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Too enthusiastic to care for safety: Present status and recent developments of nanosafety in ASEAN countries

Md. Ershadul Karim [a,*], Abu Bakar Munir [a,b], Ahmed Wasif Reza [c], Firdaus Muhammad-Sukki [d,e], Siti Hajar Mohd Yasin [f], Siti Hawa Abu-Bakar [d,g], Ruzairi Abdul Rahim [h]

[a] Faculty of Law, University of Malaya, 50603 Kuala Lumpur, Malaysia
[b] University of Malaya Malaysian Centre of Regulatory Studies (UMCoRS), University of Malaya, 59990, Jalan Pantai Baru, Kuala Lumpur, Malaysia
[c] Department of Electrical Engineering, Faculty of Engineering, University of Malaya, 50603 Kuala Lumpur, Malaysia
[d] School of Engineering & Built Environment, Glasgow Caledonian University, 70 Cowcaddens Road, Glasgow, G4 0BA Scotland, UK
[e] Faculty of Engineering, Multimedia University, Persiaran Multimedia, 63100 Cyberjaya, Selangor, Malaysia
[f] Faculty of Law, Universiti Teknologi MARA, 40450 Shah Alam, Malaysia
[g] Universiti Kuala Lumpur British Malaysian Institute, Batu 8, Jalan Sungai Pusu, 53100 Gombak, Selangor, Malaysia
[h] Faculty of Electrical Engineering, Universiti Teknologi Malaysia, 81300 UTM Skudai, Johor, Malaysia

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ABSTRACT

Nanotechnology has the prospect to vibrate the imagination of human being and has the ability to be used in almost every sector of human need. With its limitless potentials, there are many environmental, health and safety related concerns due to extremely ambivalent effects of nanoparticles. Studies revealed that nanoparticles can enter the human body through the lungs, intestinal tract, and skin. Therefore, the researchers and workers who handle nanoparticles and nanomaterials can theoretically and primarily be affected, whereas on the consumers this will have secondary effects. This paper aims at sharing and evaluating the investment scenario, present status and recent developments in nanotechnology, with specific focus on nanosafety issues in different research projects and national nanotechnology policies, strategies or roadmap in 6 ASEAN countries i.e. Indonesia, Malaysia, Philippines, Singapore, Thailand and Vietnam. In general, it can safely be inferred that like their western counterparts, though these ASEAN countries have realized the importance of investment and institutional set-ups, and already spent huge amount of money in nanotechnology, the concern for nano risk and safety is not still considered a serious issue for them. This paper provides a better understanding and highlights the importance of prioritizing nanosafety issue to the policymakers and the stakeholders of this region.

Abbreviations: ANF, Asia Nano Forum; ASEAN, Association of South East Asian Nations; CoE, Center of Excellence; DOST, Department of Science and Technology; EDB, Economic Development Board; EHS, Environmental health and safety; EU, European Union; ICON, Industry Consortium on Nanoimprint; ICON, International Council on Nanotechnology; IEC, International Electrotechnical Commission; IOM, Institute of Occupational Medicine; IRPA, Intensification of Priority Research Areas; ISO, International Organization for Standardization; LIPI, Research Center for Physics of Indonesian Institute of Sciences; MDGs, UN Millennium Development Goals; MOSTI, Ministry of Science, Technology and Innovation; NANOTEC, National Nanotechnology Center; NICT, Nanosafety Information Center of Thailand; NIOSH, National Institute for Occupational Safety and Health; NKEA, National Key Economic Areas; NND, National Nanotechnology Directorate; NNI, National Nanotechnology Initiative; NRDA, Nanotechnology Regulatory Document Archive; NSTDA, National Science and Technology Development Agency; NTU, Nanyang Technological University; NUS, Singapore National University; OECD, Organisation for Economic Co-operation and Development; R & D, research and development; REACH, Registration, Evaluation, Authorisation and Restriction of Chemicals; SHTP, Saigon Hi Tech Park; TC, Technical Committees; UN, United Nations; UNESCO, United Nations Educational, Scientific and Cultural Organization; UNITAR, United Nations Institute for Training and Research; USA, United States of America; USPTO, United States Patent and Trademark Office.

* Corresponding author. Tel.: +60 18 218 2817.
E-mail address: ershad@siswa.um.edu.my (M.E. Karim).

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1. Introduction

Nanotechnology, the science of manipulating, modifying and utilizing objects at the atomic level, has the potential to solve many existing problems of the developing countries. The wave of the future, nanotechnology is no more *terra incognita*, it is no more an agenda of scientists only, rather it has turned into a multi-disciplinary study. The United Nations (UN) Task Force on Science, Technology and Innovation (part of the process designed to assist UN agencies in achieving the United Nations Millennium Development Goals (MDGs)) addressed the potential of nanotechnology for sustainable development and for the betterment of 5 billion people of the developing countries. It was further discussed on how nanotechnology can assist the developing countries in achieving these goals. Sharing the findings of Salamanca-Buentello et al. (2005), the United Nations Educational, Scientific and Cultural Organization (UNESCO) reiterated the top ten applications of nanotechnology within the UN MDGs, which are (UNESCO, 2006): (a) energy storage, productions and conversion; (b) agricultural productivity enhancement; (c) water treatment and remediation; (d) disease diagnosis and screening; (e) drug delivery systems; (f) food processing and storage; (g) air pollution and remediation; (h) construction; (i) health monitoring, and (j) vector and pest detection and control.

Its limitless potentials lure most of the countries to continuously invest huge amount of money in its research and development (R & D) program. Starting from mid-1990s (Fairbrother and Fairbrother, 2009), the latest data from the Project on Emerging Nanotechnologies developed by the Woodrow Wilson International Center for Scholars shows that more than 1600 consumer products manufactured using nanomaterials are already in the market (PEN, 2014). International Labour Organization (ILO) predicts that by the year 2020, approximately 20% of all goods manufactured around the world will be developed based on nanotechnology (ILO, 2010). Besides, the prospect of nanotechnology has been projected in a number of reports released by popular market research companies like Lux Research, Cientifica, BCC Research Market and also many government reports.

It is a matter of fact that in the absence of any specific legal framework nationally and internationally to regulate nanotechnology, the issue of risk and safety is crucial in the development of nanotechnology. If this issue cannot be settled with considerable satisfaction of the consumers and the workers/researchers, it may have to embrace a similar situation like the genetically modified food or nuclear energy, etc., which were initiated to introduce with huge expectations but could not be completely successful in meeting the demand.

Asia, the largest and most populous continent of the world, is very lucrative to the multinationals due to the availability of cheaper labor market. India and China can be the world's producers of nanoenabled products; Japan, South Korea, Taiwan, Singapore, Iran, Turkey, and Hong Kong are known and powerful players in nanotechnology research. The Association of South East Asian Nations (ASEAN), the eighth largest economy in the world, is a geo-political and treaty based organization of ten Asian economies i.e. Brunei, Indonesia, Malaysia, Myanmar, Philippines, Singapore, Thailand, Cambodia, Laos, and Vietnam. ASEAN comprises of 4,435,624 km^2, with 616,632 thousand people (ASEANStat, 2013). It has a Gross Domestic Product (GDP) growth of 5.7% in 2012 (ASEANStat, 2013). This region is also a very popular tourist destination as every year 85,464 thousand visitors visit this part of the world (ASEANStat, 2013), and the region is very important in terms of nanotechnology R & D due to some distinctive attributes which is discussed in details in the later part.[1]

The new century began with lots of enthusiasm and inspiration as some of the Asian countries like Japan and China started their nano venture officially since 2001 – in line with their western counterpart – through national nanotechnology policy or strategy. The Republic of Korea, Taiwan, Thailand and Vietnam followed Japan and China immediately. Singapore, Malaysia and Indonesia are the newest entry in the list of Asia Pacific nations (Liu, 2009). However, Singapore even started its nanotechnology journey from 1995, which evolved around the National University of Singapore. To add to this discussion, it will be interesting to share here that over the period of time nanotechnology has attracted people from this region and it is turning to be a matter of interest for the people, which is reflected in the Fig. 1. This figure clearly shows the interest of Asia with nanotechnology and three of the countries from this Fig. 1, i.e. Singapore, Malaysia and Philippines will be considered in this paper.

All these issues inspire the authors to examine the government policy or regulatory setup to handle the risks and safety aspects of nanotechnology in these countries. To this end, focus should be given on various issues including the nanotechnology strategy paper, initiatives taken by the governments, the existing occupational health and safety laws, and the performance of the national bodies e.g. Health Administration, Food and Drug Authority, Department of Labor, and Department of Standard, among others, in this regard. To gather ideas on these issues, this paper is divided into three main segments alongside with the introduction and conclusion. Initially, the findings related to risk and safety published in leading academic journals are presented. After that, an evaluation of the investment scenario, nanotechnology framework, national nanotechnology strategies, policies or roadmaps of these 6 ASEAN countries, highlighting the issue of nanosafety considered in their strategies or policy papers will be made. Finally, based on the developments of other parts of the world, some suggestions will be shared at the end of the paper.

2. Risk and safety concerns with nanotechnology

The risk and safety concerns of nanotechnology are almost contemporary with the emergence of it. However, it is a matter of fact that in order to share different kinds of risk and safety issues associated with nanotechnology, the phrase 'nanosafety' is used which is not defined by any authority, rather it is used as the title of some projects and then gained the popularity e.g. EU NanoSafety Cluster. This phrase is commonly used by many people to refer to different issues relating to safety of nanomaterials and nanotechnology. The

[1] Pertinent to mention here that this paper has no connection with the ASEAN as an organization and the word "ASEAN" in the title of the paper was selected to share an idea of the content of the paper with the readers only.

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