The impact of COVID on the digitization of Hungarian maintenance sector

L. Juhász¹ and L. Pokorádi²

¹ PhD student, Doctoral School on Safety and Security Sciences, Óbuda University, Bécsi út 96/b, H-1034 Budapest, Hungary
² full professor, Óbuda University, Institute of Mechatronics and Vehicle Engineering, Népszínház u. 8, H-1081 Budapest, Hungary
j.laszlo92@stud.uni-obuda.hu

Abstract. One of the biggest recent innovation trends in the manufacturing industry is the use of Industry 4.0 tools and the introduction of various digitalization solutions. However, in 2020, the COVID19 pandemic significantly changed the way companies organize their day-to-day operations and the way they plan to innovate in their sector, in the near future. In this paper, we present the views of maintenance professionals in Hungarian automotive companies. We have compared the status of different types of enterprises. In particular, we looked at the differences in the status of these companies in terms of digitalization development. This allowed us to draw further conclusions.

1. Introduction

Maintenance is one of the most important processes that affect thruput for the production within a company [1]. Hungary's most technologically advanced manufacturing companies include car manufacturers, and their supply chain partners. In Hungary, the innovations that affect an entire company, usually appear first in the automotive industry. Moreover, the domestic sector has been characterized by a very high level of overall development in recent times. In 2019, the number of cars produced in Hungary reached a record high [2]. The sector has also seen very strong investment. Industry 4.0 and various industrial digitalization solutions were also seen as a further development point and innovation perspective by the Hungarian automotive industry players.

This great upward trajectory for the entire automotive industry was interrupted in the year 2020 by the COVID-19 pandemic [3] that also hit this country. The initial phase of the pandemic was characterized by supply chain disruptions [4], followed by a downward trend in new car sales [5]. A further major change in the life of companies was the increasing use of home offices in more and more workplaces in order to maintain social distancing [6]. In addition, the whole sector is facing a major technology shift, with manufacturers announcing successive target dates for the phasing out of internal combustion technology [7]. In our research, we seek to understand how the pandemic has affected the transition to new digital technologies by automotive players in the domestic industry, in particular maintenance departments.

The current paper presents the partial results of a larger, longer-term study. The primary results of this research have been previously reported in various studies [8][9][10]. The main steps of our larger research are illustrated in Figure 1. In this framework, we first defined the objectives of our research and then started a literature search in order to draw on the latest available expertise in the field for further
research. As a result, we were able to publish several summary articles on the relationship between digital solutions and modern industrial maintenance [8][9]. This was followed up by qualitative research interviews with maintenance managers and professionals. For quantitative results, we conducted a preliminary survey of automotive industry players in Hungary [10]. Here, our aim was to get a general impression from the professionals about the current trends in the Hungarian sector and to explore the interrelationships between the trends. A further objective was to test our sampling and evaluation methodology. These results were used to prepare our final survey. The purpose of this paper is to present the results of this survey about the effects of the COVID-19 pandemic on the industry.

The study consists of the following chapters: In Section 2, the survey methodology and the data collection process are described. In Section 3, the data provided by respondents will be analyzed. In Section 4, we describe the conclusions that can be drawn from the data. Finally, the authors summarize the study results and articulate their future research objectives.

2. Methodology of the survey
The research was conducted in the form of an online questionnaire. In this questionnaire, we also asked a number of additional questions, but only the points relevant to this publication are presented here. The survey started with questions on different individual parameters of the company in order to be able to draw appropriate conclusions for a subgroup. Based on our experience and previous research [11], there is a big difference in the work culture of domestic compared to foreign-owned companies and their views on different issues. For this reason, the nationality of ownership of the company was a particular question. Another question was the age of the companies' machinery and their overall level of automation. We also asked separately about the current state of the implementation of Industry 4.0 at the respective companies, in order to understand the situation of these companies at different stages. Due to the complexity of the whole survey, we only asked a simple question about COVID-19: how has the COVID-19 pandemic affected the adoption of Industry 4.0 in your company? There were three possible answers: did it speed up, slow down or have no impact.

The survey focused on the domestic automotive industry and was completed anonymously by 129 representatives of different companies between spring and summer of 2021. Compared to the Hungarian automotive industry as a whole, the responses of these representatives are considered significant. The proportion of domestic and foreign-owned companies completing the questionnaire is illustrated in

**Figure 1.** The main steps of the larger research (own figure).
Figure 2. In addition, Figure 3 shows the size of the respondents' companies (according to Hungarian rules, a company is considered a large company if it employs more than 250 people). Figure 4 presents the general age of the respondents' machinery (average machinery less than 10 years old is considered modern). Figure 5 indicates the overall level of automation of the respondent's machinery (semi- and fully automated production machines and production lines were counted in the automated category, everything else was included in the non-automated section).

Figure 2. Nationality of owners of companies completing the survey (own figure).

Figure 3. Size of companies completing the survey (own figure).

Figure 4. The age of the machinery of the companies completing the survey (own figure).

Figure 5. The level of automation of the machinery of the companies completing the survey (own figure).
3. Results and analysis
This chapter analyses the opinions of Hungarian automotive maintenance professionals, separated to different subgroups of respondents mentioned earlier.

Based on the responses, there is no significant difference in the impact of the pandemic on the adoption of Industry 4.0 in terms of company ownership (Figure 7) or company size (Figure 8). Approximately half of the respondents (46-56%) across all types of companies agreed that COVID-19 had accelerated these processes, with the remaining 50% split roughly equally between those who said it had slowed down (21-33%) and those who said it had had no impact (17-27%). This suggests that the changes brought about by the COVID-19 pandemic have had a mostly positive impact on Industry 4.0 adoption and industrial digitalization, according to the maintenance departments of domestic manufacturing companies.
In terms of the modernity of the machinery of the companies, similar proportions can be observed (Figure 9). There is, however, a greater difference in the level of automation of the machinery in the companies (Figure 10). Companies with automated and semi-automated machines have a much lower proportion of positive respondents (42%) and a much higher proportion of negative respondents (32%). For companies with non-automated equipment, the trend is the opposite. Here, the proportion of respondents who are in favor of accelerating Industry 4.0 adoption is significantly higher (61%), while the proportion of respondents who are in favor of slowing down adoption and those who are neutral are the same (20-20%). This suggests that the maintenance departments of domestic manufacturing companies believe that the changes brought about by the COVID19 pandemic have had a positive impact on the introduction of Industry 4.0 and industrial digitalization, primarily on less advanced companies with non-automated equipment.

![Figure 9](image1.png)

**Figure 9.** Comparison of the COVID-19 effect with the modernity of companies' machinery (own figure).

![Figure 10](image2.png)

**Figure 10.** Comparison of the COVID-19 effect with the level of automation of companies' machinery (own figure).

It is also worth looking at how different companies at different stages of Industry 4.0 implementation have been affected by the pandemic (Figure 11). In the early stages of Industry 4.0 adoption (there is no strategy or strategy under development stage), a high acceleration effect can be found (58-60%), similar to the previous figures. Based on our survey, these companies are the most numerous in the Hungarian automotive sector (Figure 6). However, the trend is reversed at the next stage, at companies with a formulated strategy showing a predominance of companies with a strongly negative impact (55%), while those with a positive view have declined to 36%. Thereafter, as the state of implementation continues to evolve, the response rate becomes increasingly positive. At the start of the pilot implementation, all three responses are at about the same level (35-35-30%), and then at full implementation the previously seen 50-25-25% ratio returns.

This shows that the maintenance departments of domestic manufacturing companies consider that the impact of COVID-19 depends on how advanced the company is in implementing Industry 4.0. For the vast majority of the advanced states (this includes the vast majority of companies), the pandemic had a positive impact. However, in some cases the perception is unclear (pilot implementation has started) and in some cases it has explicitly had a negative effect (strategy has been formulated). These are the phases where most of the investment in an Industry 4.0 implementation takes place (e.g. system
deployment, training of support staff). These companies support other projects during the pandemic, which can slow down further industrial digitalization.

Figure 11. Comparison of the COVID-19 effect with the stage of development of companies in Industry 4.0 (own figure).

4. Conclusions
Based on the opinions of the Hungarian automotive maintenance professionals surveyed, the analysis of the impact of the COVID19 pandemic on the adoption of Industry 4.0 and industrial digitalization led to the following main conclusions:

- There is no significant difference in the impact of pandemic on the adoption of Industry 4.0 across different types of companies, it has had a mostly positive impact on the introduction of Industry 4.0 and industrial digitalization. Approximately half of companies believe that the pandemic has accelerated the adoption of Industry 4.0, thus has boosted industrial digitalization. The remaining 50% is split roughly equally between those who think the pandemic slowed down the adoption and those who think it had no impact.

- There was only one different company type parameter, namely the degree of automation of the machinery. Here the positive impact of the pandemic was particularly high for manufacturing companies with less automated equipment. On the other hand, the companies with the highest level of automation had the lowest positive response rate (still the highest number of answers) in all comparisons.

- The impact of COVID-19 depends on how advanced the company is in implementing Industry 4.0. For the vast majority of the implementing stages (including the vast majority of companies), the pandemic had a positive impact. However, in one case (stage pilot implementation has started) the evaluation of the impact is divided, and in another case (stage strategy has been formulated) it is explicitly negative.

5. Summary
In the Hungarian automotive industry, a huge upsurge in interest in Industry 4.0 and various industrial digitalization initiatives have been observed recently. However, the COVID-19 pandemic has fundamentally changed the budgets, development directions and basic work organization of companies. This is true for all departments of a company, especially industrial maintenance processes, which could be one of the biggest beneficiaries of Industry 4.0. Our paper shows partial results, specific to the
COVID-19 pandemic experiences of a larger, longer-term study, where we measured the overall digitalization of the domestic maintenance sector.

In this paper we described the sampling methodology of our research. Our study is broken down into different types of companies so that we could draw different further conclusions based on several parameters. These parameters included the nationality of the owner, the size of the company, the age and degree of automation of the machinery, and the current state of implementation of Industry 4.0. One conclusion was that approximately half of all companies believe that the pandemic has accelerated the adoption of Industry 4.0, thus boosting industrial digitalization. The remaining 50% is split roughly equally between those who think the pandemic slowed down the adaption and those who think it had no impact.

In the period ahead, we intend to focus on the conclusions in more depth, in the sense that we will propose solutions to the resulting difficulties, according to the type of company. Furthermore, we intend to develop further themes of our final, large survey in a similar way to the present paper.

References
[1] Ľubomír A and Katarína T 2021 Proactive Maintenance as a Tool of Optimization for Vehicle Fleets, in Terms of Economic and Technical Benefits Acta Polytechnica Hungarica Vol. 18 No. 8
[2] Bujdosó T 2021 How has the Hungarian and global car industry fared during the epidemic and what can be expected afterwards? https://www.eulerhermes.com/hu_HU/hirek-es-elemzessek/friss-hirek/hogyan-alakult-a-magyar-es-globalis-autoipar-a-jarvany-alatt-es-mi-varhato-utana.html (the last downloading: 28.12.2021)
[3] Khamis A Meng J Wang J Azar AT Prestes E Li H Hameed IA Takács Â Rudas IJ Haidegger T 2021 Robotics and Intelligent Systems Against a Pandemic Acta Polytechnica Hungarica Vol. 18 No. 5
[4] Uetz AM and Ellis NJ 2021 Continued Disruption in the Global Supply Chain - and Strained Balance Sheets - Threatens An Already Challenged Automotive Supply Industry https://www.natlawreview.com/article/continued-disruption-global-supply-chain-and-strained-balance-sheets-threatens (the last downloading: 28.12.2021)
[5] Túry G 2021 The transformation of the car industry is inevitable - mass redundancies are no longer an option https://www.portfolio.hu/krtk/20210514/elkerulhetetlen-az-autoipar-atalakulasa-tomegesleepitesekkel-ez-mar-nem-uszhato-meg-483062 (the last downloading: 28.12.2021)
[6] Durucu M and Bayraktar CA 2020 The Effect of Working from Home on Work and Private Life: Automotive Sector Application Industrial Engineering in the Digital Disruption Era pp 148-155
[7] Motavalli J 2021 Phasing Out Internal Combustion Engines? It’s Already Happening https://www.autoweek.com/news/a36292118/phasing-out-internal-combustion-engines/ (the last downloading: 28.12.2021)
[8] Juhász L and Pokorádi L 2018 Augmented reality in modern maintenance Repüléstudományi Közlemények 30 p 37-46 (Szolnok)
[9] Juhász L and Pokorádi L 2018a Interconnections between Internet of Things and maintenance in our days GRADUS 5 p 99-106. (Kecskemét)
[10] Juhász L and Pokorádi L 2021 Industry 4.0 and Modern Maintenance in Today’s Hungarian Vehicle Industry J. Phys.: Conf. Ser. 1935 01 2008
[11] Nick GA 2018 Challenges of adopting the Industry 4.0 paradigm in Hungary in the context of its territorial and company aspects (Győr: Széchenyi István University)