



INDUSTRY 4.0 TRENDS IN LITHUANIA AND LEADING EU MANUFACTURING COMPANIES

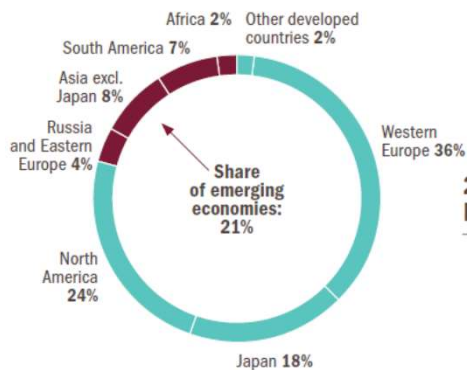
Mantas Vilkas
School of Economics and Business
Kaunas University of Technology, Lithuania

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 810318. The opinions expressed in the document are of the authors only and in no way reflect the European Commission's opinions. The European Union is not liable for any use that may be made of the information.

CONTENT

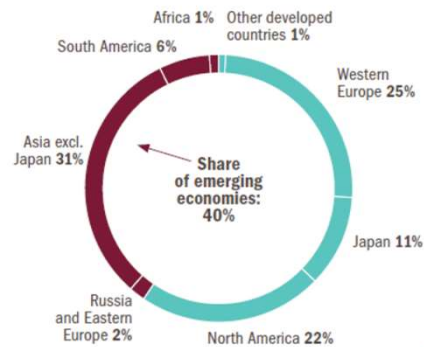
1. **The diffusion of Lean practices, digital innovations and service-oriented business models: data from European manufacturing survey-2018**
 - Ugljesa Marjanovic, Radboud University Nijmegen, The Netherlands
 - Paul E. Ligthart, University of Novi Sad, Serbia
2. **Digital technologies adoption in Leading EU Manufacturing Companies**
 - Rodriguez, O, Aerospace Valley, France
 - Saari, H.-K. , Aerospace Valley, France
3. **Challenges and opportunities of Lithuanian manufacturing companies in the Industry 4.0 context**

1991
EUR 3,451 bn



MANUFACTURING VALUE ADDED IN THE WORLD

2011
EUR 6,577 bn



Change 1991-2011

Asia (excl. Jpan)	+23
North America	-2
Japan	-7
Western Europe	-11

Eurostat, 2018

Roland Berger, 2014

MANUFACTURING VALUE ADDED 2017 M. EU

1. Ireland (36,1%), 2. Czech Rep., (31,7%), 3. Slovenia (27,5 %),
4. Poland (27,2%) ... Lithuania - 10 position (22,7 %)

Increased (2007-2017)	
Ireland	13,1
Serbia	3,7
Latvia	2,1
Poland	1,9
Greece	1,5
Bulgaria	1,2
Lithuania	0,9
Portugal	0,8
Estonia	0,4
Hungary	0,4
Slovenia	0,3
Turkey	0,1
Czech rep.	0

Decreased (2007-2017)	
Spain	-0,1
EU28	-0,5
UK	-0,5
Romania	-0,9
Italy	-1,3
Switzerland	-1,9
Austria	-2,2
Denmark	-2,5
Belgium	-2,7
The Netherlands	-3,1
Slovakia	-3,4
Sweden	-5,3
Finland	-7,2

Eurostat, 2018

DIGITAL INNOVATIONS IN MANUFACTURING: THREE USED CASES

1. New business models: from products to services



2. Increase of competitive advantage: flexibility, cost effectiveness, fast delivery

3. New „smart“ factories: highly productive



THE EXTENT OF DIFFUSION OF DIGITAL INNOVATIONS AND DIGITAL INNOVATIONS-ENABLED BUSINESS MODELS

1. **Diffusion** of lean methods, digital innovation and digital services
2. **Contingent** on size, industry, extent of product mix flexibility?
3. If extensive adoption can constitute competitive advantage?

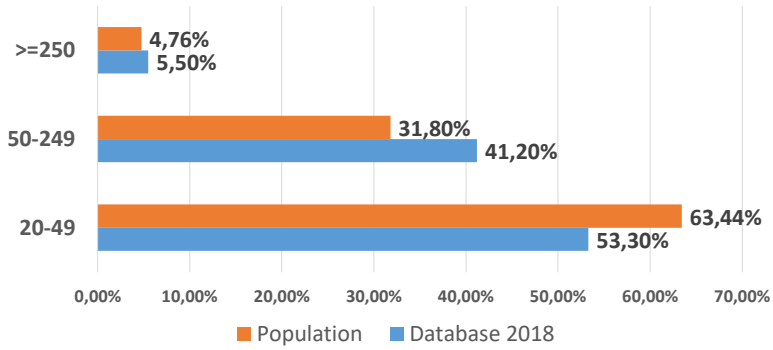
Sample:

Lithuania (200/500); **Serbia** (237); **The Netherlands** (185)

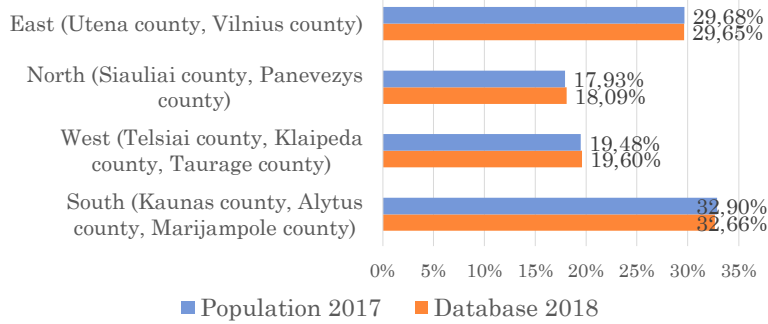
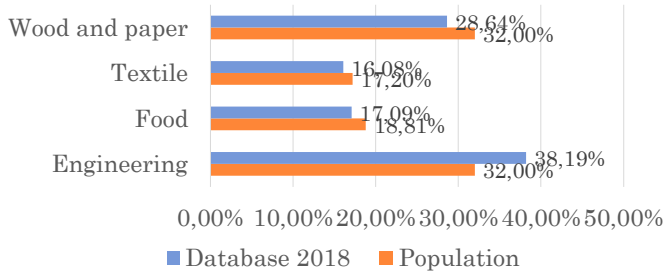


European Manufacturing Survey

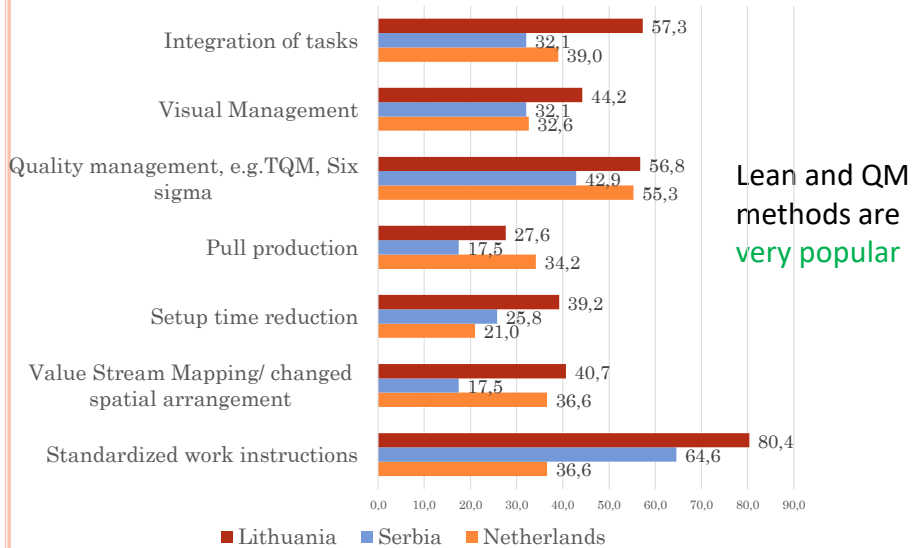
- Starting 2001. Each three years in EU. 15+ countries participate. Data collection in Lithuania in 2018 for the first time.
- Population 8678, **Sample: 500 firms**: 300 firms under 20 employees; 200 firms 20+ employees. Response rate 21,5%.



POPULATION AND SAMPLE



LEAN METHODS

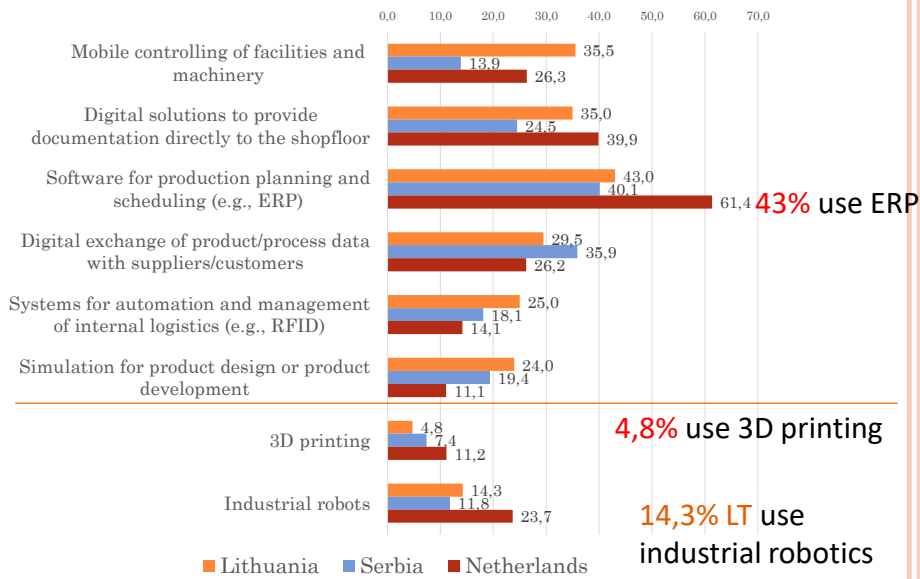


Lean and size

	1 - 9 employees (1)	10 - 49 employees (2)	50 - 249 employees (3)	250+ employees (4)
Standardized work instructions	55,1%	64,4%	87,3%	92,9%
Value Stream Mapping	11,1%	29,8%	40,5%	71,4%
Setup time reduction	16,2%	27,4%	39,2%	64,3%
Pull of production	14,6%	18,3%	34,2%	35,7%
Customer- or product-oriented lines/cells	15,7%	21,6%	40,5%	71,4%
5S	19,2	28,8%	46,8%	64,3%
Total productive/preventive maintenance	42,4%	54,3%	79,7%	78,6%
Statistical process control	15,2%	29,3%	63,3%	85,7% ^c
Visual management	17,7	31,7	48,1%	64,3
Involvement into improvement	62,1%	53,4% ^a	53,2	85,7%
Integration of tasks	21,2%	38,5%	64,6%	71,4%
Customer involvement	53,0%	62,0%	75,9%	92,9%
Development of suppliers	35,9%	44,2%	54,4%	64,3%
Supplier feedback	65,2%	76,9%	84,8%	92,9%
Just-in-time delivery	68,7%	62,5%	51,9%	35,7%

Lean and sector	Engineering (1)	Food (2)	Textile (3)	Wood and furniture (4)
Standardized work instructions	64.8%	79.7%	61.4%	60.0%
Value Stream Mapping	23.2%	39.1%	14.3%	25.8%
Setup time reduction	24.0%	31.3%	24.3%	29.0%
Pull of production	16.8%	26.6%	17.1	21.9%
Customer- or product-oriented lines/cells	21.6%	32.8%	21.4%a	23.9%
5S	30.4%	40.6%	22.9%	20.6%
Total productive/preventive maintenance	48.0%	62.5%	50.0%	59.4%
Statistical process control	29.6%	42.2%	28.6	28.4%
Visual management	27.2%	34.4%	25.7%	31.6%
Involvement into improvement	60.8%	59.4%	52.9%a	54.2%
Integration of tasks	36.8%	43.8%	24.3%b	43.2%
Customer into production	64.8%	70.3%	61.4%a	60.6%
Development of suppliers	47.2%	51.6%	37.1%a	42.6%
Supplier feedback	75.2%	79.7%	64.3%a	75.5%
Just-in-time delivery	61.6%	56.3%	65.7%	62.6%

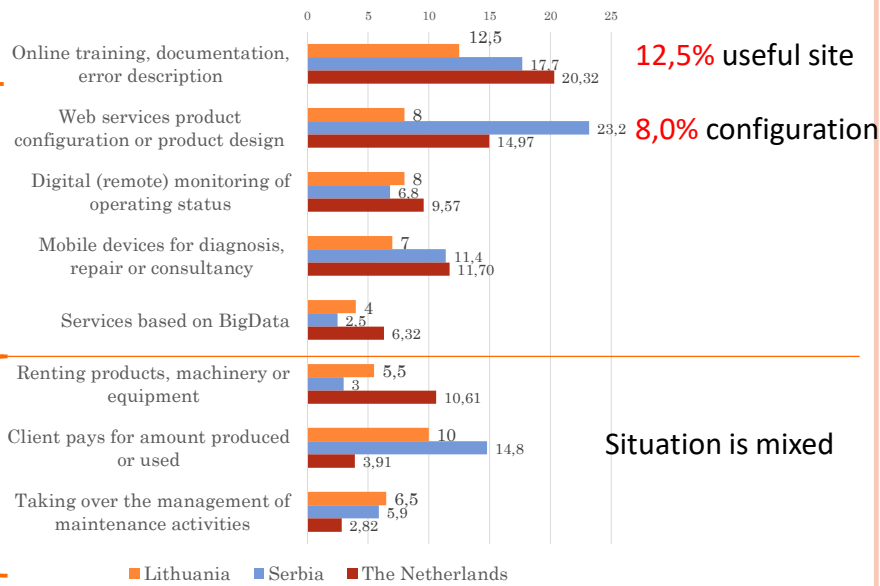
DIGITAL MANUFACTURING INNOVATIONS ,%



Size and digital innovations	20 - 49 (1)	50 - 249 (2)	250+ (3)
Mobile programming and controlling of facilities and machinery	34.0%	37.7	64.3%
Digital solutions to provide documentation directly to the shopfloor	34.0%	42.7%	38.5%
Software for production planning and scheduling	33.0%	56.8%	78.6%
Digital exchange of product/process data with suppliers/customers	33.7%	24.6%	69.2%
Near real-time production control systems	31.9%	37.8%	64.3%
Systems for automation and management of internal logistics	22.4%	26.7%	61.5
Simulation for product design and development	19.4%	32.9%	38.5%
Industrial robots	18.2%	28.6%	21.4%
3D printing	5.4%	8.5%	14.3%a

Sectors and digital innovations	Engineering (1)	Food (2)	Textile (3)	Wood and furniture (4)
Mobile programming and controlling of facilities and machinery	36.2%	37.5%	36.7%	36.4%
Digital solutions to provide documentation directly to the shopfloor	55.3%	20.0%	21.4	43.6%
Software for production planning and scheduling	60.9%	39.4%	35.5%a	42.6%
Digital exchange of product/process data with suppliers/customers	34.0%	35.5%a	24.1%	37.3%
Near real-time production control systems	47.8%	38.7	26.7%	35.8
Systems for automation and management of internal logistics	40.4%	24.2%	31.0	13.2%
Simulation for product design and development	31.9%	12.9%	22.6%a	30.8%
Industrial robots	35.4%	18.2%	23.3%	14.5%
3D printing	10.9%	10.0%	NA	7.8%

DIGITAL SERVICES AND SERVICE-ORIENTED BUSINESS MODELS

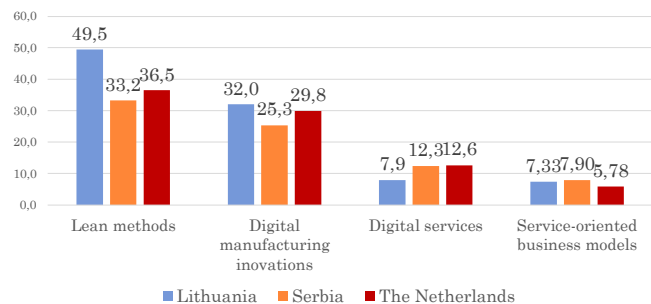


Services and sectors	Engineering (1)	Food (2)	Textile (3)	Wood and furniture (4)
Software development	16.8%	1.6%	4.3%	10.3%
Online training, documentation, error description	22.4%	6.3%	10.0%	12.3%
Web services product configuration or product design	14.4%	6.3%	11.4%	12.9%
Remote monitoring of operating status	16.8%	1.6%	5.7%	7.1%
Mobile devices for diagnosis, repair or consultancy	15.2%	1.6%	7.1	7.7%
Data-based services based on big data analysis	2.4%	NA	1.4%	1.9%
Renting products, machinery or equipment	8.0%	NA	4.3%a	7.7%
Full-service contracts	32.0%	17.2%	22.9%	30.3%
Operation of products at customer site for the customer	19.2%	6.3%	5.7%	14.2%
Taking over the management of maintenance activities	12.0%	1.6%	4.3%	10.3%

Services and type of design	According to customers specification (1)	incorporating customer-specific options (2)	Standard assortment (3)
Software development	11.6%	8.0%	7.7%
Revamping or modernization	17.8%	18.2%	14.1%
Online training, documentation, error description	17.0%	12.5%	14.8%
Web services product configuration or product design	19.1%	5.7%	9.2%
Remote monitoring of operating status	12.9%	5.7%	7.7%
Mobile devices for diagnosis, repair or consultancy	12.0%	3.4%	11.3%
Data-based services based on big data analysis	1.7%	NA	2.1%
Renting products, machinery or equipment	8.7%	2.3%	3.5%
Full-service contracts	40.2%	17.0%	18.3%
Operation of products at customer site for the customer	16.2%	12.5%	12.7%
Taking over the management of maintenance activities	10.8%	6.8%	7.7%

VRIO

FRAMEWORK (BARNEY AND CLARK, 2011)



1. Valuable?	2. Rare?	3. Costly to imitate?	Competitive implications	Performance
No	---	---	Competitive disadvantage	Below average
Yes	No	---	Competitive parity	Average
Yes	Yes	No	Temporary competitive advantage	Above average
Yes	Yes	Yes	Sustainable competitive advantage	Above average

SUMMARY

- Lean methods are positively associated with **size** and the most prevalent in **food sector**
- Digital innovations are positively associated with **size** and most prevalent in **engineering** sector
- Digital services and service oriented business models **is not associated with size**, tend to be prevalent among firms with **high product mix flexibility**, especially in **engineering sector**

- Lean methods, digital innovations are valuable but not rare – they increase possibility of competitive parity and allows not to lag behind
- Digital services and service-oriented business models are less prevalent – may still be a source of **competitive advantage**

CONTENT

1. The diffusion of Lean practices, digital innovations and service-oriented business models: data from European manufacturing survey-2018
 - Ugljesa Marjanovic, Radboud University Nijmegen, The Netherlands
 - Paul E. Ligthart, University of Novi Sad, Serbia

2. **Digital technologies adoption in Leading EU Manufacturing Companies**
 - Rodriguez, O, Aerospace Valley, France
 - Saari, H.-K. , Aerospace Valley, France

3. Challenges and opportunities of Lithuanian manufacturing companies in the Industry 4.0 context

METHODOLOGY

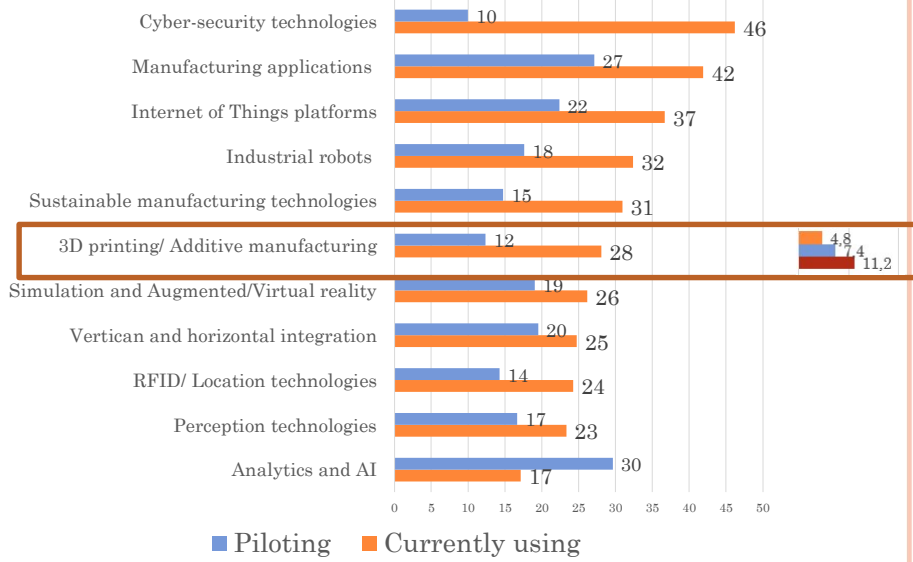
Eleven Industry 4.0 technologies

1. Industrial robotics (Static, Collaborative, Mobile)
 2. RFID/ Location technologies
 3. 3D printing/ Additive manufacturing
 4. Internet of Things platforms
 5. Analytics and AI
 6. Simulation and Augmented/virtual reality
 7. Sustainable manufacturing practices
 8. Perception technologies
 9. Manufacturing applications
 10. Vertical and horizontal integration practices
 11. Cybersecurity
- 35 medium-high and high R&D intensity companies
 - EU manufacturing stars such as
 - Heineken
 - Nokia
 - Philips
 - Bic
 - Liebherr Aerospace
 - Arcelormittal
 - Etc.

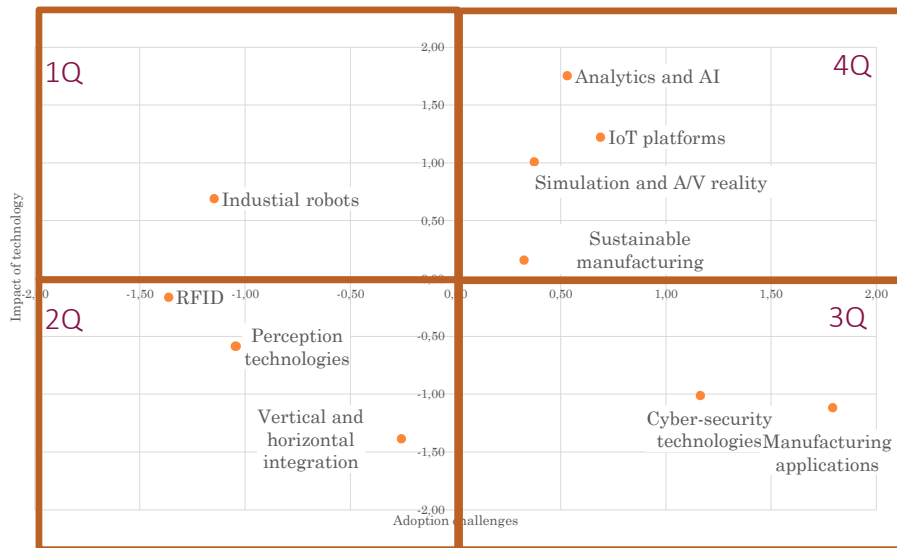
FOCUS ON USED CASES AND ADOPTION STATUS

- **3D printing/ Additive Manufacturing: list of used cases**
 - 3D printing for prototyping, production of demo parts for marketing and trade shows
 - 3D printing for production of low-volume parts or components
 - 3D printing for making tooling and molds on the plant floor as required
 - 3D printing for spare part production
 - 3D printing for making products of complex geometry
- Are you currently using, piloting or planning to invest in the following technologies?
 1. using
 2. piloting
 3. planning to invest < 3years
 4. No plans to invest < 3 years

PILOTED AND USED TECHNOLOGIES, % COMPANIES

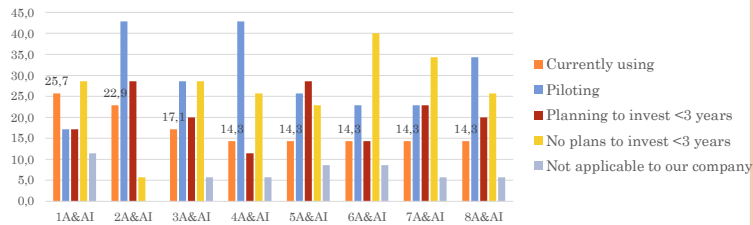


ADOPTION CHALLENGES AND PERCEPTION OF IMPACT ON PERFORMANCE



Vilkas, M., Rodriguez, O., Saari, H.-K. 2020. Digital Technologies and their Use Cases: Evidence from High and Medium-high R&D Intensive Manufacturing Firms. Technical report.

Analytics and AI



- 1A&AI Sales and demand forecasting
- 2A&AI Predictive maintenance
- 3A&AI Product development cycle optimization
- 4A&AI Inventory and parts optimization
- 5A&AI Logistics network and warehouse optimization
- 6A&AI Procurement and spend analysis
- 7A&AI Workforce productivity and efficiency
- 8A&AI Real-time re-planning (including MRP and factory scheduling)

CONTENT

1. The diffusion of Lean practices, digital innovations and service-oriented business models: data from European manufacturing survey-2018
 - Ugljesa Marjanovic, Radboud University Nijmegen, The Netherlands
 - Paul E. Ligthart, University of Novi Sad, Serbia
2. Digital technologies adoption in Leading EU Manufacturing Companies
 - Rodriguez, O, Aerospace Valley, France
 - Saari, H.-K. , Aerospace Valley, France
3. Challenges and opportunities of Lithuanian manufacturing companies in the Industry 4.0 context

CHALLENGES

- Weak demand environment (Baltic states 6 mln.)
- Low R&D expenditures (LT 1,0 %, EU28 2,0% , China 2.1%, USA 2,8%; Israel 4.9%)
- The extent of future labour force (still negative population trends, ageing society)
- Skills
 - Availability of scientists and engineers (52nd out of 100)
 - Quality of vocational training (53 out of 100)
 - ICT specialists % of employment 2,7% (EU 3,9%)
 - ICT graduates 2,7% (EU 3,6%)

OPPORTUNITIES

- Availability and use of digital technologies (1st quartile WEF I4.0 reediness index; important sectorial and size differences exist)
- High exposure to regional and global value chains and exports (65% is exported)
- Increasing economic complexity (28th), 24,5 % of manufacturing value is created by the medium high tech and high-tech industries (Germany 65%)

COLLABORATION OPPORTUNITIES

- European manufacturing survey. Fraunhofer ISI. 15+ EU countries. Next round 2022 spring. Rep. Mantas Vilkas
- Product development survey. Next round 2021 autumn. Rep. Monika Petraite