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Guidelines on the environmental efficiency of machine learning processes in supply chain management

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Focus Group Technical Report

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Technical Report ITU-T FG-AI4EE D.WG3-07

Guidelines on the environmental efficiency of machine learning processes in supply chain management

Summary

This Technical Report ITU-T FG-AI4EE D.WG3-07 provides guidelines on the environmental efficiency of machine learning (ML) processes in supply chain management. This guidance document is intended to support machine learning researchers and operators to measure and improve the environmental efficiency of ML, and other emerging technologies (e.g., blockchain, big data, 5th generation of wireless networks (5G)) used in supply chain management.

Keywords

Big data, blockchain, machine learning, supply chain.

Note

This is an informative ITU-T publication. Mandatory provisions, such as those found in ITU-T Recommendations, are outside the scope of this publication. This publication should only be referenced bibliographically in ITU-T Recommendations.

Change log

This document contains Version 1 of the ITU-T Technical Report on "Guidelines on the Environmental Efficiency of Machine Learning Processes in Supply Chain Management", approved at the ITU-T Study Group 5 meeting held online, 11-20 May 2021.

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Guidelines on the environmental efficiency of machine learning processes in supply chain management

1 Scope

This guidance document is intended to support machine learning (ML) researchers and operators to measure and improve the environmental efficiency of ML, artificial intelligence (AI) and other emerging technologies used in supply chain management. The requirements, recommended processes, best practices and other considerations regarding the measurement and verification of environmental impact/efficiency contained in this document are developed based on inputs from leading academic experts and industry leaders. These requirements provide general guidelines applicable to the use of ML, AI and other emerging technologies in supply chain management.

Other stakeholders may also use this guidance document to gain a new understanding of the environmental impacts of ML, AI and other emerging technologies used in supply chain management.

2 References

[1] [Telecom Italia Group – Gruppo Tim] – Telecom Italia Group – Gruppo Tim (2020), *5G & Supply Chain*. https://www.gruppotim.it/content/tiportal/it/notiziariotecnico/edizioni-2020/n-3-2020/7-5G-Verticals-Abilitatori-Package/approfondimenti-1.html.

[2] [Gartner] – Gartner (2020), *Gartner Top 8 Supply Chain Technology Trends for 2020*. https://www.gartner.com/smarterwithgartner/gartner-top-8-supply-chain-technology-trends-for-2020/.

[3] [Automation Anywhere] – Automation Anywhere, (2021) *Hyperautomation is end-to-end automation accomplished by harnessing the power of multiple technologies*. https://www.automationanywhere.com/rpa/hyperautomation.

[4] [Forbes] – Forbes (2018), *What Is Continuous Intelligence?* https://www.forbes.com/sites/forbestechcouncil/2018/10/18/what-is-continuous-intelligence/?sh=72687aa27d25.

3 Terms and definitions

3.1 Terms defined elsewhere

None.

3.2 Terms defined here

None.

4 Abbreviations and acronyms

5G 5th Generation of mobile networks

AI Artificial Intelligence

AR Augmented Reality

BC Blockchain

DDC	Data Driven Company
eMBB	enhanced Mobile BroadBand
ERP	Enterprise Resource Planning
GCA	Global CyberSecurity Agenda
IoT	Internet of Things
KPI	Key Performance Indicator
LCA	Life Cycle Assessment
ML	Machine Learning
mMTC	massive Machine Type Communication
SDGs	Sustainable Development Goals
UN	United Nations
URLLC	Ultra Reliable Low Latency Critical Communications
VR	Virtual Reality
WTO	World Trade Organization

5 Environmental efficiency of machine learning processes in supply chain management

5.1 ML and AI in procurement and supply chain

For the procurement and supply chain management function of many businesses, the adoption of machine learning (ML) and artificial intelligence (AI) for renewal of their traditional technologies and processes (e.g., with real-time analytics or process automation) is a key factor of development and digital transformation. This is essential to gain efficiency, accuracy, and strategic decision-making that can help build and maintain a competitive advantage.

ML and AI in procurement contribute to *minimizing costs* (in both overall spending and supply chain management in particular), *effective data management* (optimization of collection, management, and spend analysis, inventory, and performance/compliance data), *risk management* (risk exposure generated by an internal factor, e.g., fraud, rogue spend, process inefficiencies, etc., or external ones, e.g., quality/price/contract management issues, market risks, natural disasters and pandemics, etc.), *ensuring business agility and supply chain resilience* (through optimized and accurate financial data and a fine-tuned, contingency-ready supply chain that can help preserve business continuity when disaster strikes).

ML and AI solutions integrate digital enhancements that improve accuracy, security, risk management, efficiency, and strategic planning. Procurement organizations can therefore, move beyond the limitations of traditional processes and compete effectively in the modern marketplace.

5.1.1 DDC – data driven company

A data driven company (DDC) is able to take decisions on the basis of real information and data, not on personal opinions or feelings. Digital technology is also able to bring the "data-driven" approach to all company management levels (and the marketing area is nowadays, strictly linked to digital and web analytics).

From a technological point of view, data taken from different sources can be of different types (e.g., structured or unstructured) and is stored and managed in a "data lake", which can further be managed in a flexible and open manner. For example, in the marketing area, the adoption of a specific customer data platform (CDP) gives the possibility to collect and share real-time customer data and to analyse them with advanced analytics or data science systems. ML and AI play a relevant role in this, and blockchain technology with its data certification possibilities, provide relevant contributions to supply chain management improvements (e.g., in the tracking of goods and services, to certify the origin and source of products or services).

5.1.2 5G and supply chain

Future networks will be based on 5th generation of mobile networks (5G), the fifth generation of mobile radio access, already under deployment will link together different technologies, such as artificial intelligence (AI), Internet of things (IoT), augmented reality (AR) / virtual reality (VR), edge computing, etc. 5G will provide enhanced mobile broadband (eMBB), massive machine type communication (MMTC) and URLLC (ultra reliable low latency critical communications). Ubiquity and high velocity data transfer will allow communication with many IoT devices to spread in companies and related supply chain environments (production, transport, final use, decommissioning,), with low latencies and data availability and related management in real-time (Figure 1). The supply chain area will therefore, take advantage of these features in its digital transformation [1]. [Telecom Italia Group – Gruppo Tim].

Figure 1 – Supply chain eco-system

New technological trends will affect and contribute to supply chain evolution, as depicted in Figure 2.

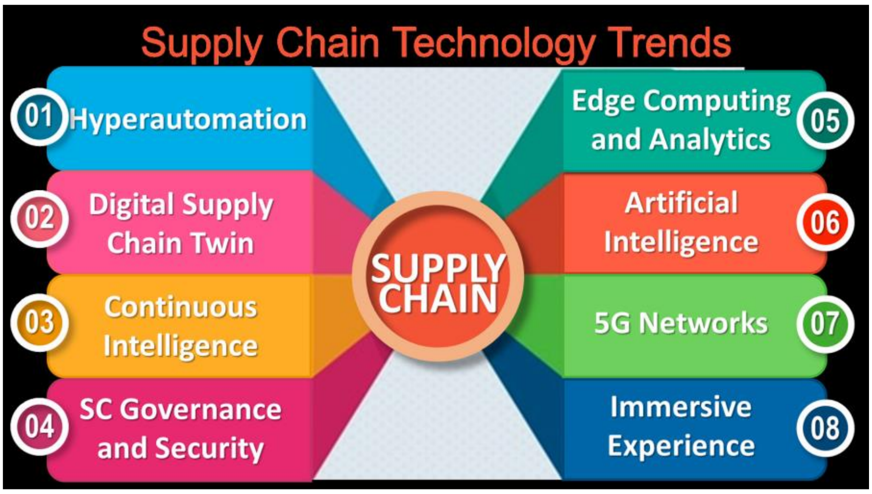

Figure 2 – New technological trends for supply chain

Here is a detailed list of the above new technological trends, that will impact supply chain [2]. [Gartner]:

1) **Hyperautomation**: framework for end-to-end automation of company legacy platforms, going beyond boundaries of single and siloed processes [3]. [Automation Anywhere]. It combines robotic process automation (RPA) tools, machine learning (ML) and artificial intelligence (AI).
2) **Digital supply chain twin**: a digital representation of the physical supply chain. It is derived from all relevant data across the supply chain and its operating environment. This makes the digital supply chain twin (DSCT) the basis for all local and end-to-end decision making.
3) **Continuous intelligence**: ability to process automatically as well as real-time data at a much faster pace than people. Supply chain leaders – or other systems – can look at the processed data, understand what is happening and take action immediately [4]. [Forbes].
4) **Supply chain governance and security**: an increasingly important macro trend, as global risk events are on the rise and security breaches impact companies on both the digital and physical levels. Use of advanced track-and-trace solutions, smart packaging, and next-gen RFID and NFC capabilities.
5) **Edge computing and analytics**: in the edge computing framework, data is processed and analysed close to its collection point, with the use of Internet of things (IoT) devices. Its technology is needed when there is a demand for low-latency processing and real-time, automated decision making. Edge computing is right now making its way into the manufacturing industry. For example, some organizations have adopted driverless forklifts for their warehouses. Heavy equipment sellers can use edge computing to analyse when a part needs maintenance or replacement.
6) **Artificial intelligence**: in the supply chain, AI provides a toolbox of technological options that help companies understand complex content, engage in a natural dialogue with people, enhance human performance and take over routine tasks. Currently, AI helps supply chain leaders solve longstanding challenges around data silos and governance. Its capabilities allow for more visibility and integration across networks of stakeholders that were previously remote or disparate.
7) **5G networks**: 5G is a massive step forward with regard to data speed and processing capabilities. The ubiquitous nature of 5G boosts its potential for supply chains. For example, running a 5G network in a factory can minimize latency and enhance real-time visibility and IoT capabilities.
8) **Immersive experience**: virtual, augmented, and mixed reality has the potential to radically influence the trajectory of supply chain management. Those new interaction models amplify human capabilities, and companies already see the benefits in use cases like onboarding new workers through immersive on-the-job training in a safe, realistic virtual environment.

5.2 Environmental efficiency of ML/AI in supply chain management

5.2.1 Introduction

Adoption of ML, AI, and other emerging technologies (e.g., blockchain, 5G) brings together huge data processing and computing in server farms that host an increasing number of processing and storage systems, related to relevant environmental impacts (e.g., energy consumption, end of life and waste management of systems). The best available techniques (BAT) and recommendations for environmental impact reduction of these systems and technologies shall therefore, be adopted to have a green supply chain management.

It must also be said that improvements in the environmental efficiency of processes involved in supply chain management are foreseen from the adoption of ML, AI, and other emerging technologies in this area. Positive effects are foreseen, for example, on optimization of goods transportation and distribution (e.g., reduction or optimizations of trucks rolls) with the management of the supply chain supported by ML and AI, both for supplier and final customer sides.

In the following paragraphs the relevant references for environmental efficiency, made available from the main technical standardization bodies, are listed.

5.2.2 ITU-T Recommendations

1) ITU-T Recommendations:

a) L.12nn series on sustainable power solutions for ICT networks, specifically:

L.1200	Direct current power feeding interface up to 400 V at the input to telecommunication and ICT equipment
L.1205	Interfacing of renewable energy or distributed power sources to up to 400 VDC power feeding systems
L.1206	Impact on ICT equipment architecture of multiple AC, -48VDC or up to 400 VDC power inputs
L.1207	Progressive migration of a telecommunication/information and communication technology site to 400 VDC sources and distribution
L.1210	Sustainable power-feeding solutions for 5G networks
L.1220	Innovative energy storage technology for stationary use – Part 1: Overview of energy storage
L.1221	Innovative energy storage technology for stationary use – Part 2: Battery
L.1222	Innovative energy storage technology for stationary use – Part 3: Supercapacitor technology

b) L.13nn series on energy efficiency of ICT infrastructures, specifically:

L.1300	Best practices for green data centres
L.1302	Assessment of energy efficiency on infrastructure in data centres and telecom centres
L.1303	Functional requirements and framework of green data centre energy-saving management system
L.1304	Procurement criteria for sustainable data centres
L.1305	Data centre infrastructure management system based on big data and artificial intelligence technology
L.1310	Energy efficiency metrics and measurement methods for telecommunication equipment
L.1316	Energy efficiency framework
L.1320	Energy efficiency metrics and measurement for power and cooling equipment for telecommunications and data centres
L.1325	Green ICT solutions for telecom network facilities
L.1330	Energy efficiency measurement and metrics for telecommunication networks
L.1331	Assessment of mobile network energy efficiency
L.1332	Total network infrastructure energy efficiency metrics

L.1350 Energy efficiency metrics of a base station site

L.1351 Energy efficiency measurement methodology for base station sites

L.1360 Energy control for the software-defined networking architecture

L.1361 Measurement method for energy efficiency of network functions virtualization

L.1362 Interface for power management in network function virtualization environments - Green abstraction Layer version 2

L.1370 Sustainable and intelligent building services

L.1371 A methodology for assessing and scoring the sustainability performance of office buildings

L.1380 Smart energy solution for telecom sites

L.1381 Smart energy solutions for data centres

L.1382 Smart energy solution for telecommunication rooms

c) L.14nn series on life cycle assessment, (LCA) with specific reference to the following ones:

L.1400 Overview and general principles of methodologies for assessing the environmental impact of information and communication technologies

L.1410 Methodology for environmental life cycle assessments of information and communication technology goods, networks and services

L.1420 Methodology for energy consumption and greenhouse gas emissions impact assessment of information and communication technologies in organizations

L.1430 Methodology for assessment of the environmental impact of information and communication technology greenhouse gas and energy projects

L.1450 Methodologies for the assessment of the environmental impact of the information and communication technology sector

L.1470 Greenhouse gas emissions trajectories for the information and communication technology sector compatible with the UNFCCC Paris Agreement

2) Key performance indicators from U4SCC – united for smart sustainable cities

The U4SSC developed a set of international key performance indicators (KPIs) for smart sustainable cities (SSC) to establish the criteria to evaluate ICT's contributions in making cities smarter and more sustainable, and to provide cities with the means for self-assessments, to achieve the sustainable development goals (SDGs). These KPIs can be found in the Collection Methodology for Key Performance Indicators for Smart Sustainable Cities.

Figure 3 – KPIs from U4SSC

The KPIs related to environmental topics included in this methodology can be used as a reference to measure/verify environmental efficiency of machine learning processes in supply chain management:

ITU-T also published the following Recommendations on KPIs:

– Y.4900: Overview of key performance indicators in smart sustainable cities
– Y.4901: Key performance indicators related to the use of information and communication technology in smart sustainable cities
– Y.4902: Key performance indicators related to the sustainability impacts of information and communication technology in smart sustainable cities
– Y.4903: Key performance indicators for smart sustainable cities to assess the achievement of sustainable development goals
– Y.4904: Smart sustainable cities maturity model
– Y.4905: Smart sustainable city impact assessment

6 e-procurement platform

This chapter highlights how e-procurement platforms can enable the full use of AI and blockchain (BC) in the optimization of supply chain management, particularly in case it is multilingual, resulting in optimal solutions for all stakeholders.

6.1 Background

6.1.1 Environmental challenge

Environment is the biggest challenge that the modern world is faced with. It is imperative that we reduce carbon footprints from all facets of our lives to save the planet for future generations. In the recent decades, we have been quite reckless with our developmental activities, at the cost of the health of the planet. In the past few years, the International Telecommunication Union (ITU) and other international organisations have been actively engaged in taking various measures for reversing this trend. Leveraging modern technologies for mitigating these challenges is one such step. This Technical Report focuses, in this perspective, on supply chain management.

6.1.2 Supply chain management

In the past, the supply of most of the commodities to any consumption centre used to be as localised as possible. **Cost of transportation** and the **time taken** in shifting the goods from the producers to the main markets for consumers used to be an important factor in determining where the goods should be sourced from.

However, with reduction in transportation costs on account of several factors, and the use of cold storages in the transportation of perishable commodities, and the World Trade Organization (WTO) interventions have ensured that one could even get commodities like milk, vegetables and fruits from a country across continents. While it might sound exciting that human beings are able to eat apples from New Zealand while sitting in Europe, such moves have huge implications on the environment in terms of carbon footprints.

The question remains is how can such things be remedied, and what role can ITU play in this? This is where artificial intelligence/machine learning can play a role by ensuring the reduction in carbon footprints and controlling the procurement system in a transparent manner.

6.2 Concept

It is proposed that we build an automated e-procurement system that has the following features:

1) It is built keeping the environment in mind. Artificial intelligence and machine learning tools can be optimised in such a manner that:
   - **Transportation** over a long distance has an inbuilt penalty. Longer the distance from where the supplies are made, lesser the marks in preference for procurement.
   - Use of **natural fibres** for the raw materials are preferred over plastics and other materials which are a challenge to the environment.
   - Even the type of **packing materials** used would determine the preference. Natural fibres are preferred over onetime usable plastics.
   - **Quality of the product** continues to be an important parameter.
2) Transparency, so that the suppliers who are not influential, and are not capable of pulling strings, are also in a position to get a fair chance.
3) Removing language as a barrier for participating in the bidding process by use of multilingual e-procurement platforms.
4) The entire process is automated with little scope for human intervention.

This concept is explained in Figure 4.

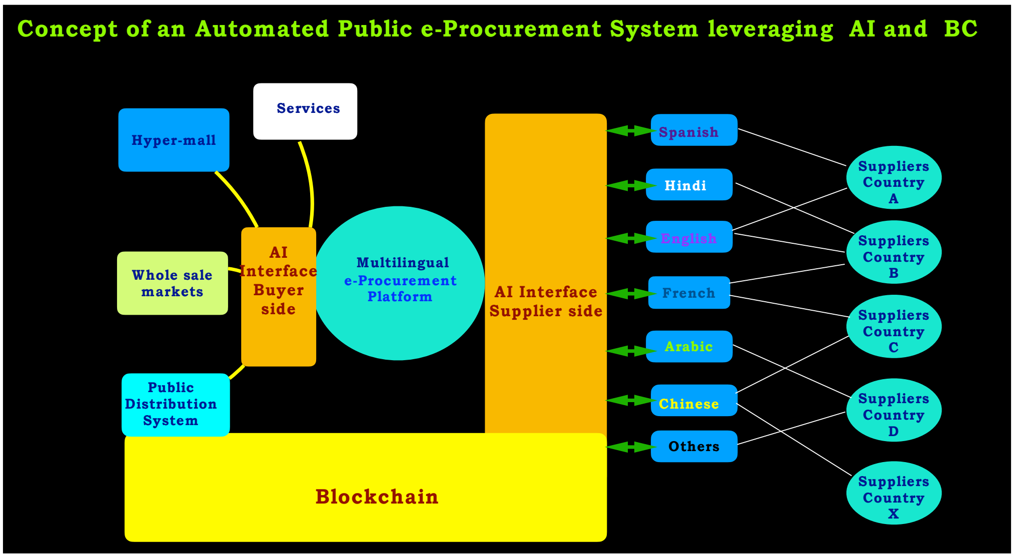

Figure 4 – Automated e-procurement system

The various components of this system is briefly explained in the following paragraphs, further elaborated on the e-tendering platform.

Buyers side

Various types of buyers could be:

- Wholesale market for goods
- Hyper malls for goods
- Public distribution system for governments
- Services for government/private sectors.

From the buyer side the enterprise resource planning (ERP) system could keep a track of the consumption patterns and generate demands on the e-procurement system in an automated way.

AI interface buyers' side

This firms up the demand and plan the goods and services to be procured based on the turnaround time in the whole chain. It would pass on a firm requisition on the e-procurement platform, in tune with the inventory management process.

e-procurement platform

This processes the entire requirement on a real-time basis, and generate a request for proposal from all the registered bidders for various goods and services. The registered bidders from any part of the globe have to meet the basic minimum qualifications to ensure:

- International quality norms
- Transparency norms
- Security norms.

Besides this, the e-procurement platform must ensure:

- Factoring in the environmental costs for each supplier location and including the raw materials used in the packaging;
- Total integrity;
- Complete transparency;
- Multilingual-so that language does not become a barrier for the small suppliers;

- Binding the suppliers to meet their commitment, in terms of security deposits, etc. by following the conventional / manual tendering system.

AI interface supplier side

This would ensure interface of the suppliers in their preferred language with the e-procurement system.

Blockchain

This ensures transparency and security in the entire process, through maintenance of a hyper ledger. This would be in addition to the inbuilt security and transparency functionalities of the e-procurement application software.

6.3 e-procurement platform - need for security, transparency and integrity

The objectives of ITU-D, according to the ITU strategic plan, include capacity building and development. It also includes expanding the benefits of the information society to membership, in cooperation with public and private stakeholders, and to promote the integration of the use of telecommunications/ICTs into the broader economy and society as drivers of development, innovation, well-being, growth and global productivity.

Another fundamental role of ITU is to build confidence and security in the use of information and communication technologies (ICTs). In 2007, ITU launched the **global cybersecurity agenda** (GCA), as a framework for international cooperation in this area.

Keeping these strategic goals of ITU in view, it is imperative that improvement in the management of supply-chain can be an important driver of growth, productivity and well-being.

Within the overall supply-chain function, the **procurement through tendering process** is perhaps the most critical, from '**integrity and transparency**' perspectives, besides directly and significantly impacting the efficiency of the supply-chain. This is important as businesses can make progress towards the sustainable development goals (SDGs) of the United Nations (UN), especially SDG-12 which entails **responsible consumption and production**, only if businesses have 'transparency and integrity' in the supply-chain processes. Paragraph-32 of the UN 2030 agenda emphasizes the need for "transparency of action and support".

Some relevant facts which need to be kept in mind are:

- 10% to 20% of the GDP of a country is due to public-procurement.
- Governments in various countries are shifting from manual procurement to e-tendering / e-procurement.
- e-tendering / e-procurement platforms are not standardized, and some of these could also be used for '**technology-based bid-manipulation and other malpractices**'.

Keeping in view ITU's strategic-goals, UN's SDGs and the facts that are briefly outlined above, relating to e-tendering / e-procurement, an important and relevant area for ITU to look at could be – 'ensuring integrity, transparency, accountability and efficiency in e-procurement, through the adoption of a suitable '**framework**', and a '**model e-procurement system of unquestionable integrity and transparency**'.

6.3.1 Other aspects relating to environmental efficiency:

Other aspects of environmental efficiency that are in the adoption of e-procurement by governments for public procurement include:

- Saving in paper related to publishing of tender notices and tender documents, and massive amounts of paper consumed in submission and evaluation of bids.

- Fuel and other costs saved due to travel and commuting which is related to participating in tenders that are conducted through the manual process thereby becoming redundant with e-tendering / e-procurement.

6.3.2 Focus on design of the e-tendering / e-procurement application

Broadly, an e-tendering / e-procurement system consists of 'hosting and network infrastructure', and '**the e-tendering / e-procurement application software**'. While the guidelines and framework for hosting network infrastructure are well established, it is in the area of e-tendering / e-procurement application software that urgent attention is required especially if ITU enables the establishment of '**model e-procurement system of unquestionable integrity and transparency**'.

In this context, some excerpts from a publication of ITU titled, 'Guide to developing a national cybersecurity strategy' may be referred to:

> *5.2 Focus area 2 – Risk management in national cybersecurity: … a risk-management approach should be adopted, as cyber-risks cannot be fully eliminated … Importantly, for the procurement and development of infrastructure or services, the risk-management methodology should furthermore provide guidance on minimising risk through secure architecture and design, recognising that* ***security is best achieved where it is an integral part of the design process of a product, process or service*** *(security by design)…*
>
> *… 5.2.4 Establishing cybersecurity policies: ….*
>
> *For example, this could include policies that address cybersecurity in procurement or development, …*

While the above cybersecurity related prescriptions of ITU are general, **references** to some important papers/publications relating to integrity, transparency and security, specifically in the field of e-tendering / e-procurement are given towards the end of this chapter.

6.4 Way forward

Keeping the above objectives of ITU in view, it is possible to help set up a **model e-procurement platform** which is multilingual, with special emphasis on security, transparency and integrity, with AI and ML being leveraged to meet the objectives of environmental efficiency.

6.5 References for e-procurement platform

[1] e-TEG (2013). Final report issued in 2013 by the e-Tendering Expert Group appointed by the European Commission. *Recommendations for effective Public e-Procurement, Part II: Operational Recommendations*. [Online]. Available at http://www.osservatorioappalti.unitn.it/viewFile.do?id=1357834384582&dataId=5906&filename=Testo.pdf

[2] iCISA (2018a). PursuIT May 2018 Issue, Audit Aids: *Integrity Issues to be kept in Perspective during Audit of E-Procurement Systems*. [Online]. Available at https://icisa.cag.gov.in/view/pdf/aHR0cHM6Ly9pY2lzYS5jYWcuZ292LmluL3Jlc291cmNlX2ZpbGVzLzkxMDlhM2FlMzUzNGY3YzJhOWI5MmI4ZGRkNTliNWExLnBkZg==

[3] iCISA (2018b). PursuIT Second Half-yearly Issue, Audit Aids: *Integrity Issues to be kept in Perspective during Audit of E-Procurement Systems*. [Online]. Available at https://icisa.cag.gov.in/view/pdf/aHR0cHM6Ly9pY2lzYS5jYWcuZ292LmluL3Jlc291cmNlX2ZpbGVzLzNhZmZhMzFjYzExY2ViNTc4MWExNTEwMDQ3Yjk5OWZkLnBkZg==

[4] Kohli, J. (2012). *Red flags in e-procurement/ e-tendering for public procurement and some remedial measures*. Paper presented at the IPPC5 in Seattle, USA. [Online]. Available at http://www.ippa.org/IPPC5/Proceedings/Part2/PAPER2-6.pdf

[5] Kohli, J. (2015). C*ombating Organized Corruption in Public-procurement Through Appropriately Designed e-Procurement Systems*. Paper presented at the Third Conference on Evidence-Based Anti-Corruption Policies (CEBAP III) on Organized Corruption', organized by Thailand's National Anti-Corruption Commission (NACC) in collaboration

with the World Bank et al., Bangkok, Thailand, June17-18, 2015. https://icisa.cag.gov.in/resource_files/9109a3ae3534f7c2a9b92b8ddd59b5a1.pdf

[6] Kohli, J. (2016). *Avoiding the Volkswagen Emissions Scandal in E-procurement Systems: Imperative of Transparent Disclosure Norms and Certification of Critical Functionalities.* Paper presented at the IPPC7 at Bali, Indonesia, August 4-6, 2016. [Online]. Available at http://www.ippa.org/images/PROCEEDINGS/IPPC7/Paper41_Kohli.pdf

[7] STQC (2011). *Guidelines for Compliance to Quality Requirements of eProcurement Systems*, issued on 31st August 2011 by STQC, Ministry of Electronics and Information Technology (MeitY), Government of India. [Online]. Available at https://www.academia.edu/34302220/Guidelines_for_compliance_to_Quality_requirements_of_eProcurement_Systems_STQC_Directorate

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