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On the Intertwining of Management, Science and Technology for a Sustainable Future: Challenges, Opportunities, and Strategies

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ABSTRACT

The management of science and technology is crucial for addressing global challenges and ensuring a sustainable future. This article reviews the current state of science and technology management, highlighting challenges, opportunities, and strategies for effective management. It discusses the role of governments, industries, and individuals in promoting innovation, addressing ethical concerns, and fostering international collaboration. In conclusion, looking back over several decades of academic journey, the merging of management, science and technology, it is impressive to note that we have made great progress toward the goal of promoting development and encouraging the applications of a science of management per se. At the same time, there has never been a more exciting time for the future of management science and technology. The massive increase in data availability, the proliferation of analytics tools, and the rise of new business models are converging to create an unprecedented need and an extraordinary opportunity for the development of a science of management. Ample opportunities exist, to fill in these gaps by providing quality communications.

KEY WORDS: INTERTWINING,MANAGEMENT, SCIENCE, TECHNOLOGY.

INTRODUCTION

The concept of management has been around for thousands of years. According to Pindur, et al [1] elemental approaches to management go back at least 3000 years before the birth of Christ, a time in which records of business dealings were first recorded by Middle Eastern priests. Socrates, around 400 BC, stated that management was a competency distinctly separate from possessing technical skills and knowledge. [2]

According to Armstrong,[3] a broad view of management is that it involves procedures to forecast, plan, analyse, decide, motivate, communicate, and implement.

On the scientific side, the definition is limited: science is the use of objective and replicable procedures to compare different approaches, techniques or theories. Management science has delivered many useful things and it has made management more efficient, but it can do much more.

Research and development in management has been remarkable, and we owe this to the pioneers of this field who have given a strong foundation to develop our world, economically as well as scientifically. How ever in the developing world, it has often been observed that only a small percentage of the studies in management science are useful, and that proportion is declining. Meanwhile, useful findings that do occur are often unseen, or rejected, or ignored.

Much has been written about the exponential growth of science and technology. It has been reported that today's iPhone has more than 100,000 times the computing power of the computer that helped land a man on the moon.[4]

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Bwalya[5], stated that management involves planning, organising, leading and controlling activities, operations and employees of organisations to attain organisational goals and objectives. Williams,[6] summarized management as getting work done through others. Managers therefore are responsible for getting work done in the organisations and departments they manage, but they have to do it through others. This demands for managers to skilfully and professionally manage others using scientific or artistic means.

Management today must grapple with the explosion of data now available to facilitate business decisions. Developing an understanding of how to use data analytics without getting bogged down will be a significant challenge for the 21st century schools of management. Collecting, organizing, utilizing data in a logical, timely, and cost-effective manner is creating an entirely new paradigm of managerial competence. In addition to data analytics, cybersecurity, drones, and virtual reality are new, exciting technologies and offer unprecedented change to the way business is conducted. Each of these opportunities requires a new degree of managerial competence which, in turn, creates opportunities for the modern-day management experts.

Science and technology are key drivers of economic growth, social development, and environmental sustainability. However, their management poses significant challenges, including ethical concerns, knowledge gaps, and innovation barriers. Technology management plays a vital role in the success of businesses in today's digital era. It encompasses technology planning, technology implementation, and monitoring of technological resources and strategies to achieve organizational goals. As a result, effective technology management enables businesses to leverage tech trends and innovations to their advantage, gain a competitive edge, and drive growth.

When we ponder over the role of management in science, we have to discuss the broad view of management, which states that it involves procedures to forecast, plan, analyse, decide, motivate, communicate, and implement. On the scientific side, the definition seems to be somewhat limited: science is the use of objective and replicable procedures to compare different approaches, techniques or theories. Combining these two great disciplines is the hall mark of today's development, using science and technology with skills of management will deliver incredible innovations.

Management science has delivered many useful things and it has made management more efficient, but it is capable of doing much more. Only a small percentage of the studies in management science are useful, and that proportion is declining. Meanwhile, useful findings that do occur are often unseen, or rejected, or ignored. So, in addition to talking about improving management science, it is important to discuss how to improve the communication of important research and development findings, we see a serious decline in quality of management and scientific communications. These areas using the latest tools of technology have to be developed by the curious minds of aspiring young generation.

We need management science because not everything can be learned from our practical experience. Many things contradict our experience and many are difficult to assess. Management is a science because it meets all the characteristics of science, universal acceptability and validity, these principles are capable of universal application, we see managers across the globe conduct annual performance appraisals in a scientific manner, to establish whether their employees are performing as expected, and if not take appropriate action such as arranging for additional training - if need be.

This is a world-wide practise in human resource management, an important component of management as well as science. Organised body of knowledge – Management, like science, already has a systematized body of knowledge. Principles of management are virtually available in every function of science. Experimenting and Observation – The principles of management existing today have been developed through continuous observations and empirical verification. These have been developed by studying large numbers of managers' practical experiences, views and approaches. Cause and effect relationship, scientific principles identify, establish and explain a cause-and-effect relationship between two or more variables.

Science is an organised body of knowledge pertaining to a particular field of enquiry, which accommodates general facts explaining a phenomenon[7]. Science is systematized in the sense that is establishes a cause-and-effect relationship between various variables. Beasley [8] and Luthans [9] observed that science is characterised by the features such as universal acceptability and validity. Scientific principles and conventions have global genuineness and are capable of universal applications. Science contains concepts, theories and principles which help explain past events and can also be used to predict the future outcome of specific actions.

It is our view and school of thought, to regard management as a set of principles and techniques that can be studied and applied systematically like science. There is an emphasis on the importance of data-driven decision making, Koontz and Weihrich[10] and use of empirical evidence to guide managerial decisions6. Proponents of the science perspective submit that management can be taught through formal education and managers can use scientific methods to improve organisational performance. It is how ever worth noting that management as a science is not as exact as other allied branches of sciences – such as biology, physics and chemistry.[11]

Essentially science and art are not mutually exclusive but are complementary to each other. In fact they can be seen as two faces of one coin. Management is more effective when there is a combination of both science and art.[12] Many scholars have noted that in management, science provides the knowledge while art deals with application of the knowledge and skills. Therefore, successful managers are likely to be those who have mastered the 'know-how' –

from science and the application of 'doing' – from art. Based on the arguments above, management is both an art and a science. The trick lies in separating the good ideas from the bad ones and knowing when to be scientific or artistic. Today's managers need a blend of acquiring the knowledge of science and the art of applying it. Managers should be both scientific and artistic – as the situation dictates.

Challenges In Management

Ethical concerns: Ensuring responsible innovation and addressing societal implications.

Human resources and management professionals may find it challenging to manage ethical issues effectively. Although there are laws to hold people accountable, unethical behaviour can still occur in the workplace and an organisation can also act unethically. As a management expert, learning about the ethical issues a business can face can help the organization to prepare and manage them effectively, if they occur. Ethical issues in business and management occur when a decision, activity or scenario conflicts with the organisation's or society's ethical standards. Both organisations and individuals can become involved in ethical issues since others may question their actions from a moral viewpoint. Complex ethical issues include diversity, compliance, governance and empathetic decision-making that align with the organisation's core values

Ethical conflicts may pose a risk for an organisation, as they may imply non-compliance with relevant legislation. In other instances, ethical issues may not have legal consequences but may cause an adverse reaction from third parties. It may be challenging to effectively manage ethical issues when no guidelines exist. For this reason, an HR or management professional can help develop policies to guide employees to make the right decision when faced with moral and ethical issues. Having a good work ethic generally means there is a commitment to do the best job possible at all times. It can mean you possess dedication, responsibility, and a positive attitude towards everything your work requires. Doing your job diligently with a strong work ethic can help you perform tasks better, form stronger relationships with colleagues and develop a positive image for the business.

Work ethic is a combination of qualities, personality traits and beliefs that an individual applies on their job which includes accountability, discipline, honesty, humility, integrity, organization, high-quality work, responsibility, teamwork and time management. A good work ethic is essential for building strong networking connections, career advancement, and fostering a positive workplace environment leading to new professional opportunities and career goals. To improve and demonstrate a good work ethic, one should minimise distractions, set and focus on goals, organize workspaces, manage time effectively, and maintain a healthy work-life balance.

Knowledge gaps: Bridging the gaps between management, science, and technology

Dutton[13] discusses few important initiatives that could help bridge the gap between management-organizational and public policy. First enriching research distribution channels, arguing that traditional avenues for publishing are a more valuable means for distributing research to a specialized group of academics and practitioners than they are for reaching public policy makers. Second, that incentives be created to encourage contributions to public policy knowledge and debate and lastly, the author advocates the creation of social networks linking researchers and public policy makers, suggesting that doctoral education should place a greater emphasis on public policy issues.

Schauz[14] has been shown that there is a perceived gap between scientists and policy makers as research is now being considered largely a concept of science-based policy or of negotiations between the scientific community and policy makers. While science profits from society's growing demand for research, researchers simultaneously face pressure from society's expectation that science should produce knowledge for evidence-informed policy making. Scientists and policy makers are beginning to join forces to narrow the gap between them. Operating in this gap are many knowledge experts who use research to influence policy and often carry out knowledge transfer, knowledge brokering, and other activities. The usual answer to how to bridge the gap between management, research and practice or policy is to disseminate scientific findings more efficiently. This focuses on the back end or downstream, (knowledge dissemination) of the knowledge transfer process.[15]

Innovation barriers

Overcoming obstacles to innovation and adoption: Innovation has been widely recognized as the main driver and first impetus for a sustainable regional or national economic growth, as well as global competency. Consequently, both developed and developing countries are trying to build up their national innovation system in order to cultivate creative talents, high-tech based start-ups and new technology that could be translated into sustainable power for industrial upgrading and economic growth.[16]

This is also the main reason why Asian countries such as South Korea, Japan, China and India continue to increase their domestic expenditure on research and development (R&D), sharing the largest proportion of the worldwide R&D expenditure, about 42.9 percent in 2017, according to the 2017 Annual Global R&D Funding Forecast. For example, South Korea ranks number one in national innovation competitiveness among all the countries in 2018, according to the 2018 Bloomberg Innovation Index. China moved up two spots to 19th, buoyed by its high proportion of new science and engineering graduates in the labour force and an increasing number of patents by innovators such as Huawei Technologies Co and is the first-ever developing country who gets a position in the top 20 most innovative countries in history.

Innovation is a double-edged sword in terms of social impact.[17] On the one hand, many innovative products make our life better. For example, the plane and the high-speed rail make travel faster, and Apple smart devices have

changed our lifestyle fundamentally. A large number of new products and services are delivered to every corner of the world. An increasing share of the public can have access to more plentiful food, life necessities and better medical services.

But innovation means possible negative effects as well. For example, industrial technologies may cause pollution, agricultural and fishing technologies may aggravate ecological problems and medical technologies may involve drug-resistance problems and bioethical issues (like genetic engineering). However, technology is essentially a knowledge-based means of solving problems and achieving goals. Overall, innovation, if effectively managed, will minimize its negative effects to better serve mankind, in which case we call it an inclusive innovation or responsible innovation. [18]

Opportunities in Management and Technology: Strategies for International Development

Fostering global partnerships for management, science, and technology.

The recent report on global cooperation in science, technology and innovation for development has been presented by United Nations in April 2024, where in it has been stated that due to the growing complexity of new technologies and their fast pace of change, as well as the significant transformation brought about by recent waves of innovation, there is an urgent need for a collaborative approach to Science Technology and Innovation.

In view of the scale of global challenges and the significant potential of technology to deliver responses, global cooperation is indispensable, hence steps are being taken urgently, to achieve the international community's commitment to leave no one behind. Global partnerships, particularly in areas of management, science and technology, including the Global Partnership for Sustainable Development is being addressed under Sustainable Development Goal 17 of the United Nations.

There is a great necessity to mobilize financial and knowledge resources from government, business, academia and civil society, including the talent and knowledge available in developing countries and to facilitate the co-creation of global solutions to global challenges. Strengthening the national capacities of developing countries in science and technology is therefore integral to the achievement of the 2030 Agenda for Sustainable Development, which is the road map of the international community for a prosperous and sustainable future for all.

Implementing the inclusive 2030 Agenda will require collaborative efforts to accelerate the development of the national innovation systems of countries in which such systems are still emerging, in order that truly global technological networks can thrive and deliver results.

Integrated approach Encouraging interdisciplinary research and collaboration.

Interdisciplinary research has been a topic of interest among scientists, scholars, university administrators, and policy makers for many decades.[19] According to Lattuca [20,] the question of how to join different strands of knowledge within a learning environment is as old as academic scholarship itself. Interest in interdisciplinarity stems from a belief in its various perceived benefits: many observers such as, Lattuca, [20,22,23] who claim that interdisciplinary collaboration, by its very nature, promotes creativity, innovation, and outside-the-box thinking.Moreover, there is increasing consensus that real-world policy problems are inherently interdisciplinary and cannot be addressed with knowledge from only a single scientific or academic discipline.[23,24,25]

And yet, even now, in an era of advanced communications technology, instantaneous access to information, and increasingly insistent demands for academics to demonstrate research impact, and despite continued research efforts in this area, there is still much we do not understand about how to stimulate collaboration across research disciplines. Newman26 in a recent detailed review of literature on promoting interdisciplinary research collaboration suggests to adopt a view toward generating more empirical data on practical strategies for connecting researchers and encouraging them to work together across disciplinary boundaries, will be required to further the research agenda on interdisciplinary collaboration.

It has been suggested that interdisciplinary collaboration is desirable because of its ability to promote creativity and innovation, and also for its potential to help academic research contribute to addressing real-world challenges. In addition to discipline-based research, interdisciplinary research can add value that is greater than the sum of its parts. There is, therefore, understandable interest in how interdisciplinary research can be increased, without diminishing discipline-based research. [26]

Promoting diversity, equity, and inclusion in science and technology

Technology plays a pivotal role in fostering diversity and inclusion by providing accessible platforms, tools, and services. In this digital era, technology breaks down barriers and eliminates historical patterns of discrimination. By offering inclusive technology that ensures equal access and opportunities, it exemplifies the transformative power of digital tools in driving societal change. The findings of rigorous investigation of Tripletti 27 suggest that technology plays a vital role in promoting diversity and inclusion. The study revealed that technological tools and solutions have the capacity to actively dismantle barriers, thus leading to a more inclusive and diverse society.

While the findings demonstrate the positive impact of technology on diversity and inclusion, it is essential to acknowledge the challenges and limitations in this area.

One primary challenge is the digital divide, which refers to the unequal access to technology and the internet among different socioeconomic groups. This can hinder the full realization of the potential benefits of technology in promoting diversity and inclusion. Additionally, concerns regarding privacy, security, and online harassment were raised by participants, highlighting the need for continuous monitoring and improvement of technological solutions to effectively tackle these issues.27 These challenges and limitations underscore the importance of adopting a comprehensive approach that addresses both technical and social aspects, ensuring that technology facilitates diversity and inclusion in a fair and ethical manner.

Digitalization in Management Science and Technology

Education is the most important sector for attaining sustainable development goals (SDGs) where digital technology can play a crucial role. Nowadays digital technology has become an essential part of the learning environment. The integration of digital technology into education is necessary for leveraging better education for all by 2030 28.

Leveraging digital technology is the access to technology for the transformation of the traditional learning system to modern and digitalized learning system. 29. Digital technology provides an opportunity to reduce the gap between traditional manner to modern learning approach as an inclusive factor with underpinning human rights and dignity.[30]

Digital technology in education generally means to model which engage in information and communication technology (ICT) for supporting, enhancing and enabling the delivery of education. It is an effect on individual or combination of various digital devices for better education. The major indicator of leveraging digital technology in education are a political commitment, curriculum, infrastructure, teaching staff and development, public participation, skills, outcome and impact. [31, 32 33]

Managing a business, regardless of its size and nature, can be challenging. Imagine having to manually track various processes, data, and information. This can consume significant time and effort, leaving little room for growth and innovation. Fortunately, with the rapid advancement of technology, businesses now have access to a wide range of digital tools that can help streamline and improve their management processes.

In business and management, data security has become a major concern for businesses, especially AI (Artificial Intelligence) startups, with the increasing use of digital tools. However, technological advancements have also brought about robust security measures, along with policies such as cyber essentials checklist, to protect sensitive information. Some of the best data security tools include firewalls, antivirus software, encryption tools, and secure cloud storage services. These tools can safeguard your business's confidential information, such as financial records, customer data, and trade secrets.

Also, using digital tools for data security can also save businesses from costly breaches and reputational damage. It is essential to regularly update these tools and train employees on proper cybersecurity practices to ensure maximum protection. Effective communication is crucial for the success of any business. With traditional methods, ensuring timely and efficient communication among team members can be challenging, especially in a remote work setting.

Digital tools such as project management software, online video conferences, and instant messaging applications make it easier for working teams to better communicate and collaborate. These tools allow for real-time communication, file sharing, task allocation, and progress tracking, making it easier for teams to work together even when physically apart. Thus digital technology has made a tremendous development in management, science and technology.

Selecting the right digital tools and incorporating them effectively into business processes can greatly enhance productivity, customer experience, and overall success. It is essential for the management of businesses to continually evaluate their needs and invest in the right tools to stay competitive in the digital world we are in. With the right combination of technology and strategic decision-making, one can drive growth and achieve long-term success in this digital world which is in fierce competition, advancing in days rather than years.

Adaptive management Embracing flexibility and continuous learning in science and technology management

Adaptive management is a structured approach to decision-making that involves learning and improving management practices over time. It is an intentional approach to making decisions and adjustments in response to new information and changes in context, required in fast changing developments in management, science and technology.

Adapting or adaptive management also refers to intentionally and systematically using relevant knowledge to inform decision-making and ultimately take action. Within the development context, that action could be adjusting interventions or whole strategies, experimenting with new ways of working, scrapping programming that simply isn't working, or scaling approaches that have demonstrated value.

It is a well-known fact that adapting is arguably the most important element of collaborating, learning, and adapting. If we collaborate and learn effectively, but do not do anything differently as a result, then the efforts can get waste. Effective collaboration and learning can often make job more enjoyable, at the same time help in achieving desired results more efficiently and effectively.

Management of Knowledge from a Technology Transfer Perspective

Knowledge Management is a theoretical framework utilized by organizations to collect knowledge

through processes of knowledge creation, storing, sharing and application to accomplish objectives. Organizations constantly learn new ways to utilize the knowledge management framework. Good managers within organizations make use of the know-how of workers they hire with experience and necessary skills for effective management within ad-hoc situations. However, knowledge management is an effective, systematic, and more efficient way to capture knowledge.

Scholars and practitioners suggest knowledge is the most important resource within an organization. Various studies confirmed that knowledge is a key source of competitive organizational advantages. Knowledge management is vital in assisting organizations with creating and gaining knowledge and selecting, organizing, and disseminating information. Consequently, technology transfer serves as a necessary component of innovation, supporting research and development processes throughout higher education.

Anderton and Watson 34 have reviewed factors that influence knowledge management during the technological transfer process between higher education and manufacturing firms, their findings indicate higher education and manufacturing firms should acknowledge the importance of knowledge management during the technology transfer process. Evaluating the relationship between managing knowledge and innovation are emerging findings associated with the creation or modification of products, goods, or services.

The effects of knowledge sharing should be managed in a manner that would motivate workers to share knowledge during the technology transfer process. To lower the barriers to technology transfers, it is necessary to develop a strategy for a successful technology transfer based on the diagnosis of technology donors, looking to the enormous developments in science and technology, including management.

In conclusion it is strategically stated that management, science, and technology, with rapidly growing new markets through technological innovation have become critical factors in achieving success. As of now, companies cannot develop and commercialize all technologies, consequently, the importance of technology transfers will increase by leaps and bounds. Technology transfer is a crucial strategy adopted by organizations to remain innovative and competitive.

CONCLUSION

Effective management of science and technology is crucial for addressing global challenges and ensuring a sustainable future. By understanding the challenges, opportunities, and strategies outlined in this article, governments, industries, and individuals can work together to promote responsible innovation and foster a better future for all. Moreover, there is increasing consensus that real-world policy problems are inherently interdisciplinary and cannot be addressed with knowledge from only a single scientific or academic discipline. And yet, even now, in an era of advanced communications technology, instantaneous access to information, and increasingly insistent demands for academics to demonstrate research impact, and despite continued research efforts in this area, there is still much we do not understand about how to stimulate collaboration across research disciplines. With the right combination of technology and strategic decision-making, one can drive growth and achieve long-term success in this digital world which is in fierce competition, advancing in days rather than years.

Conflict of interest

The author declares no conflict of interest

Data availability

All data are available with the author.

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