RESEARCH REVIEW JOURNALS
Volume-03
Issue-10
October -2018

ISSN: 2455-3085 (Online)
RESEARCH REVIEW International Journal of Multidisciplinary
www.rrjournals.com [UGC Listed Journal]

Environmental accounting and Industry 4.0 a Digital Revolution

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ARTICLE DETAILS

Article History
Published Online: 10 October 2018

Keywords
Environmental accounting, Industry 4.0, trade societies.

ABSTRACT

The key goal of this paper is to see if environmental accounting can be used to bring a broader definition of corporate responsibility into the fourth industrial revolution's emerging vision. Environmental accounting may be improved and piggybacked on significant existing and future advances in Industry 4.0 technologies planned for business digitisation at no additional cost, according to an assertion created by engagement in the field. External environmental accounting and environmental management accounting will also benefit from using Industry 4.0 as a foundation. In related markets, organisation sizes, executive positions, collaborative processes, and supply and value chains, a recent academic research initiative is being proposed to see if Industry 4.0 can assist with more reliable, high-quality, real-time environmental management accounting and external environmental monitoring. Accountants, trade societies, and government authorities are given examples of how they can help environmental accounting reap the benefits of Industry 4.0. Education and planning, as well as improved performance, are key components of Industry 4.0. This ground-breaking paper is the first to examine how current and expected global investments in Industry 4.0 can be used to improve business sustainability by boosting sustainable accounting adoption.

1. Introduction

The focus of Industry 4.0 growth has been on reducing mistakes, improving product efficiency, liberating humans from menial and/or risky jobs, and supplying customers with the things they want when they want them. While resource conservation is discussed, there is still a lack of awareness of how the wider sense of corporate sustainability can be integrated into this agenda. The purpose of this paper is to investigate this topic in the awareness on environmental accounting. In the last 34 years, environmental accounting has come a long way. Despite this, several polls reveal a lack of commitment on the part of companies. One reason for these results may be a lack of adequate data or the resources to collect suitable data, combined with the inherent complexity of organizational survival as a concept. In the long run, a lack of timely and credible evidence can jeopardize environmental accounting's credibility and subject the profession to accusations of greenwashing.

2. Problems with environmental accounting initiatives as following:

Environmental costs can be exchanged between agencies or between parties in supply chains where adequate reporting is unavailable, resulting in lost opportunities and the need for a cost-effective operational system to properly capture and exchange environmental management accounting data. Evidence indicates that information about the effects and achievements of carbon emissions is not exchanged among divisions within the top Indian organizations sampled; instead, managers focus on carbon impacts within their own departments. It is important to participate in supply chain information structures in the brewing industry to support decision making among parties if environmental accounting is to provide sufficient support for eco-efficient choices.

The next section examines the rise of Business 4.0, which could provide a foundation for overcoming these obstacles.

3. Industry 4.0: A Succinct Overview:

Improved data collection processes are facilitated by Moore's Law, which states that transistors in integrated circuits double in capacity every two years, lowering the cost of digital electronics, reducing part size, promoting portability, and increasing data availability via connected machines.

Increased network connectivity via the Internet of Things and Internet of Services via Cyber-Physical Systems are key concepts driving Industry 4.0. Sensors will track the physical environment in future smart factories will be used to manipulate physical operating parameters. As a result, a manufacturing system that is “self-aware, self-predictive, self-comparison, self-reconfiguration, and self-maintenance” will emerge. Philips Electronics' advanced manufacturing of 600 electric shaver models in the Netherlands, for example, maximizes economic productivity in a factory with 128 robots and just nine employees to ensure quality.

Digital transformation is a glimpse of the future of industry, or more accurately, a target to aim for, rather than the industry of today. At first, Industry 4.0 was seen as a way for India to maintain a strategic advantage over emerging countries with lower labour costs.

Via advances in machine-to-machine information and communication technology, the fourth industrial revolution has been promoted as providing annual efficiency gains in manufacturing of between 6% and 8%, greater capital intensity, and more flexible job models. Nonetheless, the expected relative advantages over low-cost developing-country output

are now seen as unlikely to stem the flow of offshore activities in India with the potential course of Industry 4.0 growth seen as speculative at best. China plans to catch up with and overtake other countries in the near future, and believes that networked development, in which machines and parts share information in real time, is critical. However, lack of requirements for the language used by chips to communicate with one another, a lack of know-how, weak legal standards for data security, which will hinder adoption, and a lack of resources to invest in technology are all limiting factors. Nonetheless, China is investing heavily in the convergence of industrialization and information technology.

Given the issues raised in the section on problems with environmental accounting initiatives, as well as the potential of emerging information and communication technology being implemented into advanced manufacturing, the paper considers how Industry 4.0 could be used to enhance current environmental accounting initiatives.

4. Used Industry 4.0 as a catalyst for environmental accounting:

If a fourth technological transition emerges, Industry 4.0 could be used to enhance both external environmental accounting and environmental sustainability accounting.

External environmental accounting programs that could benefit from Industry 4.0 include:

1. Environmental accounting evidence has improved in terms of timeliness, accuracy, transparency, and interoperability.
2. Green washing and brown washing opportunities are dwindling.
3. Few control of what is assessed and how it is measured and recorded by management.
4. Data for more accuracy.

Machines are linked as a collaborative group in an Industry 4.0 digitized smart network environment, sharing vast amounts of actual data accessible in real time, not measured, averaged, or affected by human interference.

In technological terms, the digitisation of data collection and reporting in real time ensures that greenwashing and brownwashing are less likely to occur for three reasons. Data in the common pool will be made directly available to stakeholders by digital means, and there is less need for third-party audit of such data that is digitally tagged as credible using universally accepted labels from a generally accepted taxonomy, all at a lower cost.

1. Industry 4.0 may be used to enhance environmental sustainability accounting programs in a variety of areas, potentially boosting adoption:
2. Having data that had previously been unavailable
3. For environmental, reliability, data assurance, and other decision-making reasons, improving data quality by increasing precision and detail.
4. Data transfers for management monitoring have been improved.
5. Data retrieval for all forms of choices, operators, and gatekeepers is made easier by using a common pool.
6. Leverage current industrial facilities to keep costs down.

What was previously unseen and of low quality data on environmental effects and operational costs could be rendered accessible and more reliable as a basis for autonomous decisions made by intelligent machines in Industry 4.0. Machines that use real-time data wouldn't have to wait for an operator's decisions and orders before optimizing production plans, predicting errors, and performing maintenance and repairs. Rather, real-time access to appropriate and detailed digital data “should be able to dynamically recommend mission structures and change organizational criteria to maximize efficiency and product quality.”

Data accuracy for managers in the digitized advanced manufacturing setting can be increased, leading to higher efficiency, as defined for external environmental accounting. Energy prices should be measured in real time and automatically monitored to boost productivity energy supply sources could be automated to transition to low or no carbon emissions automatically. Smart grids empower volatile energy sources to be integrated into a highly dynamic energy system by balancing supply and demand in real time as our environment transitions to renewable energy sources:

Improved data flows between silos and inside supply chains will be encouraged by Industry 4.0, resulting in environmental and financial benefits from better management. Infrastructure investments in networked digital information and communication systems could provide data to help with transitions between departments or between parties in a supply chain.

A shared pool data base accessible to all, including trans disciplinary strategic teams, will inform human decision making on the way to Industry 4.0. If environmental and sustainability managers, in-house environmental lawyers, and accountants had access to shared data about environmental aspects of operations and investments thanks to increased digitised connectivity provided by the Internet of Things and Cyber-physical Systems, there will be a greater chance they could collaborate and use real-time environmental management accounting.

Another way Industry 4.0 could inspire environmental management accounting efforts is by seeing the similarity between both the data production process and eco-efficient supply chain management. Water-specific environmental conservation accounting, for example, in the Australian wine supply chain, is a clear example because it necessitates the collection and distribution of water-specific data, which is often performed collaboratively by the winemaker. As a result of Industry 4.0 systems, which are housed in a single data stream, the effects on relative environmental and financial performance have become more clear.

5. Taking advantage of Industry 4.0's scope for environmental accounting:

As stated in the Overview of Industry 4.0 segment, there is a lot of confusion about whether or not the world will enter the fourth industrial revolution. Nonetheless, considering the growing enthusiasm and significant capital investments required, the issue of what researchers, practitioners, and

policymakers should do now to ensure the future benefits of Industry 4.0 for environmental accounting growth emerges.

6. Academic implications:

Academics may be able to assist in two ways. They could, for starters, develop a research agenda to fix environmental accounting problems that could be addressed in an Industry 4.0 world, and they could, second, look into ways to enhance environmental accounting education. The research agenda will look at how external environmental accounting and environmental management accounting could benefit from Industry 4.0's ability to provide fresh, more reliable, higher-quality, real-time physical and monetary data about companies.

Academic research will be useful in determining the sectors where Industry 4.0 is most likely to have an impact and where environmentally sensitive issues occur, as it is in these sectors where changes in environmental reporting and decision-making are most likely to be successful. Until now, the emphasis of Industry 4.0 has been on future benefits for capital-intensive industries like aviation, oil and gas, transportation, power generation and distribution, manufacturing, healthcare, and mining. Environmental accounting research has looked at sectors that influence and are influenced by environmental concerns like water protection and greenhouse gas emissions. Academic research could focus on identifying and exploring overlaps between planned Industry 4.0 impact sectors and environmentally sensitive sectors to help advance environmental accounting and enhance corporate environmental efficiency.

A potentially important second line of academic research would be to look at the sizes of companies most likely to be impacted by Industry 4.0, as these companies could benefit from faster communication and better data, and therefore would be good targets for raising the rate of environmental accounting adoption. Most of Industry 4.0's potential appears to be directed at big, multinational corporations so far. Small sized businesses, on the other hand, are not currently active but should be. Small and medium-sized businesses do not tend to see Industry 4.0 as being particularly relevant to them, despite the fact that they will be the biggest beneficiaries of the transition. Smaller businesses are reportedly being held back from participating in current Industry 4.0 initiatives due to a lack of understanding of the economic benefits, a lack of resources for establishing intelligently networked systems, and a lack of expertise among their employees. Until these obstacles are solved, Industry 4.0 investments and innovations in larger organizations will likely be the more powerful driver for environmental accounting growth. Environmental accounting tools are intended to facilitate decision-making by businesses of all sizes, but if Industry 4.0 were adopted by smaller businesses, research may be conducted to highlight the circumstances in which eco-efficiency assessment and reporting are more likely to thrive.

Internal research into the effect of Industry 4.0 on the functions of and interactions between managers with various environmental obligations may be a third potentially useful avenue of investigation. Physical and cyber dimensions of manufacturing processes, knowledge flows, and the role of production and information technology managers in improving efficiency and reducing risk are all highlighted in discussions of Industry 4.0. Environmental accounting also necessitates monetary performance measures, and although this isn't emphasized in the Industry 4.0 literature at the moment, research should look into whether and how the connection between physical and eco-efficiency measures could be introduced at a low cost.

A fourth research subject may be determining if, how, and to what degree there is a spin-off for environmental accounting in Industry 4.0 from collaborative management. Industry 4.0 requires cross-disciplinary engineering to occur seamlessly in the design, production, manufacture, and disposal of goods, as well as data at each point of the product life cycle becoming accessible by all from a single source on the cloud. It also increases the need for transdisciplinary thought, which involves practitioner participation. By definition, environmental accounting is transdisciplinary, and it necessitates the collaboration of teams of professionals with various specialties. Environmental administrators, accountants, attorneys, and meteorologists, for example, work together to define, assess, optimize, and possibly monitor environmental and economic efficiency when it comes to water shortage problems. Given the relative availability of reliable real-time digital physical engineering, environmental, and monetary data, a comparison of pre- and post-Industry 4.0 systems and processes could identify advantages and potential obstacles for environmental accounting take-up in the two settings.

Supply and value chain management is a fifth research subject field for ensuring that the advantages of Industry 4.0 are captured for environmental accounting. Industry 4.0 emphasizes the convergence of supply chain parties in order to optimize procedures, data flows, scheduling, and exchange, as well as economic benefits, but ignores environmental concerns. If the integration processes are in place, supply chain partners can be able to access real-time common pool data to aid in the optimization of environmental and economic efficiency. However, very little research into these possibilities has been done. However, there is enough funding to support the construction of the required Industry 4.0 infrastructure to provide complex, real-time data at all stages of the value chain.

In conclusion, a new academic research program could be developed to determine how Industry 4.0 could promote more reliable, high-quality, real-time environmental management accounting and external environmental reporting in relevant industries, company sizes, across various management positions and collaborative settings, as well as in intra-organizational settings like supply chains.

Once such a research agenda is in place, the findings may be integrated into undergraduate and postgraduate student curricula as a framework for providing awareness of both Industry 4.0 and environmental accounting as a foundation for responsible business.

7. Practitioners and policymakers should be aware of the following implications:

In a variety of ways, accountants in practice and in business will assist in capturing the advantages of Industry 4.0 for environmental accounting.

One crucial question is whether professionals, as professional service providers, are willing to take on a larger position than traditional accounting allows. Industry 4.0 and environmental sustainability are two areas where accounting

can expand its horizons, especially in the field of environmental accounting. Professional accounting organizations are discussing raising awareness of the future shifting nature of accounting work as part of their thought leadership. Industry 4.0's hallmarks include exponential improvements in computer processing capacity, connected work that can be done virtually anywhere in the world, automation replacing mundane, repetitive accounting, audit, and taxation activities. Both or neither of these factors may have an effect on professional services firms.

In favor of focusing on facets of Industry 4.0, environmental accountants will need to be educated at university and qualified by continuing professional growth to consider new digitised data network structures and appreciate the benefits of digitalisation for gathering quality and timely data about organizational eco-efficiency and other related concepts. Environmental management accounting, which is entirely free of external constraints and depends on evidence unique to management to make decisions, is unlikely to be affected by government. Government funding for strengthening the principles underlying language systems in place for collecting and sharing data is more likely to be the cause of effect if companies are to be influenced to adopt environmental accounting in an Industry 4.0 context. Perhaps the digital consolidated reporting system for monetary data may be used to achieve this. Furthermore, the profession could contend that government funding requests for Industry 4.0 developments for small to medium-sized enterprises should include environmental accounting foundations, addressing greenhouse dioxide mitigation, water scarcity, land use enhancements, and other challenges in a step-by-step fashion.

8. Conclusion:

Industry 4.0 is indeed a futuristic portrayal of a business world that is closely integrated. The promise of improved corporate environmental efficiency and a greater footprint for environmental accounting is present, but not included in this vision for more highly digitised industries and commerce at this time. The paper poses issues for scholars to answer, as well as practitioners and policymakers, the potential to improve awareness of the importance of environmental accounting to businesses through greater transparency, reduced the risk of greenwashing and brownwashing, and a focus on the sectors and sizes of businesses that matter most, among other things. The marginal cost of such facilitation could be very low, since the generation of numbers revealing environmental performance for decision-making and reporting could piggyback on the major infrastructure investments already being made to increase digitisation and connectivity. In terms of environmental accounting, these expenditures would be sunk costs, but for proponents of Industry 4.0, they may be seen as providing previously unconsidered benefits.

Environmental accounting tools may be implemented as the growth of Industry 4.0. The tools could, for example, combine measurements of environmental and economic performance to show mutual benefits in real time, more precisely and with higher quality data than was previously possible before the spread of emerging digital technologies like the Internet of Things and Services, as well as Cyber-physical Systems. Industry 4.0 networking of innovative computer systems channeling operational data to a common base, such as the cloud, for possible interrogation by multiple managers with different professional backgrounds and roles, multiple external stakeholder groups with their own interests and cultures, and through multiple countries facing multiple environmental opportunities and concerns holds great promise. However, if the Industry 4.0 vision is expanded, it has the ability to serve as a forum for many smaller businesses to adopt environmental accounting. Both present an opportunity and a threat that scholars, practitioners, and policymakers should consider, as argued in the paper. With its heavy investment in Industry 4.0 and concerns about environmental issues associated with development, Asian countries, especially China, could be prime candidates to take on this challenge.

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