Addleton Academic Publishers

Journal of Self-Governance and Management Economics 8(3), 2020
pp. 16–22, ISSN 2329-4175, eISSN 2377-0996

Product Decision-Making Information Systems, Real-Time Big Data Analytics, and Deep Learning-enabled Smart Process Planning in Sustainable Industry 4.0

Elisabeth Peters
e.peters@aa-er.org
The Cognitive Artificial Intelligence
Systems Laboratory at ISBDA, Cambridge, England
(corresponding author)
Tomas Kliestik
tomas.kliestik@fpedas.uniza.sk
Faculty of Operation and Economics
of Transport and Communications,
Department of Economics,
University of Zilina, Zilina, Slovak Republic
Hussam Musa
hussam.musa@umb.sk
Faculty of Economics, Matej Bel University,
Banska Bystrica, Slovak Republic
Pavol Durana
pavol.durana@fpedas.uniza.sk
Faculty of Operation and Economics
of Transport and Communications,
Department of Economics,
University of Zilina, Zilina, Slovak Republic

ABSTRACT. This article presents an empirical study carried out to evaluate and analyze sustainable Industry 4.0. Building our argument by drawing on data collected from Capgemini, Deloitte, McKinsey, MHI, we.CONECT, and World Economic Forum, we performed analyses and made estimates regarding the relationship between product decision-making information systems, real-time big data analytics, and deep learning-enabled smart process planning. Data collected from 4,600 respondents are tested against the research model by using structural equation modeling.

JEL codes: E24; J21; J54; J64

Keywords: big data analytics; Industry 4.0; smart process planning; deep learning

How to cite: Peters, E., Kliestik, T., Musa, H., and Durana, P. (2020). "Product Decision-Making Information Systems, Real-Time Big Data Analytics, and Deep Learning-enabled Smart Process Planning in Sustainable Industry 4.0," *Journal of Self-Governance and Management Economics* 8(3): 16–22. doi:10.22381/JSME8320202

Received 7 July 2020 • Received in revised form 5 September 2020
Accepted 7 September 2020 • Available online 9 September 2020

1. Introduction

Industry 4.0 generates significant alterations to the structure of manufacturing plants concerning their value proposition (Andrei et al., 2016a, b; Hoffman and Friedman, 2018; Nica, 2015) and the advancement of their production interconnected system, supplier base, and customer networks. (Culot et al., 2020)

2. Conceptual Framework and Literature Review

By networking machines, parts, and systems (Andrei et al., 2020; Krizanova et al., 2019; Lăzăroiu et al., 2019; Mihăilă et al., 2018; Popescu et al., 2018a, b), smart shared interconnected channels can be configured throughout the supply chain (Lăzăroiu et al., 2017; Majerova et al., 2020; Nica et al., 2014; Popescu, 2014; Reicher, 2019), articulating smart manufacturing by self-governing supervision. (Zolotová et al., 2020) Large-scale product customization requires companies to swiftly react to customer demands, flexibly reorganize equipment and calibrate operational specifications for accidental system breakdowns and product quality issues (Duşmănescu et al., 2016), and modernize obsolete systems with cutting-edge technologies. (Kim et al., 2020)

3. Methodology and Empirical Analysis

Building our argument by drawing on data collected from Capgemini, Deloitte, McKinsey, MHI, we.CONECT, and World Economic Forum, we performed analyses and made estimates regarding the relationship between product decision-making information systems, real-time big data analytics, and deep learning-enabled smart process planning. Data collected from 4,600 respondents are tested against the research model by using structural equation modeling.

4. Results and Discussion

The workplace monitoring system advances towards adjustable smart manufacturing (Lăzăroiu, 2018; Lăzăroiu et al., 2020a, b; Mihăilă, 2017; Moghtader, 2018; Pilkington, 2018; Popescu et al., 2019) through heterogeneous customer requirements. (Li et al., 2020) To scale up the machine learning patterns for data inspection, huge volumes of data are needed to train them and facilitate incessant model updates. (Lewis Bowler et al., 2020) (Tables 1–8)

Table 1 % of contributors to success with data and analytics (asked of those who reported being effective at meeting objectives)

Constructing a strategy to pursue data and analytics	36
Ensuring senior-management leadership of analytics	33
Designing effective data architecture/technology infrastructure to support analytics activities	26
Developing a workforce that understands how to use analytics	25
Getting business users to apply analytics insights consistently in day-to-day work.	22

Sources: McKinsey; our survey among 4,600 individuals conducted June 2020.

Table 2 What advantages/optimizations do you expect for your company through Industry 4.0/Industrial Internet of Things? (%)

Increased efficiency	42
Competitiveness	27
Increased productivity	24
Faster decision-making	19
Reduction of costs	14
Increase in sales	9
Increase in quality	7

Sources: we.CONECT; our survey among 4,600 individuals conducted June 2020.

Table 3 Which topics/production areas will become more important in your company in the next 12 months? (%)

Big data/Data analytics	29
Cloud/Internet of Things platforms	19
Operational excellence	17
Production: IT/MES	14
Human machine collaboration	12
Robotics	11
Sensor/Automation technology	10
Cyber security	9
Additive manufacturing	6
Predictive maintenance	7

Sources: we.CONECT; our survey among 4,600 individuals conducted June 2020.

Table 4 Actions taken in preparation for the changes in the next 10 years (%)

Partnering with vendors to better understand applications and benefits	52
Began piloting new technologies	48
Increased investment/budget for innovative technologies	45
Recruiting for different skillsets to align with future needs	42
Changing organizational structure/incentives to create innovation culture	39
Reskilling and training workers for emerging technologies	36

Sources: MHI; Deloitte; our survey among 4,600 individuals conducted June 2020.

Table 5 The most valuable 5G-enabled use cases
for shop floor and supply chain areas (%)

Real-time analytics leveraging edge computing	87
Video surveillance of remote production lines	84
Remote control of distributed production line	82
Artificial intelligence-enabled and remote-controlled motion (e.g., collaborative robots, self-driven cars, drones)	79
Real-time service and breakdown alerts	77
Remote operations/maintenance/training solutions through AR/VR	75
Predictive/preventive maintenance	73
Self-triggered order placement based on inventory level	82
Virtual testing of parts and packing from suppliers	80
Remote monitoring of en-route shipment conditions (e g., temperature, humidity)	77

Sources: Capgemini; our survey among 4,600 individuals conducted June 2020.

Table 6 Industry 4.0 priorities on which organizations have made progress
by having comprehensive, holistic strategies (%)

Protecting our organization from disruption	79
Developing innovative/differentiated products and services	64
Finding growth opportunities for existing products and services	62
Making effective Industry 4.0 technology investments	80
Connected, integrated approach to implement Industry 4.0 technologies	57
Attracting and retaining the right talent	59
Understanding what skills will be needed	76
Training and developing workforce	78
Utilizing new labor models	82
Making a profit while positively contributing to society	74
Investing in Industry 4.0 tech with a positive societal impact	62

Sources: Deloitte; our survey among 4,600 individuals conducted June 2020.

Table 7 Projected (2022) strategies to address shifting skills needs,
by proportion of companies (%, likely)

Hire new permanent staff with skills relevant to new technologies	86
Look to automate the work	84
Retrain existing employees	69
Expect existing employees to pick up skills on the job	68
Outsource some business functions to external contractors	67
Hire new temporary staff with skills relevant to new technologies	65
Hire freelancers with skills relevant to new technologies	57
Strategic redundancies of staff who lack the skills to use new technologies	50

Sources: World Economic Forum; our survey among 4,600 individuals conducted June 2020.

Table 8 % of challenges to success with data and analytics (asked of those who reported being ineffective at meeting objectives)

Constructing a strategy to pursue data and analytics	42
Designing effective data architecture/technology infrastructure to support analytics activities	33
Securing talent with skills required to develop data and analytics projects	27
Ensuring senior-management leadership of analytics	26
Developing a workforce that understands how to use analytics	20

Sources: McKinsey; our survey among 4,600 individuals conducted June 2020.

5. Conclusions and Implications

Machine learning procedures necessitates massive quantities of quality training datasets, while concerning supervised machine learning, manual input is routinely needed for labeling them. (Alexopoulos et al., 2020) The volume of data gathered and distributed has improved both predictive precision and enablement of prescriptive solutions. (Schniederjans et al., 2020)

Survey method
The interviews were conducted online and data were weighted by five variables (age, race/ethnicity, gender, education, and geographic region) using the Census Bureau's American Community Survey to reflect reliably and accurately the demographic composition of the United States. Sampling errors and test of statistical significance take into account the effect of weighting. Stratified sampling methods were used and weights were trimmed not to exceed 3. Average margins of error, at the 95% confidence level, are +/-2%. For tabulation purposes, percentage points are rounded to the nearest whole number. The precision of the online polls was measured using a Bayesian credibility interval. An Internet-based survey software program was utilized for the delivery and collection of responses.

Data and materials availability
All research mentioned has been published and data is available from respective outlets.

Funding
This paper was supported by the Slovak Research and Development Agency under Grant no. APVV-17-0546: *Variant Comprehensive Model of Earnings Management in Conditions of The Slovak Republic as an Essential Instrument of Market Uncertainty Reduction.*

Author contributions
All authors listed have made a substantial, direct and intellectual contribution to the work, and approved it for publication.

Conflict of interest statement
The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

REFERENCES

Alexopoulos, K., Nikolakis, N., and Chryssolouris, G. (2020). “Digital Twin-driven Supervised Machine Learning for the Development of Artificial Intelligence Applications in Manufacturing,” *International Journal of Computer Integrated Manufacturing* 33(5): 429–439.

Andrei, J.-V., Mieilă, M., Popescu, G. H., Nica, E., and Manole, C. (2016a). “The Impact and Determinants of Environmental Taxation on Economic Growth Communities in Romania,” *Energies* 9(11): 902.

Andrei, J.-V., Ion, R. A., Popescu, G. H., Nica, E., and Zaharia, M. (2016b). “Implications of Agricultural Bioenergy Crop Production and Prices in Changing the Land Use Paradigm – The Case of Romania,” *Land Use Policy* 50: 399–407.

Andrei, J. V., Popescu, G. H., Nica, E., and Chivu, L. (2020). “The Impact of Agricultural Performance on Foreign Trade Concentration and Competitiveness: Empirical Evidence from Romanian Agriculture,” *Journal of Business Economics and Management* 21(2): 317–343.

Culot, G., Orzes, G., Sartor, M., and Nassimbeni, G. (2020). “The Future of Manufacturing: A Delphi-based Scenario Analysis on Industry 4.0,” *Technological Forecasting and Social Change* 157: 120092.

Dușmănescu, D., Andrei, J.-V., Popescu, G. H., Nica, E., and Panait, M. (2016). “Heuristic Methodology for Estimating the Liquid Biofuel Potential of a Region,” *Energies* 9(9): 703.

Hoffman, S. F., and Friedman, H. H. (2018). “Machine Learning and Meaningful Careers: Increasing the Number of Women in STEM,” *Journal of Research in Gender Studies* 8(2): 11–27.

Kim, D.-Y., Park, J.-W., Baek, S., Park, K.-B., Kim, H.-R., Park, J.-I., et al. (2020). “A Modular Factory Testbed for the Rapid Reconfiguration of Manufacturing Systems,” *Journal of Intelligent Manufacturing* 31: 661–680.

Krizanova, A., Lăzăroiu, G., Gajanova, L., Kliestikova, J., Nadanyiova, M., and Moravcikova, D. (2019). “The Effectiveness of Marketing Communication and Importance of Its Evaluation in an Online Environment,” *Sustainability* 11: 7016.

Lăzăroiu, G. (2018). “Postmodernism as an Epistemological Phenomenon,” *Educational Philosophy and Theory* 50(14): 1389–1390.

Lăzăroiu, G., Pera, A., Ștefănescu-Mihăilă, R. O., Mircică, N., and Negurіță, O. (2017). “Can Neuroscience Assist Us in Constructing Better Patterns of Economic Decision-Making?,” *Frontiers in Behavioral Neuroscience* 11: 188.

Lăzăroiu, G., Andronie, M., Uţă, C., and Hurloiu, I. (2019). “Trust Management in Organic Agriculture: Sustainable Consumption Behavior, Environmentally Conscious Purchase Intention, and Healthy Food Choices,” *Frontiers in Public Health* 7: 340.

Lăzăroiu, G., Neguriţă, O., Grecu, I., Grecu, G., and Mitran, P. C. (2020a). “Consumers’ Decision-Making Process on Social Commerce Platforms: Online Trust, Perceived Risk, and Purchase Intentions,” *Frontiers in Psychology* 11: 890.

Lăzăroiu, G., Ionescu, L., Uță, C., Hurloiu, I., Andronie, M., and Dijmărescu, I. (2020b). “Environmentally Responsible Behavior and Sustainability Policy Adoption in Green Public Procurement,” *Sustainability* 12(5): 2110.

Lewis Bowler, A., Bakalis, S., and Watson, N. J. (2020). “A Review of In-line and On-line Measurement Techniques to Monitor Industrial Mixing Processes,” *Chemical Engineering Research and Design* 153: 463–495.
Li, J., Chen, D., Peng, Y.-S., Zhang, Z., Tian, Y., Al-Nabhan, N. et al. (2020). “Using Cloud Computing Technology to Design and Implementation of Smart Shop Floor Control System,” *Journal of Ambient Intelligence and Humanized Computing*. doi: 10.1007/s12652-020-02040-9.
Majerova, J., Sroka, W., Krizanova, A., Gajanova, L., Lăzăroiu, G., and Nadanyiova, M. (2020). “Sustainable Brand Management of Alimentary Goods,” *Sustainability* 12(2): 556.
Mihăilă, R. (2017). “The Lying Epidemic,” *Educational Philosophy and Theory* 49(6): 580–581.
Mihăilă, R., Kovacova, M., Kliestikova, J., Kliestik, T., and Kubala, P. (2018). “Deconstructing Masculinist Power Politics in Society: Oppression, Control, and Domination,” *Contemporary Readings in Law and Social Justice* 10(1): 158–164.
Moghtader, B. (2018). “Pastorate Power, Market Liberalism and a Knowing without Knowing,” *Knowledge Cultures* 6(1): 18–35.
Nica, E., Popescu, G. H., Nicolăescu, E., and Constantin, V. D. (2014). “The Effectiveness of Social Media Implementation at Local Government Levels,” *Transylvanian Review of Administrative Sciences* 10(SI): 152–166.
Nica, E. (2015). “Labor Market Determinants of Migration Flows in Europe,” *Sustainability* 7(1): 634–647.
Pilkington, O. A. (2018). “Presented Discourse in Popular Science Narratives of Discovery: Communicative Side of Thought Presentation,” *Linguistic and Philosophical Investigations* 17: 7–28.
Popescu, G. H. (2014). “FDI and Economic Growth in Central and Eastern Europe,” *Sustainability* 6(11): 8149–8163.
Popescu, G. H., Petrescu, I. E., and Sabie, O. M. (2018a). “Algorithmic Labor in the Platform Economy: Digital Infrastructures, Job Quality, and Workplace Surveillance,” *Economics, Management, and Financial Markets* 13(3): 74–79.
Popescu, G. H., Mieilă, M., Nica, E., and Andrei, J.-V. (2018b). “The Emergence of the Effects and Determinants of the Energy Paradigm Changes on European Union Economy,” *Renewable and Sustainable Energy Reviews* 81(1): 768–774.
Popescu, G. H., Andrei, J. V., Nica, E., Mieilă, M., and Panait, M. (2019). “Analysis on the Impact of Investments, Energy Use and Domestic Material Consumption in Changing the Romanian Economic Paradigm,” *Technological and Economic Development of Economy* 25(1): 59–81.
Reicher, Z. R. (2019). “Opportunities for Small and Medium Sized Enterprises in the Field of Corporate Social Responsibility,” *Ekonomicko-manazerske spektrum* 13(1): 26–37.
Schniederjans, D. G., Curado, C., and Khalajhedayati, M. (2020). “Supply Chain Digitisation Trends: An Integration of Knowledge Management,” *International Journal of Production Economics* 220: 107439.
Zolotová, I., Papcun, P., Kajáti, E., Miškuf, M., and Mocnej, J. (2020). “Smart and Cognitive Solutions for Operator 4.0: Laboratory H-CPPS Case Studies,” *Computers & Industrial Engineering* 139: 105471.