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Preliminary Overview of Potential Recommendations and Future Directions in Pursuit towards the Progression of Nanotechnology in Malaysia

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Abstract — The emergence of a new technology is characterized by the authenticity of its atypical features that makes it distinguishable and distinctive from other existing technologies. Not a single emerging technology is characteristically identical as the other. This form of an unusual complexity that embeds extremely promising potential is what makes it stand out as a new and maturing technology. Even if it is a stand alone or a hybrid formation or a composition of multiple disciplines put together, this technology becomes a resourceful contributor and a source of magnificent derivative innovations and services. One that does not need any introduction to scientists and researchers worldwide is none other than nanotechnology. Nevertheless in terms of awareness and level of knowledge absorption, the term "nano' lingers only in the minds of the common public as just a buzz word. The scientific activity that takes place at the microscopic nano-scale has spurred the gigantic interest of governments all over the world because of its soon to be seen progressive and massive visionary benefits. Rest assured, comes along with it is a degree of foreseeable destruction if the right kind of planning fall short in taking place. Additionally, the translation of lab nano-prototypes into fully fledged innovations has been slow paced resulting in sluggish infiltration into the commercial arena due to many identified barriers. Since the 6 year establishment of Malaysia's National Nanotechnology Initiative (NNI) in 2006, planning has been taking place; yet there has not been a policy plan for nanotechnology that has been crafted out to address these pitfalls. Therefore, this paper suggests a preliminary overview of potential recommendations and policy directions in pursuit towards the future progression and sustainability of nanotechnology in Malaysia.

Index Terms — Nanotechnology, policy, NNI, recommendations, multidisciplinary, innovation

1. INTRODUCTION

A set of recommendations have been meticulously outlined for the main aim of progressing and augmenting the development of nanotechnology to a higher level in terms of R&D policy, incentives, initiatives, endowments, safety, awareness, linkages, infrastructure, education, entrepreneurship and availability of statistics. A thesis study diagnosing the barriers of R&D and commercialization of nanotechnology was conducted from 2011 – 2012. These preliminary recommendations were generated based on those findings.

2. RECOMMENDATIONS FOR FUTURE DIRECTIONS

The following are recommendations to enhance the development of nanotechnology in terms of research and development (R&D) and commercialization:

i. R&D policy concerning nanotechnology must take into consideration the multiplicity and diversity of economic sectors so that standards and procedures can be developed and molded to suit each sector appropriately. The R&D policy will also be dissimilar from county to country's environmental setting. Therefore, it is unlikely that one country's R&D policy will fit the needs of our country's nanotechnology R&D agenda. However, there are the several countries' R&D policies that our country can indoctrinate in terms of improving its effectiveness and efficiencies with the foremost mission of positively bringing out not just inventions but innovations that will be successful in the marketplace. [It must be said that even developing countries have suffered pitfalls in terms of R&D and commercialization of nanotechnology]. Therefore, R&D policy need not just only spell out the needs of research and development in a particular area
but also pronounce clearly and explicitly that its ultimate agenda is to steer its way towards the commercialization of a R&D prototype or

invention. With that in mind, the nanotechnology R&D policies should be meticulously planned with various parties involved (better still if every economy sector is represented) without allowing any room for ambiguities that can possibly cause mediocrities concerning nanotechnology prototypes and products.

ii. The nanotechnology R&D policy should take into careful contemplation the time factor involved between research and commercialization with special deliberation on the requirement for clinical testing, robustness of the technology, compatibility and other post - development technical procedures that make nanotechnology a cut above the other technologies in terms of complexity. It should put in place the necessity to adhere towards a certain time limit to produce a product from the time of its basic research until applied research right up to off shooting a fully fledged product in order to prevent resources provided by the government from becoming unworthy of its cause. This action will also impact on the positive utilization of government resources.

iii. The nanotechnology R&D policy needs to manifest a clause that if ever universities are in any way paralyzed by way of not being able to provide a prototype that suit the needs of the market, then they will be indoctrinated to amalgamate or bring their scientific ideas to the attention of a firm (prior development) who will be able to furnish them with the business perspectives and current market trend so as to prevent these prototypes or inventions from sitting in the shelf later. In other words, these firms will guide these universities (not in terms of scientific expertise) but with the current market needs prior development of a prototype. This way, the cost of making the product can be advocated earlier on and a straight forward financial rundown can be envisioned prior development. This will impact on the positive utilization of government resources endowed on universities.

iv. In order to bring out an invention or a product on time for market release, the government should be able to provide incentives or assistances from the perspective of reducing the time factor. These incentives and assistances should come in the form of assigning product engineers and design specialist to work closer with scientists in the labs in the course of their research and development. These product engineers or design specialist can be either the direct product of a university podium itself or the product of years of firm experience. However, the selection of these personnel should be based on their sharp expertise on nanotechnology. Scientists can request them for their projects with the condition that these research projects will be completed within a stipulated time frame.

v. Since the primary reason why governments provide endowments to universities to perform research is for them to be innovatively productive – meaning to say, bringing out innovations that will be successful in the market place. This is the era of commercialization. Except for the medical research of a particular drug to cure cancer and AIDS which takes numerous years, these government endowments are not for the purpose of allowing scientists to remain stationary at the phase of nanotechnology basic research but to progress to the stages of applied research. If ever this being the case, then the government research and development council should hold an investigative committee to enquire the solid reasons for delaying applied research considering that a great amount endowments have been supplied to research universities to bring out obvious applications. This would help construct a precipice between research in the university and commercialization in our country.

vi. An independent agency (separate entity) needs to be set up to look into the safety of nanotechnology inventions prior to mass production or market release. Malaysia's recently initiated National Nanotechnology Directorate (NND) cannot absorb all these responsibilities. Exploring and probing into the safety of nanotechnology should be a sole and designated role or portfolio authorized to an independent agency. Since it will take a while for the public to become aware of the issues surrounding nanotechnology, the government should take full responsibility in determining whether or not these products are safe and healthy for public usage. At the outset or the beginning of its initiation, it would be advisable to seek the advice of other countries' experts who have experiential knowledge of its disastrous characteristics and behaviors so as to prevent the anomalies circulating nanotechnology from out bursting within our country's environment. These experts who will form the agency need to come from a multidisciplinary array of know how's

entailing biology, chemistry, physics and technology management to better understand the incongruities and discrepancies of this technology such as exploring how the technical and precision-al intricacies that influence the nano chemical or nano – biological activity can be better managed. The agency will be given the sole authority for certifying nano products. Some products are labeled nano but not necessarily contain any nano materials or nano particles. There is no restriction or any provisions for this at the moment. Therefore, products that claims to be embedding nano material and which is created to boost the impact of the solution for the purpose intended for need to be thoroughly examined by the agency. If found that there is no nano material or particle contained in the product, the agency should issue a marker (sticker tag) on the product indicating this for the awareness of the people or even stating its possible side effects in the case of prolonged use. Or else, how will people come to know? However, this agency should be positioned under the technological wing of a higher ministry who will be able to monitor its activities.

vii. Awareness needs to be spread to the society as a whole on what nanotechnology is all about. The aspect of awareness can only be thoroughly said to have reached a saturation point if only there is at least a certain amount of understanding absorbed by the many different types of people who form the society at large. They have to be rationally warned of the side effects and dangers of unapproved and uncertified nanotechnology products or told to realize its gains in order to fully embrace its potential. Therefore, the government needs to start organizing two way interactive talks on the subject of nanotechnology and its role in society so that it is not entirely misconstrued. The talks should be structured in a way to be able to provide a surface view of the subject in lay man's terms. Schools, organizations, non research universities and shopping complexes are the best platforms to conduct this initiative but it has to be done in a continuous manner because people tend to forget in the long term. The next best platform would be the media – channels that are widely viewed by the people. Another appropriate method would be to construct unsophisticated yet informative booklet or CDs which will be easy to comprehend and understand - on the subject of nanotechnology and provide them to schools and non research universities. This successful turnout of this agenda could possibly become a catalyst towards increasing the demand and supply of nanotechnology products in the future.

viii. There should be a fixed criterion and requirement that a product needs to comply with in order to be categorized as a nano product. There should be an explicitly stated specification of what percentage (%) of nano component needs to be embedded in order to be declared as a nano product.

ix. Government initiatives and its missions with regards to nanotechnology need to be in coordination with one another. Except for grants being issued to universities by the ministries, currently there are no obvious linkages between the two. Many research activities are being conducted by research institutes (based in universities) but they are not being scrutinized or monitored to find out how productive are these research activities. Therefore, there should be a comprehensive plan crafted by the endowment agency/ministry to track the progress of these research funded activities that includes making physical visits to scientists' labs/workshop where the research is being conducted; and grants to be segmented conditionally based on various phases of research outputs (and not be made in lump sum). This will augment the standards of nanotechnology research productivity in our country.

x. Since many universities are said to be lacking very crucial infrastructure required to conduct nano research, these pertinent infrastructure for nanotechnology should be purchased and given to universities directly by the government instead of assigning the universities the responsibility to make the purchase themselves; and also restructure the high allocation given to universities. Meaning to say, the allocation can be restructured in a way that it will consider only the cost of materials, human capital (excluding equipment) and cost of maintenance. Being very exorbitantly costly, the universities have complained of not having enough from their allocation to set aside for paraphernalia. Therefore, this dilemma can be resolved if the endowing party provides the university in the form of paraphernalia instead of monetary. Once this matter is dealt with, then the government can proceed to examine to what extent has this

initiative made a difference to the standard of nanotechnology research productivity.

xi. University PhD and MSc students coming from science backgrounds should be instructed to study the maintenance manual of the necessary equipment so that in lieu of suppliers, graduates will able to conduct the maintenance on the equipment as part of their practical training or hands on training experience. This will ensure that these postgraduates will understand first hand of the ins and outs of the functionalities of microscopy equipment used for nanotechnology.

xii. Nanotechnology equipment that far exceeds the minimum cost threshold of government estimated expenditure can be placed in a centralized unit of each university. This can prevent the hassle and time depletion for one university from visiting another university to use specific equipment. Instead of purchasing equipment for each science faculty/department, one unit can be utilized by all science faculties according to time allocations. This aspect is taking in consideration the verity that these equipment are not necessarily used 24/7.

xiii. Above paraphernalia, it is the scientists, researchers, technopreneurs and entrepreneurs who are greatly required in the field of nanotechnology. In order for many transformations from prototype to product to flourish, the number of hours and number of specific expertise need to be amplified.

xiv. Encourage large local companies (e.g oil and gas) to prioritize nanotechnology research as part of their policy and provide opportunities and grants to PhD research students to work with them in nanotechnology. In this sense, professors from our country's premier universities can become affiliated with these companies on a contract basis. On top of this, these large companies can endow universities with research grants to conduct further research in nanotechnology.

xv. The Registrar of Companies need to annually assess the number of companies involved in nanotechnology in this country and find out how many are legitimately registered nanotechnology companies. Physical annual visits need to take place to see for themselves whether these companies really exist.

xvi. The Department of Statistics (DOS) and the Ministry of Science, Technology and Innovation need to measure the number of scientists/engineers involved in nanotechnology locally and globally, number of student enrollments and number of degrees/majors conferred in the area of nanotechnology in universities (if any). Many universities claim that they have many graduates specializing in the field of nanotechnology; however there is no evidence to support this claim. Therefore, it would benefit the science community if these two (2) organizations were to carry out a census to measure these statistics even if the number is small; so that the science community is aware. If the cost of carrying out census of this sort is excessive, then the government needs to also consider this cost in their annual budget allocated for nanotechnology.

xvii. In addition to this, apart from the Department of Statistics (DOS) and the Ministry of Science, Technology and Innovation providing information on spending by each country on nanotechnology, it will be more beneficial if governmental statistical surveys and census reports begin tracking figures on 'how' each country spends the total amount of governmental spending on nanotechnology.

xviii. Government should provide tax exemptions for SMEs that conduct R&D in nanotechnology. These tax exemptions should be offered for at least 10 years (not 5 years which is the minimum number given to SMEs conducting any type of R&D) since it takes a lot of high investment to venture into nanotechnology and returns could only be seen in a long term basis. However, in this case, the Registrar of Companies needs to collaborate with organizations like MIDA to monitor the progress and existence of these companies. It is of no use giving out tax exemptions to firms that claim to be conducting R&D in paper but do not conduct any type of R&D in reality.

xix. From the perspective of funding, financial aid by public and private to startups to be classified into different stratums; one of them being nanotechnology startups. Owing the fact that financial institutions have provided many forms of fiscal aid to SMEs during the past decade; it's time for these institutions to further prioritize their SME aid into different stratums. Meaning to say, focus should be directed towards the SMEs/startups involved in nanotechnology.

xx. The main reason for SMEs for not venturing into the field of nanotechnology is because high technology can be risky business. Therefore, the Ministry of Finance should be able to provide some

kind of incentive such as "*guarantor-ship*" or a helping hand if in case these companies fail.

xxi. The Ministry of Education together with the higher tertiary universities should begin crafting ways to develop a creative curriculum for kindergarten students to study not the the basic but the "pre – basic" aspects of nanotechnology. At present, it will not be seen as useful but in the near future, however, it will serve worthy in the long run. When pre- school students are able to play video games and computer games - that which was unimaginable 50 years ago, but which is comprehensible today. The integration of nanotechnology in the pre – school curriculum will be able to help boost their mind's eye of the movement of tiny particles (referring to atoms and molecules) picturesquely and serve as "pre – foundation" or preparation to boldly take on science subjects when offered and taught in schools.

xxii. The subject of nanotechnology should be incorporated into the undergraduate curriculum particularly in Management, Information Technology, Social Sciences degrees and also in the MBA curriculum. It should be provided as a core subject or offered to students as a minor/major option.

xxiii. The missions of each individual member of an industry - academia partnership should be made clear right from the beginning. The different directions headed by both industry and academia should be able to ultimately reach a common goal. Even though research publications still measure up as a standard benchmark used in university rankings and there are very few scholars cum patentees in our country especially in the field of nanotechnology; over the years, academia has also recognized the importance of patenting. But it is the industry that is not willing to have a positive outlook towards the importance of academic publications. Industries in Malaysia should be made aware that many inventions or successful innovations have been the result of conversions from paper to prototype. Industries pride themselves with their own 'publications' but it is the university academic research publications that are certified as *qualified*. If ever industry is hesitant in disclosing data for the purpose of university publications, then this is where the relevant parties should identify their needs and together craft a constructive and productive work plan to address this issue. As it is, there are so many partnerships, but no evident innovations as proof of output.

3. CONCLUSION

These preliminary recommendations and potential policy directions stated above are the creative epitome of what needs to be done and holds lots of promise if correctly implemented by the rightful authorities.

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