The Essentials of

SCIENCE, TECHNOLOGY AND INNOVATION POLICY

OMAR ABDUL RAHMAN

ABOUT THE AUTHOR

Omar Abdul Rahman,Tan Sri, is a B.V.Sc. from Sydney University, Australia and a Ph. D. from Cambridge University, United Kingdom (Magdalene, 1963-1966; Visiting Fellow, Wolfson, 1979). He is the Founding President and Senior Fellow of the Academy of Sciences Malaysia, the Founding and current Chairman of CPTM Ltd, the Founding Joint Chairman of MIGHT and the Coordinator of the STI Policy Unit of the UNESCO-Malaysia International STI Centre (ISTIC). He was Science Adviser in the Prime Minister's Department, Malaysia from July 1984 to Jan 2001. His career began as a research officer in the VRI, Ipoh in 1960. He was appointed professor and founding Dean of the Faculty of Veterinary Medicine and Animal Sciences at Universiti Pertanian Malaysia in 1972 and became Deputy Vice-Chancellor Academic Affairs in 1982. He was President and CEO of the Malaysia University of Science and Technology (MUST) in 2007–2009. Tan Sri Omar is Emeritus Professor of UPM, a founding Fellow of the Islamic World Academy of Sciences and Fellow of the Academy of Sciences for the Developing World (TWAS). He was a member of the United Nations Committee on Science and Technology for Development (UNCSTD) and UNESCO's World Commission on the Ethics of Scientific Knowledge and Technology (COMEST). He is currently a member of the National Science and Research Council, Malaysia.

To TUN DR. MAHATHIR MOHAMAD
From Dr. Madrakin,
This book is the result of 16½ years
of working under you. Terima kasih

The Essentials of Science, Technology and Innovation Policy

OMAR ABDUL RAHMAN

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Commonwealth Partnership for Technology Management (CPTM)

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Academy of Sciences Malaysia

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TUN DR MAHATHIR MOHAMAD

MESSAGE

When on 28 February 1991, I presented the paper *Malaysia: The Way Forward* to the then Malaysian Business Council, I suggested the idea that Malaysia should be a developed nation by the year 2020. That was later acclaimed as Vision 2020. To become a developed nation in our own mould by 2020, I had spelled out nine challenges[1] to be overcome. Two of these have relevance to this book—The Essentials of STI Policy.

Challenge No. 6: ...*establishing a scientific and progressive society, a society that is innovative and forward looking, one that is not only a consumer of technology but also a contributor to the scientific and technological civilization of the future.* This is what Tan Sri Omar has called Policy for STI.

Challenge No. 9: ...*establishing a prosperous society, with an economy that is fully competitive, dynamic, robust and resilient.* I know fully well that this is not possible without a strong STI capability. This is what I believe Tan Sri Omar referred to as STI for Policy.

Tan Sri Omar has emphasized STI for Policy as a compelling reason for Government to devote time and resources to establishing a Policy for STI. I believe this is a valid argument. In my time I have myself devoted much effort in strengthening the STI infrastructure and resources in the conviction that STI is a driver for economic growth. I must have, I suspect, caused some discomfort to some of my scientific personnel for being hands-on in pursuing some projects related to STI.

The crucial role of STI in economic growth is abundantly demonstrated by Malaysia's neighbours to the east—Japan and South Korea. Japan in its time, and even now, is an economic giant and South Korea is in economic ascendency. But both countries have little by way of natural resources. They have however promoted, developed, nurtured and strengthened their human resource, infrastructure, funding and management of STI so that it now is the driver of their economies. This fact should not be lost on the leaders of all developing countries. Attention to STI policy matters in national development planning must be championed from the very top. By pointing out the key elements that require attention, The Essentials of STI Policy will help make easier the task of championing this factor in development.

DR MAHATHIR MOHAMAD
15 February 2013

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FOREWORD

The Academy of Sciences Malaysia (ASM) and Malaysian Industry-Government Group for High Technology (MIGHT) have been waiting for a long time for Tan Sri Omar, our founding President and Senior Fellow, and founding Joint Chairman, respectively, to put down on paper his thoughts on STI policy and related matters, based on his long experience as Science Adviser to our fourth Prime Minister, Tun Dr Mahathir Mohamad. This book on the Essentials of STI Policy is what the doctor ordered. It is not a chronicle of his time as Science Adviser (although that would have been interesting reading in itself!) but rather a distillation of the issues that must be considered in the formulation of a National STI Policy.

An important factor in moving the national STI agenda is the presence of a strong champion. We have been fortunate in Malaysia in having Tun Dr Mahathir as the supreme champion for STI. Many institutions and processes were put in place when Tun Dr Mahathir was Prime Minister of Malaysia. The momentum that has been built must not be lost. Unless STI continues to be emphasized in national development planning and bold steps taken to strengthen it, we may not achieve the targets we have set for ourselves in our agenda for national development.

In this context the strengthening of the STI governance system is critical. Tan Sri Omar has given an example how this might be organized. To move the STI agenda, apart from the need for a supreme champion, the governance structure for STI must ensure appropriate authority across all sectors of government. This is because STI cuts across all government ministries and this in turn, must link effectively with the private sector. Fragmentation of policy bodies for the different components of the STI landscape must be urgently addressed, consolidated and harmonized.

The Essentials of STI Policy is a valuable addition to the literature on STI I believe it will prove to be a useful practical guide to the formulation of STI policy, particularly for countries in the developing world. Of course, it must be customized to suit local context but the key elements which are clearly spelt out in this book must be given serious consideration and incorporated into the STI Policy.

TAN SRI DR AHMAD TAJUDDIN ALI
President, Academy of Sciences Malaysia
and
Joint-Chairman, Malaysian Industry-Government Group for High Technology

FOREWORD

The Commonwealth Partnership for Technology Management (CTPM) colleagues in the Smart Partnership Movement and myself are very proud and honoured to be part of the unique evolution of the STI Policy framework in Malaysia, since the late 1980s, under the guidance of Tun Dr Mahathir Mohamad as Prime Minister and in the implementation of which, our Chairman Tan Sri Omar, as his Science Adviser, was very much involved.

The wisdom accumulated over more than 16 years through sharing the evolution of Malaysia's STI policy framework is synthesized in a unique way by Tan Sri Omar in this book – the Essentials of STI Policy. For the CPTM members and Smart Partners, this book is especially significant because it is derived from his real-time experience in the Office of the Science Adviser, Prime Minister's Department, Malaysia, and therefore it has the highest degree of authenticity as well as authority, legitimacy and credibility.

Malaysia witnessed rapid development under the leadership of Tun Dr Mahathir who is acclaimed as "the Father of Industrialisation" and champion of STI, his effort complementing the emphasis in agricultural development of his predecessors. The country's technology management principles and practice framework described in the book revealed the many STI initiatives introduced during his premiership with Tan Sri Omar as his Science Adviser. Most of the STI initiatives were implemented through collaboration among Malaysian government agencies, businesses and professionals, as well as with non-Malaysian partners. This collaboration was based on a new networking approach referred to as Smart Partnership, which became the main ethos and practice of CPTM members in the Commonwealth and beyond. In this book, Tan Sri Omar has emphasized Smart Partnership as the preferred mode of implementing STI policy initiatives.

In my view, technology could be looked at as having three meanings: technology as a means to fulfill a human purpose, technology as assemblage of practices and

components and technology as the entire collection of devices and engineering practices available in a given context. Therefore, Tan Sri Omar's Technology Management framework is based on "technology inclusiveness", which refers to policy frameworks and approaches for using innovation to foster "inclusive growth", not only strong growth, but "resilient growth", "smart growth". This approach requires synchronization through dialogues, joined up thinking and action, towards a common Vision, with measures to support new entrants with riskier projects in advanced materials (such as composites), nanotechnology, information and communication technologies, high performance computers, synthetic biology and virtual manufacturing.

Since 1995, CPTM became the platform for Tan Sri Omar to put forward his ideas and the CPTM's members provided him a sounding board. This was possible because CPTM members themselves had their own hands-on experience in STI policy matters and their implementation. This interaction has been mutually enriching, sustainable and very smart. This book is therefore rich in practical pointers for STI policy formulation and implementation. CPTM thanks Tan Sri Omar for putting in a nutshell the Essentials of STI Policy for the benefit of its members in the Commonwealth and beyond.

On Behalf of CPTM Smart Partners Colleagues

DATUK DR MIHAELA Y. SMITH
CPTM Chief Executive and Joint Dialogue Convener, Smart Partnership Movement

FOREWORD

Tan Sri Omar and I started the journey together to establish the Academy of Sciences Malaysia (ASM) in 1991. When ASM was officially established under the Academy of Sciences Malaysia Act in 1995, He was founding President and I was founding Secretary-General. Together we nurtured ASM holding firm to ASM's mission statement "the pursuit, encouragement and enhancement of excellence in the field of science, engineering and technology for the development of the nation and the benefit of mankind". With his vast expertise and experience in the formulation and implementation of science and technology policy in Malaysia, it was not surprising that ASM's primary focus was "Science Advice to Government".

When the International Science, Technology and Innovation Centre for South-South Cooperation under the Auspices of UNESCO (ISTIC) was launched in Kuala Lumpur on 22 May 2008, Tan Sri Omar, then the President of the Malaysian University of Science and Technology (MUST), immediately offered to anchor the Science, Technology and Innovation (STI) Policy Agenda of ISTIC. ISTIC subsequently established the STIP Unit under Tan Sri Omar to offer advice and guidance to policy makers from G77 countries. It was ISTIC's ambition that the STIP Unit would be able to offer practical assistance to UNESCO in the formulation of national STI policies for UNESCO member states. This has not come to pass. Nevertheless, on behalf of ISTIC, Tan Sri Omar did travel to Mongolia and Sudan to participate in workshops to review their national STI policies formulated by UNESCO.

The annual ISTIC STI Policy workshops for high level STI policy makers in Kuala Lumpur under Tan Sri Omar have been very popular for participants from G77 countries. The participants have found the Malaysian STI policy template, which is also that of Tan Sri Omar, very focused and doable. In sharing Malaysian STI policy experience with them, we open it for examination, warts and all. We have also in these workshops examined national STI policy implications for industry, whose engagement has often been neglected and which Tan Sri Omar has persistently championed. The most innovative aspect has been the grouping of participants to analyse and provide STI policy advice to particular developing countries during the workshops. ISTIC has promised these enthusiastic STI "consultants" that ISTIC will organize "consultancy" missions for them to designated developing countries under Tan Sri Omar.

I was fortunate to have been appointed by then UN Secretary-General Kofi Annan as Co-Chair of the UN Millennium Project "Science, Technology and Innovation" Task Force under Professor Jeffrey Sachs, his Special Advisor for the Millennium Development Goals (MDG). In the STI Task Force Report "Innovation: Applying Knowledge in Development", the Science Advice and Science Governance recommendations were based on the work of Tan Sri Omar during his tenure as Science Advisor to Malaysian Prime Minister Tun Dr Mahathir Mohamad. I am pleased to see the UN Millennium Project STI Task Force Report in the Bibliography.

ISTIC look forward to this book "The Essentials of Science, Technology and Innovation Policy" being the basic reference publication for all future ISTIC STI Policy training programmes.

Dato Ir. Lee Yee Cheong,
Chairman, ISTIC Governing Board.

PREFACE

This book started as The Five Templates of Science, Technology and Innovation Policy which I wrote as a contribution to my biography which is been written by Dr Ahmad Ibrahim, Chief Executive Officer of the Academy of Sciences Malaysia (ASM).

What prompted me to write The Essentials of Science, Technology and Innovation (STI) Policy, the longer version, was firstly because of the discussion and consultation in 2012 on Malaysia's Third STI Policy in which I was deeply involved. The more one deliberated on this topic the more one got the sense of déjà vu. Many of the ideas, concepts or proposals coming out of the deliberations have been discussed and argued about and even articulated in the earlier two science policies.

Secondly, the younger generation in Malaysia coming on the STI Policy scene is not aware of what had happened before and what had gone into previous policy documents. They are very much aware, however, of the writings of international experts on the subjects of science policy.

I am not claiming ownership of all the ideas presented in this book. Many have been picked up from public domain documents but have been dissected, expanded, modified and rearticulated and implemented after various interactions with colleagues both in Malaysia and abroad. These interactions included the Annual Scientific Conferences of The Islamic World Academy of Sciences, the Smart Partnership International Dialogues in Malaysia and Africa and Think-Tanking Sessions at the Commonwealth Partnership for Technology Management's (CPTM's) Smart Partnership Hub in London, as well as many seminars and workshops organized by the Academy of Sciences Malaysia, the Malaysian Industry-Government Group for High Technology (MIGHT) and the International Science, Technology and Innovation Centre (ISTIC), Kuala Lumpur.

The interaction with CPTM network members I consider as especially valuable. CPTM is an organization originating from the now defunct Commonwealth Science Council. It deals with issues in STI for development in the emerging economies focusing on technology management best practice as an agent for change, and national vision as a starting point for action on socio-economic transformation. Many networking members of CPTM have hands-on experience in dealing with STI issues and strategies and their implementation.

I quote from Ahmad Ibrahim, "His experience (Omar's) in STI Policy in Malaysia was shared with colleagues in the Commonwealth through his work with CPTM and his active participations in the Smart Partnership International Dialogues which are co-organised by CPTM. Through the Dialogues which promote learning through sharing as well as through his involvement in other international organizations, Omar has been able to increase his grasp of the main requirement of STI Policy thus making him more effective in his work (as Science Advisor). This has resulted in continuing improvement of the STI infrastructure in Malaysia and more learning and sharing with colleagues in the CPTM network".

Both Malaysian and other countries' examples are used to illustrate the various components and elements of the STI policy described in the book.

I hope this book is useful as a practical guide to writing an STI Policy embodying the essential elements without the trimmings of lengthy academic analysis and argument which can be added if required, according to the flavour of the month. The "Essentials of STI Policy" is also aimed at emphasizing the role of STI as a major enabler of national development, and therefore the importance of STI policy as an integral part of national development policy, so as to be meaningful to development policy makers rather than just preaching to the converted, namely the scientific community.

ACKNOWLEDGEMENTS

I owe a debt of gratitude to Dr Ahmad Ibrahim of ASM who persuaded me to put my thoughts on STI Policy and related matters on paper for my Biography he is writing entitled *"From Science to Science Policy—One Man's Passionate Journey"*. The "Five Templates of STI Policy" for the Biography is expended into this book.

Valuable comments to the draft of the manuscript were received from The Hon Prof Heneri Dzinotyiweyi, Minister of Science and Technology of Zimbabwe; Dr Mustafa El Tayeb, President, Future University, Khartoum, Sudan, formerly Director, Science Policy and Sustainable Development, UNESCO, Paris; Datuk Dr Mihaela Y Smith, Chief Executive of CPTM Ltd; Mrs Catharine M. Cunningham, CPTM Companion, former member, Office of the Government Chief Science Adviser, Cabinet Office, London; Dr Ashok Jain, CPTM Companion, formerly Director of NISTADS, New Delhi, India; Dr Hassan Mshinda, Director General, Tanzanian Commission for Science and Technology, Dar es Salaam, Tanzania; and Prof Yong Hoi Sen, Senior Fellow, Academy of Sciences Malaysia. Adznir Mokhtar of Prima Consulting helped with the figures and the updates of the Technology Management Best Practice Checklist for Malaysia in Annex 1.

I thank Muhammad Fardy Md Ibrahim, Norhafiza Awang Idris, Nur Shafawaty Ahmad and Asmah Amat of the Academy of Sciences Malaysia for assistance with the manuscript.

Last but least my thanks to Tun Dr Mahathir Mohamad, Malaysia's Fourth Prime Minister. It was while working as Science Adviser in the Prime Minister's Department from July 1984 to January 2001 that I had to learn quickly what I could about STI policy and related matters in order to discharge my duties. Tun Mahathir's open mindedness and preparedness to listen made the work of the Science Adviser both challenging and fulfilling.


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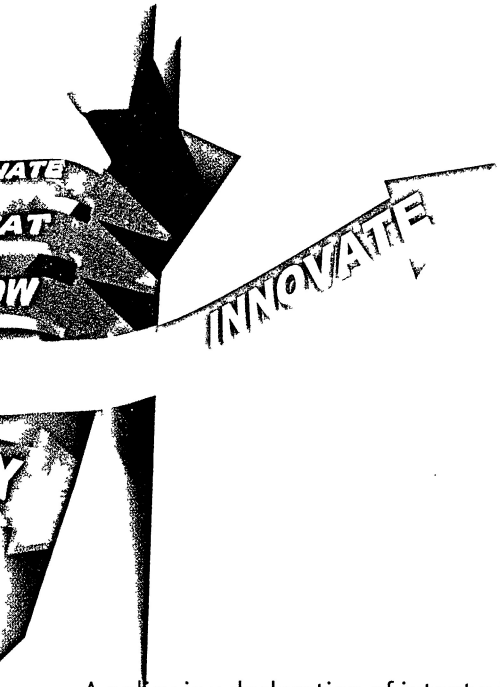

INTRODUCTION

A policy is a declaration of intent with legitimate justification. To be relevant an **STI Policy** cannot be a stand-alone policy. It must be an integral part, or at least in support of, the national development policy. It provides the basis for informed decision in managing an important instrument of **Socio-economic transformation**, the current idiom for the objective of national development.

There are four **critical groups of technologies** essential for socio-economic transformation:

1. Technologies for meeting basic needs such as food, water and shelter;

2. Technologies for quality of life, e.g. education, healthcare, stabilization of population size, environmental sustainability;

3. Technologies for wealth creation in support of economic growth and competitiveness; and

4. Technologies for good governance in both public and private sector.

Within the four technology groups, the needs of each nation varies according to its stage of development. These needs once identified become the **National STI Agenda**.

Technology however cannot be considered in isolation. It is now accepted to be part of a system consisting of science, technology and innovation. The national STI agenda, which the STI policy must identify and deliver, is therefore the sum total of the sciences, technologies and innovations required to achieve socio-economic transformation. Because of this STI policy consideration now embraces the whole system.

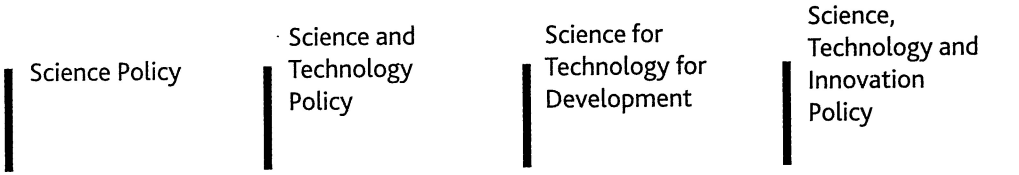

Figure 1. The evolution of science policies.

It has not always been this inclusive. The evolution of STI policy can be briefly traced thus: Initially it was just a 'science policy' emphasizing the need to do 'good science'. Then it was a Science and Technology (S&T) policy, linking knowledge (science) to its application (technology). Much later there was a move for a policy for "science for technology for development" focusing on harnessing S&T for national development. This gave rise to the concept of science for development (role of S&T in achieving development objectives) and development for science (measures to strengthen the S&T capacity).

Currently it is "science, technology and innovation (STI)" policy, implying that doing good science is not good enough. Science must translate into innovative technologies in the marketplace. In other words, STI must be an instrument of the economic transformation programme (ETP) and part of the economic system and therefore STI for Policy, and in turn STI must be strengthened so it can deliver the goods, hence a Policy for STI *(Figure 1)*.

Underpinning the STI for Policy and Policy for STI are two important parallel systems namely, the **research, development and commercialization (RD&C)** system and the **science, technology and innovation (STI)** system. RD&C was at one time referred to as research, development and engineering (RD&E). Research gives knowledge (science) and development results in technology which becomes innovation when commercialized or in anyway usefully utilized *(Figure 2)*.

Actually, central to the RD&C system is **invention** which is the result of systematic R&D or trial and error tinkering. Invention becomes **innovation** when applied or commercialized.

The story of the slow acceptance in Europe of the concept of STI and of its role in the economy and national

development is well documented (King 2006). Science was at one time considered only as part of social or education policy. Of course the situation has now completely changed. Even in education, universities are now deeply involved in STI and RD&C. The so-called third generation universities are distinguished by excellence in STI and RD&C (Wissema 2009).

STI Policy formulation must therefore be inclusive of the STI and RD&C systems and provide for the total eco-system to deliver the **National STI agenda**. Once this is done a number of sectoral policies may be formulated such as for innovation, commercialization or research funding.

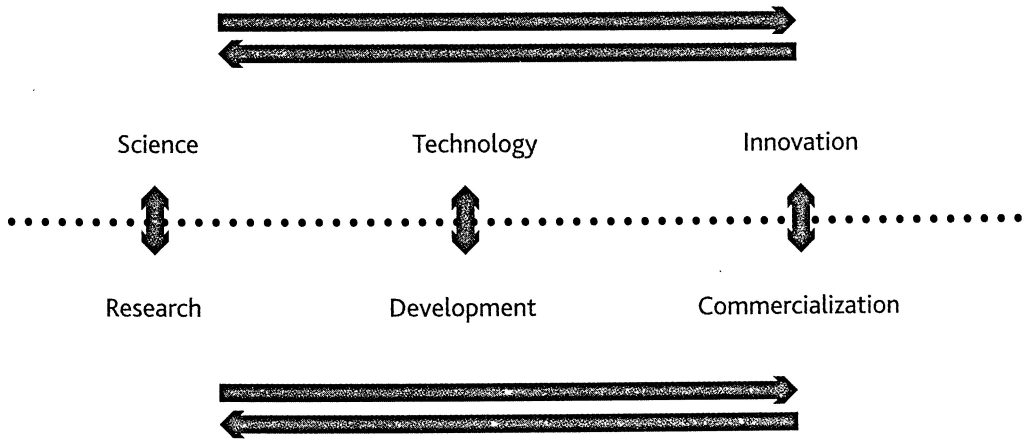

Figure 2. The STI and RD&C parallel systems.

PART 01

THE FIVE TEMPLATES OF STI POLICY

Template 1 The six components of STI policy

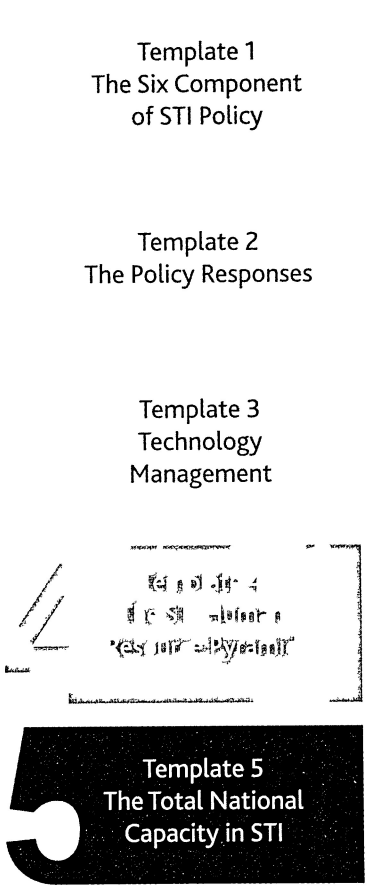

Figure 3. The five templates of STI Policy.

There are various ways of articulating an STI policy. It can be very academic and analytical in approach or concise and practical leading to a set of clear implementation strategies. However an STI policy which is an integral part, or supportive of, a national socio-economic transformation programme, must deal with the six basic components. These are **STI for Policy, Policy for STI, STI and the Private Sector, STI and the Community, International Collaboration in STI, and STI and Governance.**

STI for policy

STI for policy is the most important component and must be customized to the needs of a country's STI agenda in support of its current socio-economic transformation programme and its anticipated future needs for continued **growth and competitiveness** in the global marketplace. STI for policy must therefore deal with the national need in the context of the four major

groups of critical technologies, namely technologies for basic needs, for quality of life, for wealth creation and economic competiveness, and for good governance. The aspiration of a national transformation programme can be more ambitious but realistic when STI components are factored into the formulation process.

Policy for STI

In order to deliver the support for a nation's socio-economic transformation programme, the nation's **STI capacity and capability** must be strengthened in terms of institutions, mandates, personnel, management, funding and linkages. Measures to strengthen education and research for capacity building in the sciences relevant to the needs of policy and for public good (e.g. water, energy, biodiversity) as well as matters related to ethical issues must be part of the policy for STI.

STI and the private sector

Success in the implementation of a government economic transformation programme much depends on full commitment and participation of the private sector.

A strategy to get **private sector buy-in** is therefore crucial and will vary from country to country depending on existing public-private sector partnership framework. In situation where the private sector is innovation-recalcitrant the strategy to get buy-in must include presentation (of government's strategic direction and policy objectives), persuasion, incentivisation, legislation, active cooperation and collaboration with government entities.

STI and the community

A supportive and **science literate** community is part of the total STI ecosystem. The policy must therefore deal with issues of science enculturization which includes an appreciation of the **scientific method**. The scientific method is a logical, systematic evidence-based approach to understanding issues and solving problems in general and not just in science. An education system that includes 'science for all' and promotes **creativity, innovativeness and entrepreneurship**, i.e. a holistic human capital development must be considered. In some countries policy statement against gender discrimination in education and employment may be necessary.

International collaboration in STI

Moving the National STI agenda requires not only a close cooperation among all national stakeholders but also with **international collaborators**. There is also increasing needs for **science diplomacy** as international relation and cross border issues are becoming more complex. This is where an effective framework and mechanism of partnering is required.

STI and governance

There are two components to this namely, **Governance for STI** and **STI for Governance**. Since STI cuts across many government ministries and must

I have enjoyed reading the text of the Essentials of STI Policy. It is the most coherent and realistic treatment of STI policy formulation I have come across. I believe the book would provide a useful guidance to many countries in the formulation of national STI policy and its management.

The Hon. Heneri Dzinotyiweyi,
Minister of Science and Technology, Zimbabwe.

The Essentials of STI Policy is like Science Policy 101, a primer on policy and related matters. It focuses on major components of policy related to science, technology and innovation as well as on implementation strategy. I think it should be made compulsory reading for those in public service in ministries with any kind of S&T responsibility and those in economic and development planning. I would have benefitted from this book tremendously myself when I was in Government as the Minister of Agriculture and later on as Minister in Prime Minister's Department overseeing development planning.

Dato' Sri Effendi Norwawi,
Executive Chairman Encorp Bhd, formerly Minister of Agriculture and Minister in Prime Minister's Department, Malaysia.

The Essentials of Science, Technology and Innovation Policy is a must-read book for policy makers, students, and the general public in the developing countries. The book, written by the leading science advisor in the developing world, is a guide that addresses the different phases of policy formulation from the sixties to today's notion of STI policy; it offers a real experience of science policymaking which contributed to the process of transforming Malaysia to a developed country.

Dr Mustafa El Tayeb,
President Future University, Khartoum, Sudan, formerly Director, Science Policy and Sustainable Development, UNESCO, Paris.

The book succinctly captures the important change from the conventional and by now obsolete concept of a National Policy for Science to a Policy for Science, Technology and Innovation. Distilling his hands-on long years of practical experience, Tan Sri Omar has brought out valuable 'guide' for all those concerned with structure, policies and programs of dovetailing science, technology and innovation with national development aspiration.

Dr Ashok Jain,
Fellow National Academy of Sciences, India, Hon Vice President, Research & Academic Division, EMPI, New Delhi; formerly Director, National Institute of Science, Technology and Development Studies, New Delhi.

The author of this book was Science Adviser for almost seventeen years to a Prime Minister who believed that science and technology would play a crucial role in bringing about the innovations at all levels needed to meet the objectives set out in Malaysia's National Vision 2020. Dr Omar played a big role to put in place the institutional infrastructure necessary to make this happen. His ability to think clearly about the complex relationship between science and society, about how to facilitate the use of science in the service of society, is well illustrated in this book.

Catherine M. Cunningham,
CPTM Companion, former member, Office of the Government Chief Science Adviser, Cabinet Office, London.

I have read with interest the Essentials of STI Policy and found it educative and inspiring. I appreciate Tan Sri Omar's willingness to share his experience with the rest of us. The book is based on his real and personal experience rather than on theoretical or academic considerations.

Dr Hassan Mshinda,
Director General, Tanzania Commission for Science and Technology Dar es Salaam, Tanzania.

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