The mechatronic training strategies to enable new skills for industry realignment towards industry 4.0: the case of Portugal

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1. Introduction

- The Portuguese economy has been recovering after the last financial crisis of 2008 and 2011. However, recovery has been due to the capacity to increase exports of manufactured products and to a decrease in unemployment rates.

- An important contribution has also been achieved by the service sector, especially the tourism that pushed several other service sub sectors to perform better than the previous decades. However, it is important to understand that the entrepreneurial sector (in particular, manufacturing) played a decisive role with higher levels of innovation.

- In recent years, companies have been investing strongly in R&D. In relation to GDP, these expenses in 2016 represented just 0.62% of the total GDP, but it increased to 0.92% in 2020.

- The amount is relatively low, compared to some EU countries, but at the national level it means a recent process of modernization and innovation capacity.

- There has been a continuous growth of imports of machinery and of automobile vehicles. Machinery is not only applied to the automotive sector, but to all manufacturing industries. That means in particular, **new machinery** acquired for new modernization projects, namely those under the **Industry 4.0** concept and other challenges.

2. Challenges for Industry 4.0

- Besides these problems related with the implementation of automation systems, the impact of Industry 4.0 is still unclear.
- We still know little if the regional factor plays a role on that: are the companies in regions with higher industrial experience more open to apply these new concepts?
- Several national initiatives took place in Germany, France, China, Portugal, Italy, Spain and the USA, among others
- They are playing a huge role on the automation development in the industry infrastructure in these countries.
- Further questions about Industry 4.0 should be made to acknowledge and analyse the emerging challenges and the new problems related with organisational changes and technological developments, and especially, with the emergent competence and skill needs of a large portion of the sector labour structure.

3. Methodology

Problem: Almost **no empirical research** on the skills for Industry 4.0 and Electric powertrains in the Portuguese Automotive sector

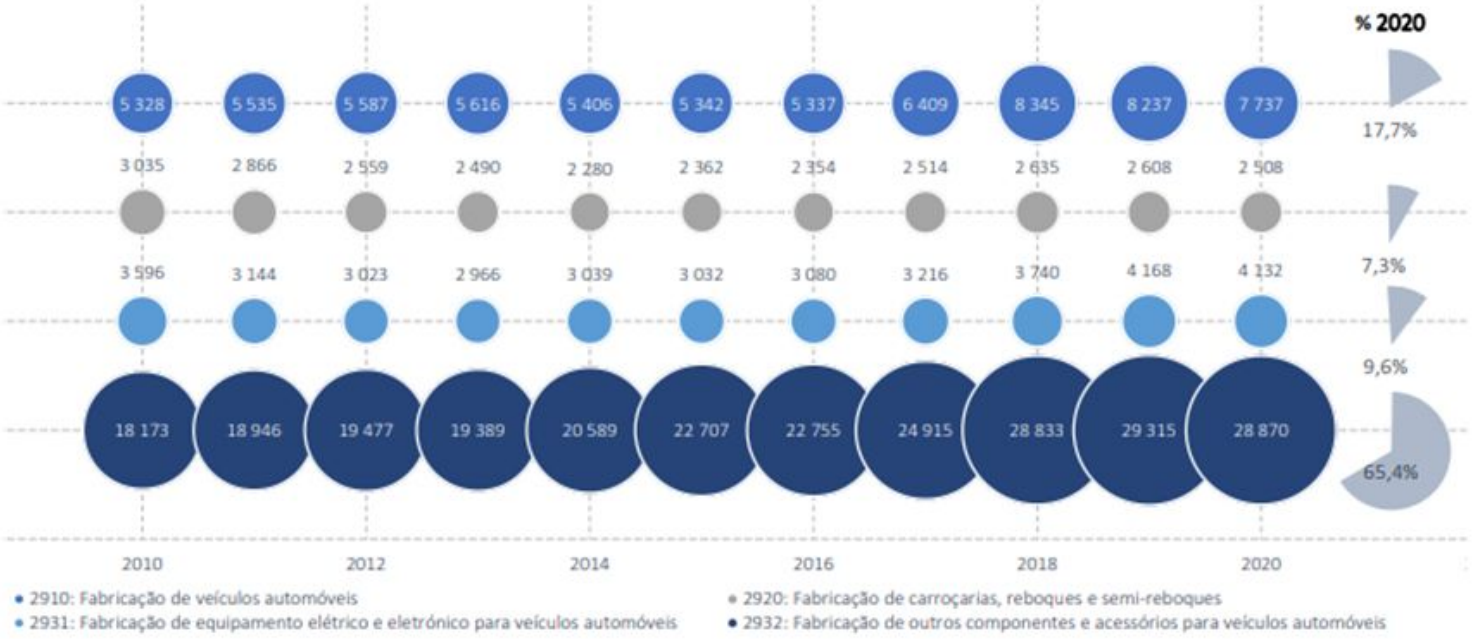
Approach: Mixed methods of quantitative and qualitative to support findings on skills to skilled workers for industry realignment with challenges of one sector (Automotive NACE 29.1 and NACE 29.32) and in one country (Portugal).

- **Desk research** (literature review, quantitative analyses of databases, analyses of official documents and exploratory interviews)
- **Empirical research**:
  - Interviews with representatives of workers (works councils and trade unionists) in firms that developed R&D projects in automotive sector
  - experts on organizational change and labour processes about implications on work organisation, skills and qualifications required

NACE 29.1 - Manufacture of motor vehicles
NACE 29.32 - Manufacture of other parts and accessories for motor vehicles

4. Results - Employment

Figure 1 - Evolution of Employment in the automotive industry, in Portugal, a) by sub sector, 2010 – 2020; b) total employment in the automotive industry 2010-2020



a)

Manufacture of motor vehicles, CAGR 2010-2020 = 4%

Manufacture of bodies for motor vehicles; manufacture of trailers and semi-trailers CAGR 2010-2020= -2%

Manufacture of electrical and electronic equipment for motor vehicles, CAGR 2010-2020 = 1%

Manufacture of other parts (components) and accessories for motor vehicles, CAGR 2010-2020 = 5%

Manufacture of motor vehicles, trailers and semi-trailers, CAGR 2010-2020 = 4%

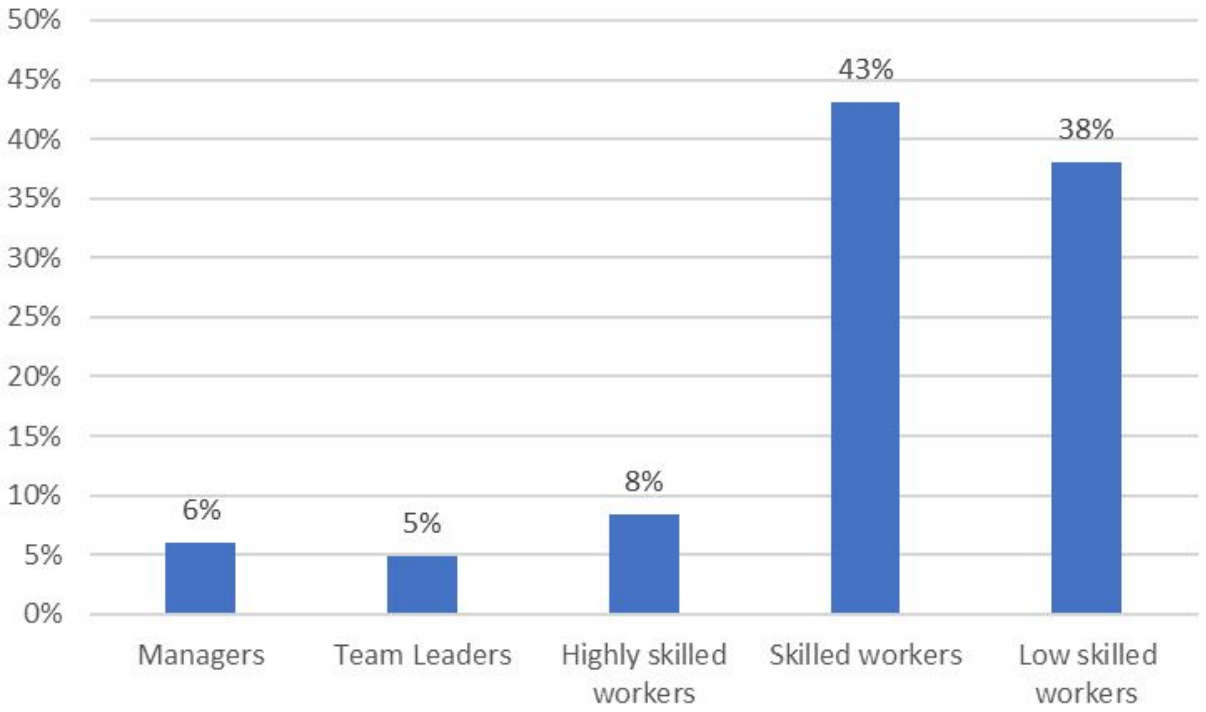
b)

Source: a) Cadernos Temáticos – A Indústria Automóvel em Portugal, 2010 – 2020; b) authors calculation based on Cadernos Temáticos – A Indústria Automóvel em Portugal, 2010 – 2020

Note: CAGR – Composed Annual Growth Rate

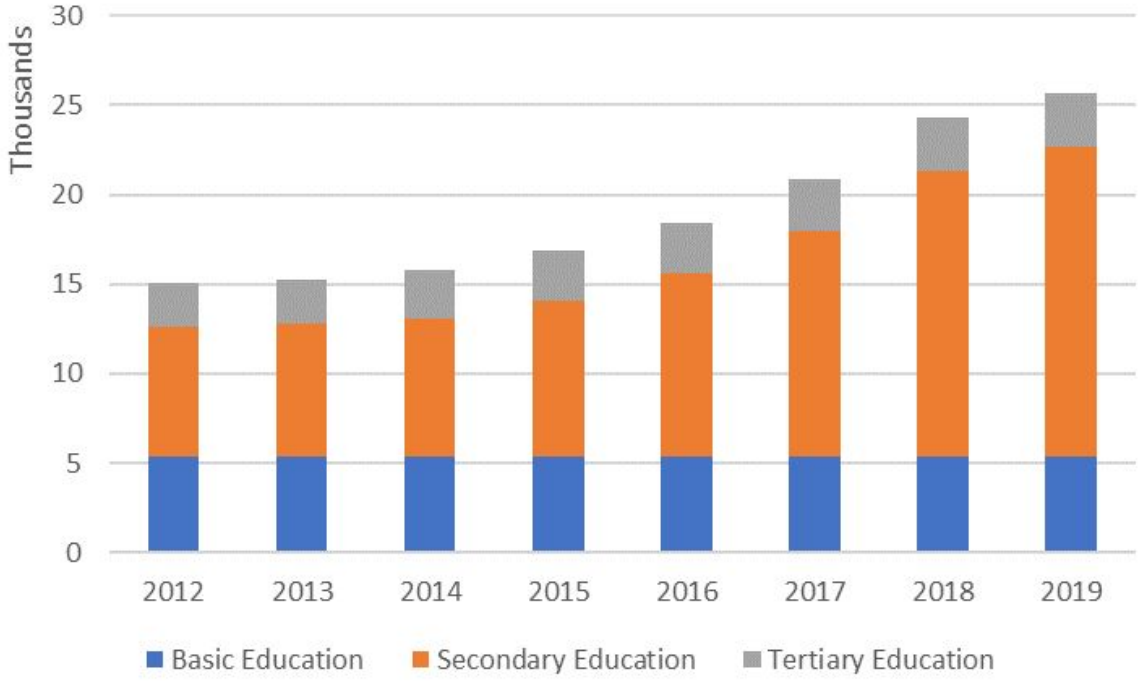
4. Results – Employment and automotive mechatronics technician

Figure 2 - Distribution of qualifications in the automotive industry, in Portugal, in 2019



Source: Authors' calculation based on Quadros de pessoal 2019

Figure 3 - Distribution of schooling in the automotive industry, in Portugal, in 2019



Source: Authors' calculation based on Quadros de Pessoal 2012 -2019

4. Results – Automotive mechatronics technician

- In the National Catalogue of Qualification, the occupation "**Automobile mechatronics technician**" (code 525089) is defined for the field of Motor Vehicle Manufacturing and Repair (525)

- The job description includes "**to carry out maintenance, diagnose anomalies and carry out repairs to the various mechanical, electrical and electronic systems of passenger cars in accordance with the parameters and technical specifications defined by the manufacturers and with the applicable safety and environmental protection rules**"

- Source: https://catalogo.anqep.gov.pt/ufcdDetalhe/4486

4. Results – Mechatronics Vocational training and industrial plants

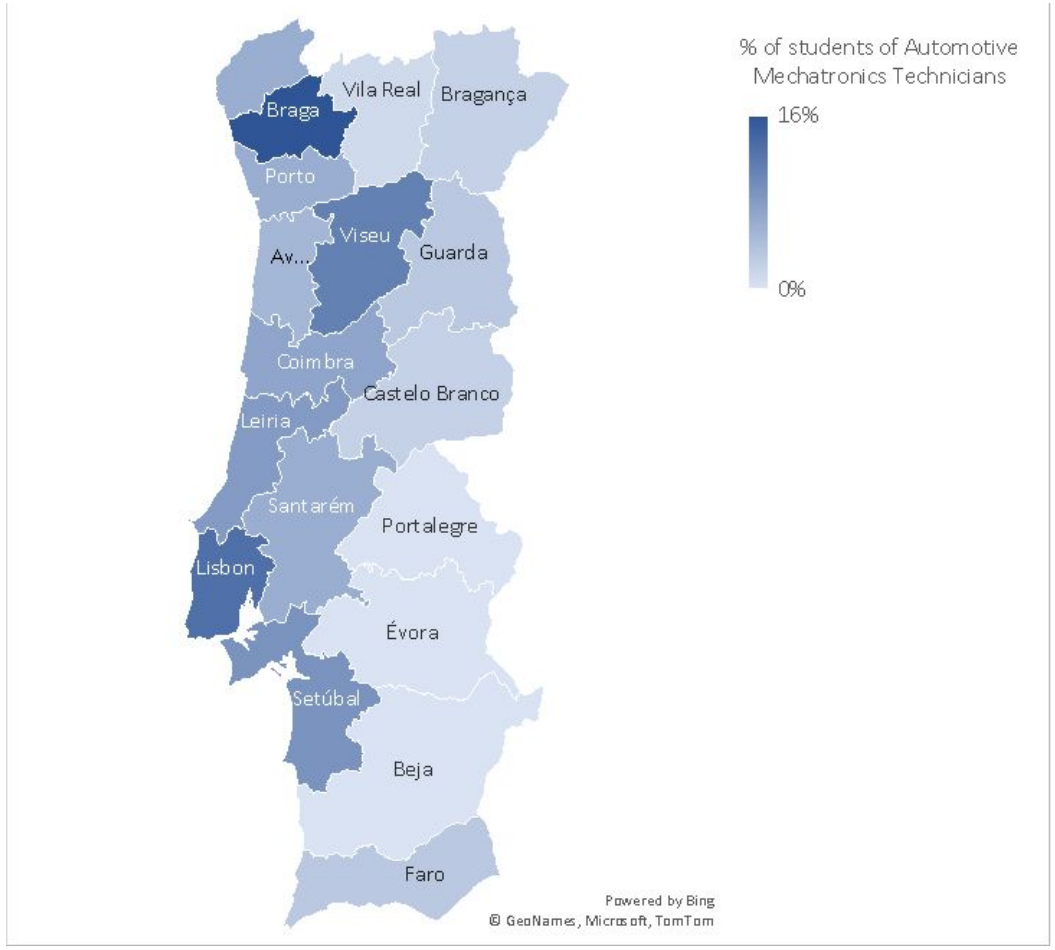


Figure 4 – Distribution of students of Automotive Mechatronics Technicians
Source: DGEEC (2021)

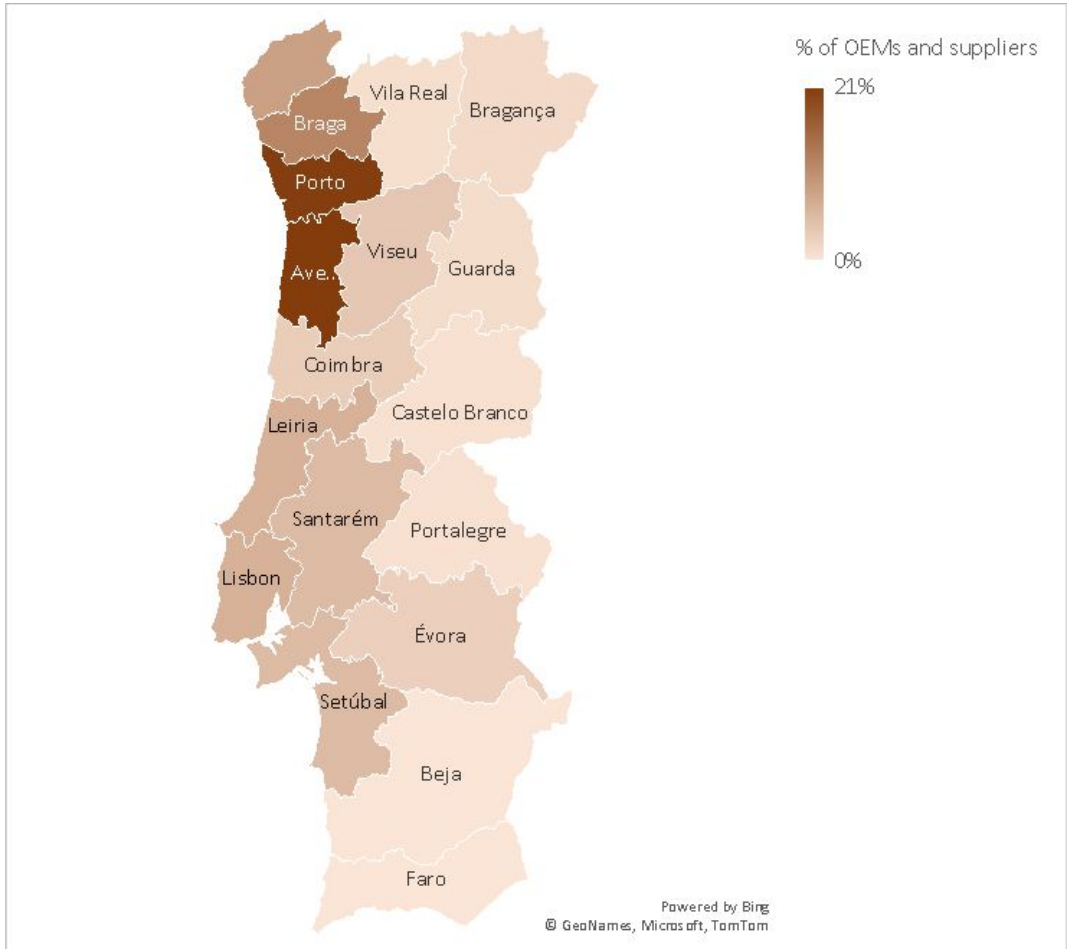


Figure 5 – Distribution of industry plants in Portugal 2020
Source: AFIA 30/3/2022

4. Results – Industry 4.0

Description

- Automobile mechatronics technicians must have "**In-depth knowledge of the constitution, operation and regulation of communication and information systems for light vehicles**."
- The curriculum has one course of Diagnosis and repair of information and communication systems of **50 hours in 1000 hours of the diploma**.

Tasks

- Diagnose anomalies and repairs in light vehicle ICT systems, using the appropriate techniques and procedures, in accordance with their technology and the parameters and technical specifications defined by the manufacturers
- install ICT systems, using the appropriate tools and instruments, and to check the functioning and state of conservation of the different components of the ICT systems, using the appropriate diagnostic equipment.
- correct anomalies in ICT systems, carrying out repair or replacement of components, using the appropriate tools and instruments, and to test the installed and repaired ICT systems, carrying out the appropriate tests, with test equipment, to prove their correct functioning.

Conclusions Industry 4.0

- The vocational system does not has a course to prepare Automobile mechatronics technicians to Industry 4.0 technologies
- The curriculum does not determine a level of literacy students need to deal with challenges of Industry 4.0 technologies and their continuous deployment in production lines
- The curriculum was designed to briefly prepare students to be technicians in the maintenance sector of automobiles and according to the type of technologies most cars use presently

Source: https://catalogo.anqep.gov.pt/ufcdDetalhe/4486

4. Results – Electric powertrains

Description

- Automobile mechatronics technician must “identify and characterize the different types of wiring, and to characterize the charging and starting systems .”

- The curriculum has one course about ‘**automotive electricity**” with 75 hours in a total of 1000 hours, that includes:

Tasks

- Fundamentals of electricity and electronics (current intensity, resistance, voltage and their meaning)
- Wiring: Continuity check; Wiring diagnostics; Wiring repair; Repairing CAN wiring harnesses; Repair of MOST wiring harnesses
- Batteries: Types of batteries; Function and functioning of batteries; Battery maintenance and charging
- Loading systems: Charging system function; Types of charging systems; the working principle of the charging system; the load circuit; components of charging systems; Electric current rectification; and Voltage regulation

Source: https://catalogo.anqep.gov.pt/ufcdDetalhe/4486

Conclusions electric powertrains

- The vocational system has a course to prepare Automobile mechatronics technicians
- The curriculum does not include skills to deal with electric powertrains during their assemblage in production lines nor maintenance
- The curriculum was designed to prepare technicians in the maintenance sector of diesel and gasoline powertrains

5. Preliminary findings

- In this paper we acknowledge the **increasing process of automation** in the Portuguese manufacturing industry. This automation is **perceived with an increase of investment on robotics and other digitised systems** applied to the manufacturing process. Portugal has adopted **state incentives to implement the concept of Industry 4.0,** following the experiences of other countries
- Most of the companies involved in this modernization of the industrial infrastructures were from the automotive sector, OEM as well 1st and 2nd tier suppliers. This last tier also involves companies from the **electric material, textile, plastics, leather, glass and rubber sub-sectors.** This means that a large amount of the industrial tissue is **already involved in the Industry 4.0** performance process. The impact on the labour force will as well be significative
- However, from the policy making side, the support measures for technology investment **have not the same orientation towards the incentive investment on competence building.** This means the education and training activities **have not** been supported to provide updated training toward the **skill needs for the Industry 4.0 measures**
- We took the example of the training for automotive mechatronics technicians, and we verified that companies do not receive similar incentives to re-skill or up-skill their workforce, and the training courses **are not updated with the recent needs for digitalisation and electrification** in the automotive sector
- The conventional training contents prevail. This may imply a substantial shortage of specialised qualifications for the realignment of the sector

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Thank you.

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