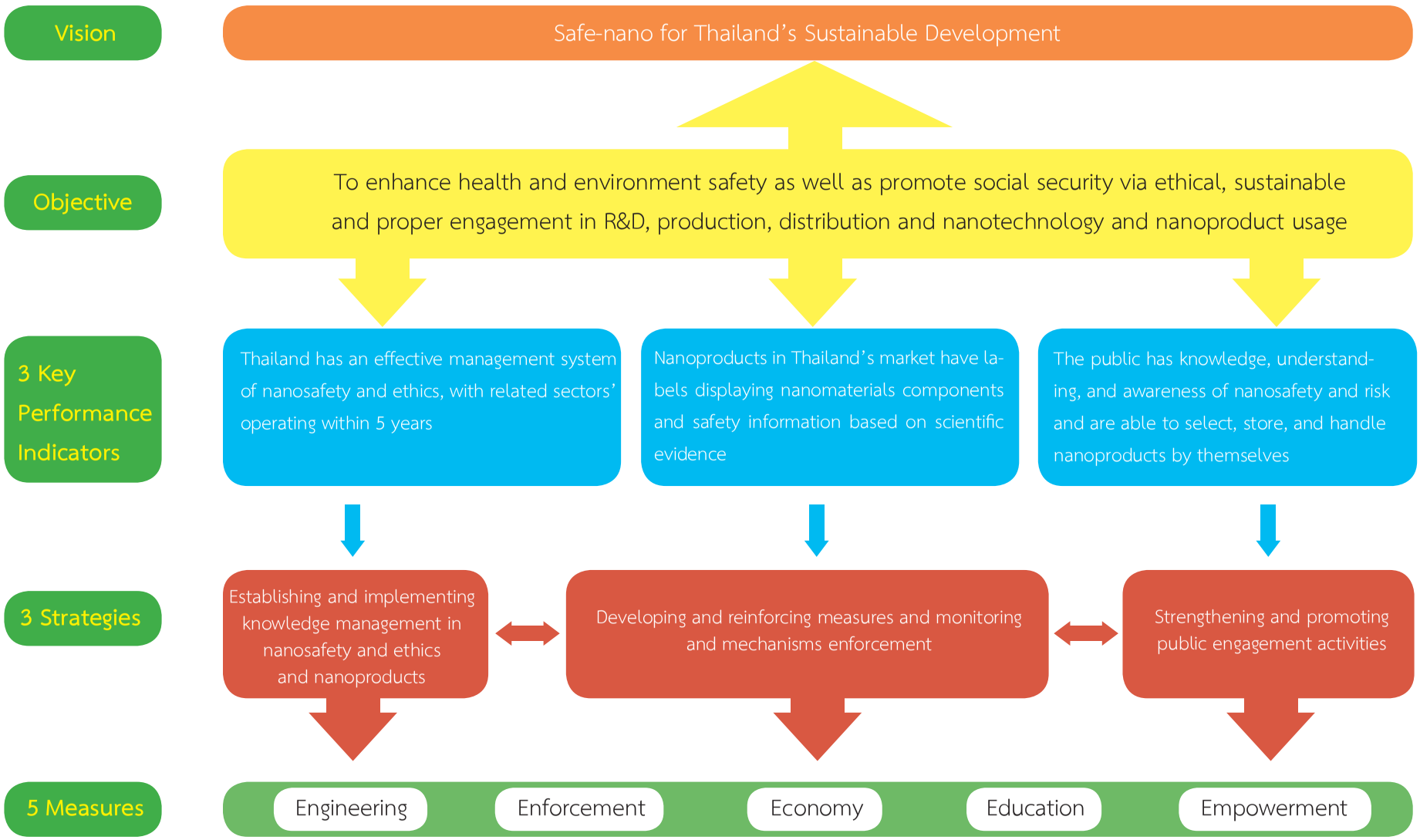
**Strategy 3 :** Strengthening and promoting public engagement activities

The 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, implement safety regulations on health, environment, and national security, and build sustainable public participation in the Nanosafety and Ethics Strategic Plan. The following diagram (Figure 3.2) demonstrates the relationship between vision, objective, indicators, strategies and measures of 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

Figure 3.2: The diagram of the relationship between vision, objective, indicators, strategies and measures of the National Nanosafety and Ethics



# Chapter 4

# Nanosafety and Ethics Strategies

## 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 both in national and international level.
3. To support all sectors for equal access to knowledge and information and to expand knowledge to the society in order to build awareness on nanoproducts' safety and selecting process.

### 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. Having a database system on nanosafety and ethics which is accessible to the public.
2. 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 safe usage of nanotechnology and nanoproducts manuals and procedures for the industry, laboratory, and user levels.
3. Develop a center for nanotechnology and nanoproducts' safety and ethics information center, linking nationally and internationally, in order to build an accessible gateway for academics, manufacturers, and the public.

### Economy and Finance

4. Promote, support, motivate, and ensure sufficient budget for reliable research on the nanosafety and the effects of nanomaterials and nanoproducts which may pose impacts on health, environment, and national security.

### Empowerment

5. Build 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 an unified concept.

### Strategic Goals

Set nanosafety and ethics management system which integrates 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, monitor, and enforce 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 make recalls, discontinue sales in the market, and eliminate fake nanoproducts.
6. Having controls on advertising and set nanoproducts advertising guidelines.

## 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 at national and international level, in order to improve and develop Thailand's nanosafety and ethics laws, regulations, 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 and suggestion or consultation on the policies to support, monitor, and enforce nanosafety and ethics measures, as well as provide advice in cases wherein consumers are affected by nanoproducts.

### Engineering

5. 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 materials for every levels in the society.

### Strategic Goals

The public has knowledge, understanding and awareness in nanotechnology and nanosafety. Moreover, they 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 on nanotechnology, nanosafety and risks are accessible and the public is aware 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 "nanomark"* label to verifying nanoproduct advertisement.

**Empowerment**

5. Campaign to the public network, community, and local governmental 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' safer nanoproduct selection.
7. Assign responsible and relevant agencies to develop activities for strengthening and promoting public participation

*Nanomark is defined as the certified mark for products which contain nanomaterials. The mark specifies the size of nano-particles used and the properties of nanoproduct. For example antibacterial and water repellant properties, etc.

Table 4.1 Key performance indicators, targets, primary responsible agencies, and supporting agencies for the Nanosafety and Ethics Strategic Plan.

| Strategy | Key performance indicators and Targets | Primary responsible agencies (responsible to key performance indicators) | Supporting agencies (supporting 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<br>- The Federation of Thai Industries<br>- Office of the National Research Council of Thailand<br>- Ministry of Industry<br>- Ministry of Agriculture and Cooperatives<br>- Ministry of Public Health |
| | 2. Having a knowledge management process which can be integrated by every sector leading to an effective and sustainable implementation. | - National Nanotechnology Center<br>- Nanosafety Information Center of Thailand (NICT) | - The Federation of Thai Industries<br>- Office of the National Research Council of Thailand<br>- Ministry of Industry<br>- Ministry of Agriculture and Cooperatives<br>- Ministry of Public Health |

| Strategy | Key performance indicators and Targets | Primary responsible agencies (responsible to key performance indicators) | Supporting agencies (supporting 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<br>- National Science Technology and Innovation Policy Office<br>- Food and Drug Administration<br>- National Bureau of Agriculture Commodity and Food Standards<br>- Department of Agriculture<br>- Department of Fisheries<br>- Department of Livestock Development<br>- The Customs Department<br>- The Fiscal Policy Office<br>- The Industrial Standards Institute<br>- Department of Industrial Works<br>- Pollution Control Department<br>- Department of Environment Quality Promotion<br>- Occupation Safety and Health Bureau<br>- Department of Labour Protection and Welfare<br>- Office of the Consumer Protection Board | - Center of Excellence in Nanotechnology of Higher Education Institutions<br>- Ministry of Science<br>- Department of Science Service<br>- National Institute of Metrology (Thailand)<br>- Department of Medical Sciences<br>- Consumer Organization<br>- Consumer Protection Police Division<br>- The Federation of Thai Industries<br>- The Thai Chamber of Commerce and Board of Trade of Thailand (Bangkok) |

| Strategy | Key performance indicators and Targets | Primary responsible agencies (responsible to key performance indicators) | Supporting agencies (supporting 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<br>- National Science Technology and Innovation Policy Office<br>- Food and Drug Administration<br>- National Bureau of Agriculture Commodity and Food Standards<br>- Department of Agriculture<br>- Department of Fisheries<br>- Department of Livestock Development<br>- The Customs Department<br>- The Fiscal Policy Office<br>- The Industrial Standards Institute<br>- Department of Industrial Works<br>- Pollution Control Department<br>- Department of Environment Quality Promotion<br>- Occupation Safety and Health Bureau<br>- Department of Labour Protection and Welfare<br>- Office of the Consumer Protection Board | - Center of Excellence in Nanotechnology of Higher Education Institutions<br>- Department of Science Service<br>- National Institute of Metrology (Thailand)<br>- Department of Medical Sciences<br>- Consumer Organization<br>- Consumer Protection Police Division<br>- The Federation of Thai Industries<br>- The Thai Chamber of Commerce and Board of Trade of Thailand (Bangkok) |

| Strategy | Key performance indicators and Targets | Primary responsible agencies (responsible to key performance indicators) | Supporting agencies (supporting 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<br>- Food and Drug Administration<br>- The Industrial Standards Institute<br>- National Bureau of Agriculture Commodity and Food Standards | - Center of Excellence in Nanotechnology of Higher Education Institutions<br>- Nanotechnology Association of Thailand<br>- The Federation of Thai Industries<br>- The Thai Chamber of Commerce and Board of Trade of Thailand (Bangkok)<br>- Department of Science Service<br>- National Institute of Metrology (Thailand)<br>- Department of Medical Sciences<br>- Consumer Organization<br>- Royal Thai Police<br>- Department of Industrial Works<br>- Ministry of Commerce<br>- The Customs Department |

| Strategy | Key performance indicators and Targets | Primary responsible agencies (responsible to key performance indicators) | Supporting agencies (supporting data and network) |
|---|---|---|---|
| **2. Developing and reinforcing measures and monitoring mechanisms and enforcement** | 4. Having agencies and organizations which provide services on analysis, testing, calibrating, and certifying nano label for nanoproducts. | - National Nanotechnology Center<br>- Department of Science Service<br>- Department of Medical Sciences<br>- Thailand Textile Institute<br>- Thailand Institute of Scientific and Technological Research | - Center of Excellence in Nanotechnology of Higher Education Institutions<br>- Central Labaratory<br>- National Institute of Metrology (Thailand) |
| | 5. Having agencies or surveillance and warning systems for nanosafety, which coordinates with authorized agencies to determine measures as well as make recalls, discontinue sales in the market, and eliminate fake nanoproducts. | - Nanosafety Information Center of Thailand (NICT)<br>- National Nanotechnology Center<br>- Office of the Consumer Protection Board | - Royal Thai Police<br>- Nanotechnology Association of Thailand |
| | 6. Having controls on advertising and set nanoproducts advertising guideline | - Office of the Consumer Protection Board | - The Government Public Relations Department |

| Strategy | Key performance indicators and Targets | Primary responsible agencies (responsible to key performance indicators) | Supporting agencies (supporting data and network) |
|---|---|---|---|
| **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<br>- Foundation for Consumers<br>- Bangkok's Consumer Protection Association | - Food and Drug Administration<br>- National Bureau of Agriculture Com modity and Food Standards<br>- Department of Agriculture<br>- Department of Fisheries<br>- Department of Livestock Development<br>- The Customs Department<br>- The Fiscal Policy Office<br>- The Industrial Standards Institute<br>- Department of Industrial Works<br>- Pollution Control Department<br>- Department of Environment Quality Promotion<br>- Occupation Safety and Health Bureau<br>- Department of Labour Protection and Welfare<br>- Office of the Consumer Protection Board |

| Strategy | Key performance indicators and Targets | Primary responsible agencies (responsible to key performance indicators) | Supporting agencies (supporting data and network) |
|---|---|---|---|
| **3. Strengthening and promoting public engagement activities** | 2. Information on nanotechnology and nanosafety and risks are accessible and the public is aware and can utilize them appropriately and promptly. | - Nanosafety Information Center of Thailand (NICT)<br>- Thai Journalists Association<br>- The Press Association of Thailand<br>- Thai Broadcast Journalist Association<br>-The Government Public Relations Department | - National Nanotechnology Center<br>- The Federation of Thai Industries<br>- Office of the National Research Council of Thailand<br>- Ministry of Industry<br>- Ministry of Agriculture and Cooperatives<br>- Ministry of Public Health |
| | 3. Having appropriate nanotechnology and nano-safety materials in regional education centers both in the formal and informal education system. | - Ministry of Education<br>- Department of Academic Affair<br>- Office of the Basic Education Commission of Thailand | - National Nanotechnology Center<br>- Nanosafety Information and Knowledge Management Center<br>- Center of Excellence in Nanotechnology of Higher Education Institutions |

# Chapter 5

# 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 an 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 objectives, integrating operations while aiming to eradicate redundancy.

## 5.1 Strategy 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) **Operate by Focusing on Every Sector's Engagement:** Set clear goals and share responsibilities in order to enhance efficiency. Moreover, establish a 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 be 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 converge issues 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 to bring about integration which results in collaboration, co-ordination and leads to financial support for operations concerning the nanosafety and risk management in Thailand.

## 5.2 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 follows:

1) Organization structure leading to implementation. Beginning from the cabinet level to the local operating level (as per figure 5.1)
2) Integration of the financial support. Nanosafety will involve several ministries and sectors; therefore, implementation needs to be unified by determining a strategy which integrates 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) The 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.

## 5.3 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 results 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 co-ordinate cross-functional work.

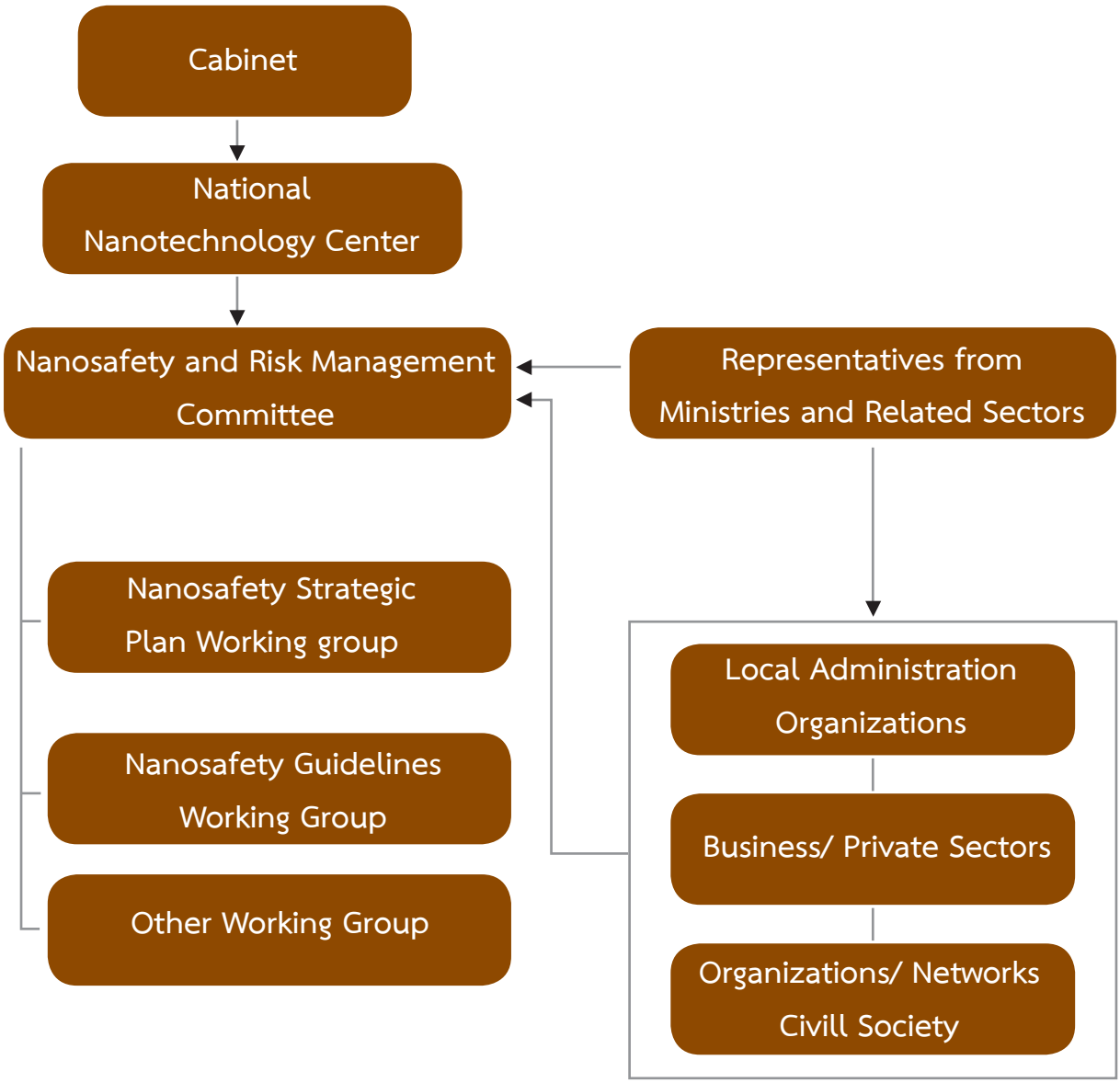



Figure 5.1 Organization chart for implementation

# Appendix 1

## Nanosafety and Ethics Strategic Plan (2012-2016)

## and related organizations

## Appendix 1

### Nanosafety and Ethics Strategic Plan (2012-2016) and related organizations

| Sector | Strategy | | |
|---|---|---|---|
| | Establishing and implementing knowledge management in nanosafety and ethics and nanoproducts | Developing and reinforcing measures and monitoring mechanisms and enforcement | Strengthening and promoting public engagement activities |
| 1) Ministry of Finance | | | |
| • Customs Department | * | * | * |
| • Fiscal Policy Office | | ** | * |
| 2) Ministry of Agricultural and Cooperatives | * | | |
| • Department of Agriculture | | ** | * |
| • Department of Livestock Development | | ** | * |
| • Department of Fisheries | | ** | * |
| • Thai Agricultural and Food Standard Institute | | ** | * |
| • Central Laboratory | | * | |

** Primary Responsible Agencies meaning the sector which is mainly responsible for operating to achieve the objectives of each strategy

* **Supporting Agencies and Networks meaning the sector which is responsible for cooperating to achieve the objectives of each strategy.**

| Sector | Strategy | | |
|---|---|---|---|
| | Establishing and implementing knowledge management in nanosafety and ethics and nanoproducts | Developing and reinforcing measures and monitoring mechanisms and enforcement | Strengthening and promoting public engagement activities |
| 3) Ministry of Natural Resources and Environment | | | |
| • Pollution Control Department | | ** | * |
| • Department of Environmental Quality Promotion | | ** | * |
| 4) Ministry of Commerce | | * | |
| 5) Ministry of Labor | | | |
| • Department of Labor Protection and Welfare | | ** | * |
| ◦ Occupational Safety and Health Bureau | | ** | |
| • Social Security Office | | ** | * |

** Primary Responsible Agencies meaning the sector which is mainly responsible for operating to achieve the objectives of each strategy

* **Supporting Agencies and Networks meaning the sector which is responsible for cooperating to achieve the objectives of each strategy.**

| Sector | Strategy | | |
|---|---|---|---|
| | Establishing and implementing knowledge management in nanosafety and ethics and nanoproducts | Developing and reinforcing measures and monitoring mechanisms and enforcement | Strengthening and promoting public engagement activities |
| **6) Ministry of Education** | | | |
| • Office of the Basic Education Commission | ** | ** | ** |
| • Center of Excellence in Nanotechnology of Higher Education Institution | * | * | * |
| • Nanosafety Information Center of Thailand (NICT) | ** | ** | ** |

** Primary Responsible Agencies meaning the sector which is mainly responsible for operating to achieve the objectives of each strategy

* **Supporting Agencies and Networks meaning the sector which is responsible for cooperating to achieve the objectives of each strategy.**

| Sector | Strategy | | |
|---|---|---|---|
| | Establishing and implementing knowledge management in nanosafety and ethics and nanoproducts | Developing and reinforcing measures and monitoring mechanisms and enforcement | Strengthening and promoting public engagement activities |
| 7) Ministry of Science and Technology | | * | |
| • National Science and Technology Development Agency | | | |
| ◦ National Nanotechnology Center | ** | ** | ** |
| • National Science Technology and Innovation Policy Office | | ** | |
| • National Institute of Metrology | | * | |
| • Department of Science Service | | ** | |
| • Thailand Institute of Scienctific and Technological Research | | ** | |

** Primary Responsible Agencies meaning the sector which is mainly responsible for operating to achieve the objectives of each strategy

* **Supporting Agencies and Networks meaning the sector which is responsible for cooperating to achieve the objectives of each strategy.**

| Sector | Strategy | | |
|---|---|---|---|
| | Establishing and implementing knowledge management in nanosafety and ethics and nanoproducts | Developing and reinforcing measures and monitoring mechanisms and enforcement | Strengthening and promoting public engagement activities |
| **8) Ministry of Public Health** | * | | |
| • Food and Drug Administration | | ** | * |
| • Department of Medical Sciences | | ** | |
| • Department of Disease Control | | ** | |
| • National Health Commission Office of thailand | | | ** |
| **9) Ministry of Industry** | * | | |
| • Department of Industrial Works | | ** | * |
| • Thai Industrial Standard Institute | | ** | * |
| • Thailand Textile Institute | | ** | |

** Primary Responsible Agencies meaning the sector which is mainly responsible for operating to achieve the objectives of each strategy

* **Supporting Agencies and Networks meaning the sector which is responsible for cooperating to achieve the objectives of each strategy.**

| Sector | Strategy | | |
|---|---|---|---|
| | Establishing and implementing knowledge management in nanosafety and ethics and nanoproducts | Developing and reinforcing measures and monitoring mechanisms and enforcement | Strengthening and promoting public engagement activities |
| **10) The Prime Minister's Office** | | | |
| • The Thailand Research Fund | * | | |
| • The Government Public Relations Department | | ** | * |
| • Office of the Consumer Protection Board | | * | ** |
| **11) Royal Thai Police** | | | |
| • Consumer Protection Police Division | | * | |
| **12) Office of the National Research Council of Thailand** | * | * | * |
| **13) The Federation of Thai Industries** | * | * | * |
| **14) Thai Chamber of Commerce** | * | * | * |
| **15) Consumer Organization** | | * | |

** Primary Responsible Agencies meaning the sector which is mainly responsible for operating to achieve the objectives of each strategy

* **Supporting Agencies and Networks meaning the sector which is responsible for cooperating to achieve the objectives of each strategy.**

| Sector | Strategy | | |
|---|---|---|---|
| | Establishing and implementing knowledge management in nanosafety and ethics and nanoproducts | Developing and reinforcing measures and monitoring mechanisms and enforcement | Strengthening and promoting public engagement activities |
| 16) Nanotechnology Association of Thailand | | * | * |
| 17) Foundation for Consumers | | | ** |
| 18) Bangkok's Consumer Protection Association | | | ** |
| 19) The Press Association of Thailand | | | ** |
| 20) Thai Journalists Association | | | ** |
| 21) Thai Broadcast Journalists Association | | | ** |
| 22) Health Systems Research Institube | * | * | * |

** Primary Responsible Agencies meaning the sector which is mainly responsible for operating to achieve the objectives of each strategy

* Supporting Agencies and Networks meaning the sector which is responsible for cooperating to achieve the objectives of each strategy.

# Appendix 2

## Nanosafety and Risk Management Committee

## Appendix 2

### Nanosafety and Risk Management Committee

| | |
|---|---|
| Assoc. Prof. Dr. Varapan Danutra | National Center of Excellence for Environmental and Hazardus Waste Management |
| Dr. Suwit Wibulpolprasert | Ministry of Public Health |
| Prof. Sirirurg Songsivilai | National Nanotechnology Center |
| Dr. Angsana Tokitkla | Office of the National Research Council of Thailand |
| Ms. Urai Churyen | Office of the National Research Council of Thailand |
| Mr. Phasakorn Bunsom | Office of the Consumer Protection Board |
| Ms. Jaruwan Katkeaw | Office of the Consumer Protection Board |
| Ms. Songsri Jumpol | Office of the Consumer Protection Board |
| Mr. Oratai Sinrapanapaporn | Thai Agricultural and Food Standard Institute |
| Ms. Narintip Panee | Thai Agricultural and Food Standard Institute |
| Ms. Chutiwan Juttupornpong | Thai Agricultural and Food Standard Institute |
| Dr. Sumol Pavittranon | Department of Medical Sciences |
| Dr. Yupin Lawanprasert | Food and Drug Administration |
| Dr. Pongpisut Jongudomsuk | Health Systems Research Institute |
| Ms. Pornpit Silkavute | Health Systems Research Institute |
| Mr. Panu Chompupong | Thai Industrial Standard Institute |
| Assoc. Prof. Dr. Lerson Tanasugarn | Faculty of Science, Chulalongkorn University |
| Mr. Somchai Urkasemsin | The Federation of Thai Industries |
| Ms. Petcharat Eksangkul | The Federation of Thai Industries |
| Mr. Chainan Ukosakul | Thai Chamber of Commerce |
| Mr. Somsak Chunharat | National Heath Foundation |
| Dr. Tipicha Posayanon | National Health Commission Office of Thailand |
| Mr. Pana Janviroj | President of the Nation |
| Dr. Chalong Laochariyakul | National Nanotechnology Center |
| Dr. Sirasak Teparkum | National Nanotechnology Center |
| Dr. Nuttapan Supaka | National Nanotechnology Center |

# Appendix 3

## Nanosafety Strategic Plan Working Group

## Appendix 3

### Nanosafety Strategic Plan Working Group

| | |
|---|---|
| Assoc. Prof. Dr. Lerson Tanasugarn | Chulalongkorn University |
| Dr. Sirasak Teparkum | National Nanotechnology Center |
| Mr. Prayut Metineerak | Office of the National Security Council |
| Mr. Ratchanun Anunthawat | Office of the Consumer Protection Board |
| Ms. Opal Waiyawut | Office of the Consumer Protection Board |
| Mr. Padet Suwantada | Royal Thai Army Chemical Department, Ministry of Defense |
| Ms. Surapee Kiratiya-Angul | Department of Agriculture |
| Dr. Pornpimol Athipanyakom | Department of Agriculture |
| Mr. Vuttichai Kaewkrajang | Pollution Control Department |
| Ms. Karnchana Karnviroj | Occupational Safety and Health Bureau |
| Ms. Preeyanun Likhitsan | Occupational Safety and Health Bureau |
| Dr. Kitipong Promwong | National Science Technology and Innovation Policy Office |
| Dr. Yupin Lawanprasert | Food and Drug Administration |
| Ms. Amornrat Leenanithikul | Food and Drug Administration |
| Dr. Aurus Kongphanit | Food and Drug Administration |
| Dr. Nalinee Sripuang | Department of Disease Control |
| Mr. Prasong Norajit | Department of Industrial Works |
| Ms. Rattana Ruktrakul | Department of Industrial Works |
| Ms. Piyaporn Thiencharoen | Department of Industrial Works |
| Ms. Witchar Pichainarong | Thai Industrial Standard Institute |
| Ms. Nutthinun Lienkatawa | Thai Industrial Standard Institute |
| Dr. Tipicha Posayanon | National Health Commission Office of Thailand |
| Dr. Chalong Laochariyakul | National Nanotechnology Center |
| Dr. Nuttapan Supaka | National Nanotechnology Center |
| Ms. Warulee Thongkum | National Nanotechnology Center |

### Coordinator

| | |
|---|---|
| 1. Ms. Pornphen Opaskitpaisan | National Nanotechnology Center |
| 2. Ms. Narisa Bunyongvorapinit | National Nanotechnology Center |