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Chapter 1

Introductory Chapter: R&D Trends and Evolution - Emerging Concepts, Frameworks, Policies, Management Systems, and Applications

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Additional information is available at the end of the chapter

http://dx.doi.org/10.5772/intechopen.69733

1. R&D trends and evolution

1.1. New trends in global funding

The changing economic conditions and balance of power around the globe have changed how nations and agencies prioritize investment in research, development, and innovation. Moreover, the growth of scientific research during the past decades has outpaced the public resources available to fund it. This has led to a problem for funding agencies and politicians and pushed toward science with expected benefits for society. For instance, Horizon 2020, the biggest multinational research program in the world, launched by the European Union (EU), shifted toward funding research and innovation activities that are ***"closer to the market."*** International cooperation is gaining a high priority on the funding agenda of nations and agencies for maintaining global competitive advantages, tackling global societal challenge, and supporting external policies [1–4].

1.2. New research evaluation frameworks

Responding to changing landscape in local, regional, and global funding needs and directions, new research evaluation frameworks were introduced stressing the importance of social impact of research besides traditional measures of research including metrics (Data Citation Index, Altmetric, Citation Score, etc.). Examples of new research evaluation framework include Research Excellence Framework (REF) in the UK, STAR METRICS in the USA, National Institute for Academic Degrees and University Evaluation NIAD in Japan, Excellence in Research for Australia (ERA), Canadian Academy of Health Science (CAHS), Evaluation Agency for Research and Higher Education (AERES) in France [5–16].

There is also a growing issue around standardization, development of new frameworks and the potential of data mining and social media in creating a paradigm shift in the way research is evaluated.

1.3. Research classification and science diplomacy

Consequently, research is classified in various categories: institutional research, basic research, applied research, research and experimental development, social innovation, and technological innovation [17–23].

"Science diplomacy" in the international cooperation in the research and innovation is an instrument of soft power and a mechanism for improving relations with key countries and regions.

1.4. New policies, strategies, and ecosystems

Realizing the importance of research, development, and innovation in driving growth and addressing societal challenges, institutions, nations, and regions are developing new policies, strategies, and ecosystems to promote R&D and innovation. There is no unified practice in devising policies, adopting strategies, and developing ecosystems for R&D and innovation. We are rather confronted with scattered efforts around the globe lacking homogeneous, synchronized, and standard actions [24–35].

1.5. New concepts emerging

Open innovation is a new concept introduced to drive R&D and innovation and to consolidate data in the hand of various economic stakeholders in order to create the so called "knowledge economy" [36–38].

Various economic stakeholders (industry, academia, government) are developing open innovation approaches, combining in-house and external resources, and maximizing economic value from intellectual property.

1.6. R&D outcome and impact

It is hard to assess R&D impact and to identify all areas that may be impacted (impact zones). It is also a challenging task to accurately estimate the timeframe to achieve an expected impact. For instance, the largest EU investment in GRID infrastructure has never delivered the expected impact within the predicted timeframe. Impact assessment is a big task and we have a long way ahead to learn from case studies, best practices, and experiences [39–42].

Moreover, identifying R&D outcome and devising outcome measurement approaches is a nontrivial task that requires a broad vision of various considerations that can shape outcome.

1.7. Rising importance of research data management and systems

To cope with a changing R&D landscape, novel data management models and systems have to be developed. Various research data management plans have been suggested and in some

instance imposed by funding agencies to maximize benefit from return on investment in R&D [43–47].

Again, there is no unified practice or standard to develop a data management plan for R&D. So far various issues considered include types of data, metadata and standards, policies for data access and sharing, data storage and preservation of access, interoperability, visualization, data management life cycle, datasets collected, processed and generated by a research project, open access of data, and criteria for open access [43–47].

1.8. Emerging R&D techniques

R&D impact and outcome evaluation is increasingly shaped by emerging technologies such as visualization (dashboards), data mining, big data analytics, communication technologies building ecosystems, and R&D and innovation e-infrastructures.

2. A quick tour of book chapters

The book chapters are classified into three sections: (1) R&D for human growth and prosperity; (2) R&D for institutional growth; and (3) R&D for economic sectors. Below is a quick tour of the book chapters.

2.1. R&D for human growth and prosperity

This section covers a topical theme on human development and research-development-extension relationships. Human capital is the most important strategic factor for development. It argues that in today's world, it becomes increasingly important to know how information can be accessed, how it is adopted, and how it can be assimilated. In this respect, each country allocates budget for training, education, and extension according to its own conditions. This budget may be intended for rural community-based social assistance, but the economic and welfare effect is essential. In this way, it is aimed to increase the living standards of the families living in the rural areas. This will naturally contribute to national income and to the prosperity of society. Moreover, the development of human resources should be emphasized and a suitable atmosphere should be prepared for its widespread prosperity.

2.2. R&D for institutional growth

This section covers a topical theme on R&D for institutional growth, with particular focus on small and medium size enterprises (SMEs). The chapter in this section addresses the topic of SMEs development through public and private partnerships and the key role of research transfer and patent information analysis. The chapter argues that innovation is today one of the best ways to improve competitiveness and to create jobs. Hence, the transformation of knowledge and competencies developed in academics laboratories and research centers must be transformed in products and services. To achieve this goal, the use of patent information is one of the best ways to understand the areas concerned by the research, to find partners and often to shift academics subjects to more relevant domains. This chapter focuses on the patent

information retrieval and automatic analysis (automatic patent analysis (APA)). It shows how the results are useful for the research valorization and transfer especially to SMEs.

2.3. R&D for economic sectors growth

This section focuses on R&D in three sectors of paramount importance for economic growth: smart microgrids, energy consumption and greenhouse gas emission, and metallurgical industry.

The chapter on smart microgrids addresses the important R&D issue of optimizing local resources toward increased efficiency and a more sustainable growth. The chapter argues that with the increasing number of small renewable power generation units, the addition of the grid storage and a high number of electric cars as additional loads the electrical power grid will become more complex. On the other hand, local generation units and smart control interfaces to devices call for forming smart microgrids that reduce complexity by performing local optimization of power production, consumption, and storage. We do not envision these smart microgrids to be island solutions but rather to be integrated into a larger network of microgrids that form the future energy grid. Operating and controlling a smart microgrid involves optimization for using generated energy locally, for example, from a photovoltaic system, and therefore employing demand response mechanisms as well as predicting consumption accurately. Further goals are providing feedback to the user in order to the human in the loop of deciding when and how to use energy-consuming devices. The chapter shows how these issues can be addressed starting with measuring and modeling energy consumption patterns by collecting an energy consumption data set at device level. The open dataset allows to extract typical usage patterns and subsequently to model test scenarios for energy management algorithms.

The chapter on energy consumption and greenhouse gas emission focuses on hybrid energy evaluation and greenhouse gas mitigation methods for sustaining the growth and economy of nations. The chapter argues that various evaluation methods have been adopted by researchers, academia, and ministries. The most effective method is the hybrid evaluation method. This takes into consideration strength of a particular method to overcome the weakness of another method. The chapter focuses on a recently proven integrated method on energy and greenhouse gas studies—integrated IDA-ANN-DEA (Index Decomposition Analysis-Artificial Neural Network-Data Envelopment Analysis). Case studies are exemplified using this approach in evaluating possible energy potential that could be saved in the manufacturing industries in Canada and South Africa as well as a particular food and beverage industries.

The third chapter sheds light on the transforming landscape of research and development in the metallurgical industry of Romania. The chapter traces the evolution/involution of metallurgical industry in Romania during the period 1990–2016. The chapter argues that the importance of metallurgical industry, for any state is substantial. The chapter presents a description of the main metallurgical companies in Romania, describes critical components concerning the involution of steel industry in Romania, and foresees the future prospect of metallurgical industry in Romania.

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