

# Dunaújváros

A Dunaújvárosi Egyetem online folyóirata 2026. XIV. évfolyam III. szám

Műszaki-, Informatikai és Társadalomtudományok



**MIKLÓS BERCZELI-ZOLTÁN WELTSCH-  
ATTILA SZABÓ**

**Comparative Adhesion of Anaerobic  
and Cyanoacrylate Adhesives to Hydro-  
philic Surface on Mild Steel**

**BILAL TUNÇ**

**A study on the historical development  
of the transition to the metropolitan  
municipality system in turkish admi-  
nistrative history**

**FARKAS IMRE**

**Hallgatói vélemények az MI felhaszná-  
lásával és oktatásával kapcsolatban**

**KESZI-SZEREMLEI ANDREA-NÁDASDI  
FERENC**

**Fenntarthatóság – értékmódszertan**



# Dunakavics

A Dunaújvárosi Egyetem online folyóirata 2026. XIV. évfolyam III. szám

Műszaki-, Informatikai és Társadalomtudományok

MEGJELENIK ÉVENTE 12 ALKALOMMAL

SZERKESZTŐBIZOTTSÁG

András István, Bacsa-Bán Anetta, Balázs László, Kovács-Bokor Éva,  
Nagy Bálint, Németh István, Rajcsányi-Molnár Mónika.

Felelős szerkesztő: Németh István

Szerkesztők: Falus Orsolya, Halmi Nóra, Kőkuti Tamás, Varga Anita

Tördelés: Duma Attila

Szerkesztőség és a kiadó címe: 2400 Dunaújváros, Táncsics M. u. 1/a.

Kiadja DUE Press, a Dunaújvárosi Egyetem kiadója

Felelős kiadó Dr. habil András István, rektor

<http://dunakavics.uniduna.hu/>

ISSN 2064-5007

# Tartalom

MIKLÓS BERCZELI-ZOLTÁN WELTSCH-ATTILA SZABÓ

*Comparative Adhesion of Anaerobic and Cyanoacrylate Adhesives  
to Hydrophilic Surface on Mild Steel*

5

BILAL TUNÇ

*A study on the historical development of the transition  
to the metropolitan municipality system in turkish administrative history*

23

FARKAS IMRE

*Hallgatói vélemények az MI felhasználásával és oktatásával kapcsolatban*

45

KESZI-SZEREMLEI ANDREA-NÁDASDI FERENC

*Fenntarthatóság – értékmódszertan*

55

*Galéria (Bogáti Vivien fotói)*

63



# *Comparative Adhesion of Anaerobic and Cyanoacrylate Adhesives to Hydrophilic Surface on Mild Steel*

**Abstract:** This study is about laser-induced surface activated DC01 and S235 mild steels, which are bonded with an anaerobic acrylic adhesive (Loctite 270) and a cyanoacrylate adhesive (Loctite 496). A fiber laser was used with 50–100% power, 20–200 kHz pulse frequencies, and scanning speeds were 500–2000 mm/s. Wettability was measured by water contact angle (WCA), and the joint performance was examined through single-lap shear tests. Both untreated steels showed hydrophobic behaviour (DC01: 72.9°, S235: 89.8°), which resulted in low shear strengths: 0.29 kN (DC01, acrylic), 2.03 kN (DC01, cyanoacrylate), 0.57 kN (S235, acrylic), and 0.06 kN (S235, cyanoacrylate). After laser treatment, the WCA was under 5° in most cases, shows complete wetting. This change was reflected in a significant increase in strength. In the case of DC01, the acrylic adhesive achieved 2.9 kN ( $\approx 10\times$ ) and the cyanoacrylate achieved 5.6 kN ( $\approx 2.5\times$ ). In the case of S235, the acrylic adhesive achieved 3.9 kN ( $\approx 7\times$ ), while the cyanoacrylate increased from 0.06 to 6.1 kN ( $\approx 100\times$ ). Based on the results the laser activation can create a clean, highly hydrophilic surface. It increases the adhesion of both adhesive systems. Although the two steels responded differently to the treatment, in all cases the reduction in the rim angle was closely related to the increased bond strength.

**Keywords:** Steel, surface treatment, laser, wettability, adhesive.

**Összefoglalás:** A kutatás célja a lézerrel indukált felületaktiválás hatásának vizsgálata DC01 és S235 lágyacélok nedvesedési tulajdonságaira és ragasztott kötéseinek szilárdságára. A mintákat két különböző ragasztórendszerrel – anaerob akrilát (Loctite 270) és cianoakrilát (Loctite 496) ragasztóval – kötötték össze. A felületkezelést impulzusüzemű szállólézerrel végezték 50–100% teljesítmény, 20–200 kHz impulzusfrekvencia és 500–2000 mm/s pásztázási sebesség tartományában. A felületi nedvesedést peremszögméréssel, a ragasztott kötések kötészilárdságát egylapos nyíróvizsgálattal értékelték.

\* *Evocon Ltd.*

Email: [berczeli.miklos@evocon.hu](mailto:berczeli.miklos@evocon.hu)  
ORCID: 0009-0004-7187-9064

\*\* *Evocon Ltd.*

Email: [weltsch.zoltan@evocon.hu](mailto:weltsch.zoltan@evocon.hu)  
ORCID: 0000-0002-6366-8281

\*\*\* *University of Dunaújváros,*

*Institute of Engineering*

Email: [Szabottilla@uniduna.hu](mailto:Szabottilla@uniduna.hu)  
ORCID: 0009-0009-3305-2804

A kezeletlen acélfelületek hidrofób viselkedést mutattak (DC01: 72,9°, S235: 89,8°), ami alacsony kötési szilárdságot eredményezett. A lézeres felületaktiválás hatására a peremszög a legtöbb esetben 5° alá csökkent, ami teljes nedvesedést jelez. A hidrofil felület kialakulása jelentős szilárdságnövekedést eredményezett mindkét ragasztórendszer esetében. DC01 acélon az akril ragasztó szilárdsága közel tízszeresére ( $\approx 2,9$  kN), a cianoakriláté pedig mintegy 2,5-szeresére ( $\approx 5,6$  kN) nőtt. S235 acélon az akril ragasztó körülbelül hétszeres ( $\approx 3,9$  kN), míg a cianoakrilát ragasztó több mint százszoros ( $\approx 6,1$  kN) szilárdságnövekedést mutatott. Az eredmények igazolják, hogy a lézeres felületaktiválás hatékony módszer hidrofil, nagy felületi energiájú acélfelületek létrehozására, amely jelentősen javítja a ragasztott kötések tapadását és ipari alkalmazhatóságát. **Kulcsszavak:** Acél, felületkezelés, lézer, nedvesíthetőség, ragasztó.

## Introduction

Adhesive bonding has become an important joining method in many manufacturing sectors, for example automotive, energy and construction. Compared with welding or mechanical fastening, the adhesive joints distribute loads more evenly, support lightweight design, and allow the joining of dissimilar materials. This technic do not introduce thermal distortion or galvanic corrosion. Industries shift toward cleaner and more efficient production and the demand for reliable, solvent-free bonding processes seems to grow. This trend is reinforced by sustainability expectations in the transport sector. Vehicle impact is now judged mainly through lifecycle CO<sub>2</sub> emissions and the energy mix that supports their operation. The performance of adhesive joints on mild steels, depends strongly on the condition of the surface. Materials such as DC01 and S235 typically carry native oxides, rolling residues and adsorbed hydrocarbons, that's why the surface energy is lower and block molecular-level contact with the adhesive. Conventional surface preparation methods, such as mechanical abrasion, chemical etching or solvent cleaning, can improve adhesion. These methods often suffer from inconsistency, environmental concerns, or difficulties in automation. Laser-based surface treatment offers a precise and clean alternative. Controlled laser irradiation can remove contaminants, renew oxide layers, and create micro- and nano-scale textures that raise surface energy and promote wetting. These changes are especially important for adhesives whose curing mechanisms rely on surface chemistry. Anaerobic acrylic adhesives, for example, require metal ions to initiate polymerization, while cyanoacrylates depend mainly on surface polarity and moisture. Both the chemical state and the microstructure of the steel surface affect their final bonding performance. This paper aim is to examine how laser-induced surface activation affects the wettability and adhesive strength of bonded DC01 and S235 steels with an anaerobic acrylic (Loctite 270) and a cyanoacrylate adhesive (Loctite 496). By comparing untreated and laser-treated surfaces, the study aims to clarify how changes in surface energy and surface chemistry translate into mechanical performance, and to identify process conditions that support clean, repeatable and industrially applicable adhesive bonding.

## Literature Review

## THE SIGNIFICANCE OF STRUCTURAL ADHESIVE BONDING OF STEELS

Structural adhesive bonding has become a key method for lightweight and hybrid constructions. Adhesive joints spread the load across a larger area, allowing thinner components without compromising strength, and this is the main difference compared to welding or mechanical fastening. In the latter mentioned technologies local stresses, heat-affected zones and distortion can introduce [1]. This is especially valuable in automotive body structures, transport applications, and various civil or energy systems where weight reduction and fatigue resistance play an important role. Adhesive bonding also makes it possible to join dissimilar materials without the risk of galvanic corrosion or metallurgical incompatibility [2]. Because the process does not involve high temperatures, it avoids phase changes and residual stresses that commonly occur in welded joints, improving dimensional stability and fatigue performance [3]. Recent studies show that hybrid solutions, where spot welds are combined with structural adhesives, can enhance crash behaviour and corrosion resistance in vehicle bodies, supporting their use in mass production [4]. Despite these benefits, steel-to-steel adhesive bonding is still limited in industry, mainly because surface preparation strongly influences long-term reliability. Native oxides, rolling lubricants and adsorbed hydrocarbons form weak layers that reduce surface energy and inhibit proper molecular contact with the adhesive [1]. Reliable bonding therefore requires controlled, consistent surface activation. As a result, research has increasingly shifted from developing new adhesive formulations toward refining surface engineering techniques that render steel surfaces more chemically active and hydrophilic. Among the most promising approaches are plasma treatments, chemical activation and various laser-based methods, all capable of removing weak surface layers and producing stable, high-energy surfaces suitable for modern adhesives [3]. These developments are also in line with broader sustainability evaluations in the European transport sector, where the environmental performance of both electric and conventional vehicles depends strongly on national energy mixes and lifecycle CO<sub>2</sub> emissions [5, 6].

[1] Sullivan, K. –Peterman, K. D. (2024): “A review of adhesive steel-to-steel connections for use in heavy construction,” *J. Constr. Steel Res.*, 213., Art. no. 108405.

[2] Akkasali, P.–Angadi, A.–Rao, K. R.–Kancharla, D. (2024): “A state-of-the-art review on adhesively bonded joints: Materials, properties, and characterization,” *J. Adhes. Sci. Technol.* doi: 10.1080/01694243.2024.2384421.

[3] Gülçiçek, E. Tokgöz– Tanoğlu, H. (2024): “Synergistic effect of surface treatment and adhesive type on the performance of adhesively bonded joints,” *Int. J. Adhes. Adhes.*, 132., Art. no. 103641. doi: 10.1016/j.ijadhadh.2024.103641.

[4] Peng, X.–Liu, Y.–Xu, J. (2025): “Nanostructuring of steel surfaces by laser irradiation for enhancing adhesion in steel/steel adhesive joints,” *Int. J. Adhes. Adhes.*, 142., Art. no. 104107. doi: 10.1016/j.ijadhadh.2025.104107.

[5] Kocsis, D.–Kiss, J. T.–Árpád, I. W. (2024): “Evaluating Battery Electric Vehicle Usage in the EU: A Comparative Study Based on Member State Energy Mixes,” *Heliyon*, 10., (9).

[6] Árpád, I. W.–Kiss, J. T.–Bellér, G.–Kocsis, D. (2021): “Sustainability Investigation of Vehicles’ CO<sub>2</sub> Emission in Hungary,” *Sustainability*, 13., (15).

- [7] Dai, F.–Yang, J.–Wang, H. (2024): “Study of laser surface texturing on the adhesion properties of SHF-2D epoxy zinc paint,” *Int. J. Adhes. Adhes.*, 128., Art. no. 103517. doi: 10.1016/j.jadhadh.2023.103517.
- [8] Wang, Q.–Kainuma, S.–Zhuang, S.–Hara-guchi, M. (2023): “Effect of continuous wave laser treatment on the adhesion and durability of Heavy-Duty Paint coated carbon steel,” *Case Stud. Constr. Mater.*, vol. 19., Art. no. e02420. doi: 10.1016/j.cscm.2023.e02420.
- [9] Berczeli, M.–Tajti, F.–Juhász, G.–Weltsch, Z. (2024): “Changing the high strength steel surface properties with femtosecond laser beam,” *Opt. Laser Technol.*, 174., Art. no. 110556. doi: 10.1016/j.optlastec.2024.110556.
- [10] Dong, T.–Cao, J.–Zhang, Y.–Wang, H. (2024): “Optimization of laser surface treatment parameters for enhancing epoxy coating adhesion on steel substrates,” *Coatings*, vol. 14., (4.), Art. no. 467., doi: 10.3390/coatings14040467.
- [11] Chen, Z.–Zhou, J.–Cen, W.–Yan, Y.–Guo, W. (2025): “Femtosecond laser fabrication of wettability-functional surfaces: A review of materials, structures, processing, and applications,” *Nanomaterials*, 15., (8.), Art. no. 573. doi: 10.3390/nano15080573.
- [12] Yong et al. (2022): “Nature-inspired super-wettability systems,” *Research*, 2022., Art. no. 9895418. doi: 10.34133/2022/9895418.
- [13] Liu, Y.–Li, S.–Wang, J. (2022): “Research progress of metal surface wettability modification and its engineering application,” *IET Bionanotechnol.*, 6., (2.), e12039. doi: 10.1049/bsb2.12039.

#### LASER SURFACE TREATMENT AS A CLEAN AND CONTROLLABLE PRE-TREATMENT TO IMPROVE ADHESION

Laser surface treatment has become a strong alternative to traditional cleaning and activation methods such as grit blasting, chemical etching or plasma treatment. The industrial popularity of the laser surface treatment comes from its environmental advantages and consistent performance [7]. Chemical processes depend on solvents or generate waste, but laser activation is a dry, contactless method. It can be fully controlled and easily integrated into automated production lines [8]. Pulsed laser radiation interacts with metal surfaces. It produces localized melting, rapid solidification and renewal of the oxide layer. These effects remove weak boundary layers and increase surface energy. The process parameters are average power, pulse frequency and scanning speed, can form different micro- and nano-scale textures. These are modifying wetting and adhesion in a characteristic way [9]. Several studies show that even moderate laser energy can reduce the water contact angle (WCA) of metallic surfaces from roughly 80–90° to below 10°. In many cases the WCA reduced to <5°, resulting in a super-hydrophilic surface that strongly favours adhesive wetting [10]. A major benefit of laser pre-treatment is its dual effect: it alters the surface chemistry, while also shaping the microstructure. The laser removes hydrocarbons and it promotes the formation of a thin, hydroxyl-rich oxide layer containing Fe–O–OH groups, so the polar component of surface free energy increased [11]. At the same time, microgrooves or microcones form on the surface. These are increasing the real contact area and supporting mechanical interlocking with the adhesive [12]. These combined changes typically lead to more stable and reproducible adhesion than what is achievable with purely chemical or mechanical preparation. Results from steel–epoxy, steel–acrylic and steel–cyanoacrylate joints show that once the WCA falls below about 10°, shear strength increases sharply, often reaching 300–400% improvement compared with untreated surfaces [13].

INFLUENCE OF ADHESIVE CHEMISTRY ON THE EFFECTIVENESS  
OF LASER SURFACE ACTIVATION

There are many adhesives, such as anaerobic acrylics, cyanoacrylates, epoxies, and polyurethanes, which can interact differently with metallic surfaces depending on their functional groups, polymerization kinetics, and sensitivity to surface chemistry [14]. Anaerobic acrylic adhesives, typically based on dimethacrylate esters, cure in the absence of oxygen and in the presence of metal ions (e.g.,  $\text{Fe}^{2+}$ ,  $\text{Cu}^{2+}$ ), which act as radical initiators. The bonding strength of anaerobic systems is highly sensitive to surface cleanliness and the availability of catalytically active metal sites [15]. Laser treatment can improve these conditions by removing passive oxide layers and exposing fresh metallic iron. Polymerization can be faster and increases the density of interfacial crosslinking. However, too much laser energy may create thick, stoichiometric oxide films. These layers reduce the availability of metal ions and can hinder curing—a behaviour reported in several recent studies on steel substrates [16]. Cyanoacrylate adhesives polymerize through an anionic moisture-induced mechanism, which does not require metallic ion activation. Instead, their performance depends primarily on surface polarity and the presence of hydroxyl or carboxyl functional groups. These groups can facilitate electron transfer and rapid polymerization initiation [17]. Laser activation, by increasing the surface's hydroxyl group density and producing hydrophilic Fe–O–OH terminations, provides ideal conditions for cyanoacrylate curing [18].

The aim of this study is to investigate the effect of laser-induced surface activation on the adhesion performance of anaerobic (acrylic) and cyanoacrylate adhesives applied to mild steels (DC01 and S235). By comparing the changes in surface wettability, chemistry, and resulting shear strength, the research seeks to clarify how laser parameters influence the interfacial bonding mechanisms of two chemically distinct adhesive systems. The goal is to identify energy-efficient, solvent-free, and industrially applicable pre-treatment conditions that enhance adhesive reliability and performance in structural steel bonding applications.

[14] Zhou et al. (2024): “Influence of femtosecond laser surface modification on tensile properties of titanium alloy,” *Micromachines*, 15., (1.), Art. no. 152. doi: 10.3390/mi15010152.

[15] Kubo, K.–Kodama, R.–Kobayashi, K.–Morikawa, Y. (2025): “Interfacial bonding mechanism of ethyl cyanoacrylate adhesive on inorganic surfaces: A periodic DFT study,” *Langmuir, Web publ.* doi: 10.1021/acs.langmuir.5c03183.

[16] Li, G.–Wu, Y.–Zhang, P.–Zhao, X.–Zheng, S.–Zhang, Y. (2024): “Interfacial study of steel joints prepared with a catechol-modified epoxy adhesive with enhanced bonding performance and durability,” *Langmuir*, 40., (31.), pp. 16549–16560. doi: 10.1021/acs.langmuir.4c02034.

[17] Du, Y.–Gao, J.–Zhao, X. (2023): “Surface treatment method to improve adhesion strength of metal substrates: A review,” *ACS Omega*, 8., (48.), pp. 44040–44064. doi: 10.1021/acsomega.3c05728.

[18] Emelyanenko, K. A.–Emelyanenko, A. S.–Boinovich, A. V. (2023): “Laser obtained superhydrophobic state for stainless steel and its corrosion protection,” *Coatings*, 13., (1.), Art. no. 194, doi: 10.3390/coatings13010194.

## Materials and Methodes

### S235 STEEL SPECIMENS

The research used S235 structural steel which is a commonly used low-carbon steel grade. It is a standard construction material in mechanical and structural engineering. It was selected because it represents a typical mild steel base material, which is frequently used during industrial adhesive bonding. This material is a relevant steel for researching about adhesion performance under engineering conditions. Rectangular specimens were cold cutted from cold-rolled S235 sheets with a thickness of 1 mm. The samples were cut into 25×100 mm specimens. Before the surface treatment the steel specimens were cleaned with ethanol to ensure that the surfaces were free from oil, dust, and other contaminations. The cleaned specimens were stored in a closed container to prevent further contamination before the surface treatment and adhesive bonding.

### DC01 STEEL SPECIMENS

The second base material in this study was DC01 cold-rolled mild steel, which is a low-carbon, high-purity steel grade. Commonly used in automotive applications. DC01 was selected because of low alloying content. Compared with S235 structural steel the DC01 has a less oxidized surface layer and a more homogenous surface. This allows a better base surface for laser induced surface modifications, wettability change and adhesion test. The specimens were prepared from the same way and geometry as S235. It was 1 mm thick DC01 sheets and cut into 25×100 mm samples. The specimens were cleaned with ethanol again.

### LASER SURFACE TREATMENT

Surface treatment process of the DC01 and S235 steel specimens was carried out using a JPT MOPA M7 fiber laser system. It is equipped with a 30 W average output fiber laser source with a wavelength of 1064 nm. This device operates in the nanosecond pulse range. The laser beam was moved and focused on the specimen surface using a galvanometric scanning head with a f-theta lens, ensuring high-speed and controlled laser energy irradiation on the treated area. The laser surface treatment process was under ambient atmospheric conditions without the use of gases. The average beam power was changed between 50% and 100% of the maximum average laser power. The pulse frequency was changed between 20 and 200 kHz, the scanning speed between 500 and 2000 mm/s.

These parameter combinations created different laser surface energy densities and this research can investigate its effect on surface activation. The laser beam was moved in linear hatch patterns, with a spacing of 0.05 mm, covering the later adhesive bonding area of each specimen.

### CONTACT ANGLE MEASUREMENT

Surface wettability was measured using a contact angle measurement equipment. The measurement is based on the sessile drop method. The machine was equipped with a high-resolution optical camera and image-processing software for precise measurement of static contact angles on the liquid droplets. The contact angle measurements were performed using 5  $\mu\text{l}$  droplets of distilled water as test fluid. The droplets were dispensed onto the treated steel surfaces after one minute of the laser surface activation. It was to minimize the effect of time dependence of the wetting behaviour. Each water droplet image was captured immediately after spreading on the surface, and the left and right contact angles were measured and averaged, this average value shows the surface wettability state in each treatment parameter.

### ADHESIVE APPLYING METHOD

The adhesive bonding experiments were carried out on the DC01 and on the S235 steel specimens. Both two steels were used to investigate the effect of laser induced surface activation on the adhesive bonding performance and strength. The steel bonding were designed in a single-lap shear configuration. Each specimen had a overlap area of 25 x 12.5 mm, corresponding to a bonded surface of 312.5 mm<sup>2</sup>.

Two different adhesive type were used to represent different curing mechanisms and chemical interactions with the metallic surfaces:

- an anaerobic acrylic adhesive (Loctite 270), which cures in the absence of oxygen and in the presence of active metal ions,
- a cyanoacrylate adhesive (Loctite 496), which cures rapidly in the activation effect of surface moisture.

Loctite 270 is a dimethacrylate ester-based anaerobic adhesive that polymerizes in the absence of oxygen and in the presence of active metal ions. Its curing mechanism depends strongly on the surface chemistry of the substrate, where the most important is that how much the metallic surfaces containing  $\text{Fe}^{2+}$  or  $\text{Cu}^{2+}$  ions. These adhesives are used for common metal-metal bondings, for threadlocking, surface sealing. Loctite 496 is a methyl cyanoacrylate adhesive that cures rapidly through anionic polymerization triggered by the surface moisture.

Unlike the type of anaerobic adhesives, it does not require metal ions and it is more tolerant of non-metallic or passive surfaces. Its bonding strengths is highly dependent on the wetting behaviour and the polarity of the surfaces.

For each overlapped adhesive joints 0.050 g of adhesive was applied on the cleand and laser surface treated area. The opposite side of the bonding area was carefully positioned to achieve full overlap without entrapping air bubbles. The specimens were pressed together using a custom alignment fixture ensuring parallel bonding surfaces and controlled press during curing.

The joints were cured under ambient laboratory conditions (22–23 °C, 45–55% RH) for 72 hours, allowing complete curing.

## Results

### WETTING CHANGING EFFECT OF THE LASER TREATMENT

In this section the modification effect of laser surface activation on the wettability of the two investigated steel substrates, the DC01 mild steel and the S235 structural steel as analysed. This is the first step to understand the adhesive bonding strength behaviour. A lower water contact angle (WCA) means that the surface is hydrophilic and it has high surface free energy and it is an activated surface. It is the favourable for strong adhesion.

The high contact angle means that the surface has a hydrophobic conition. It can be contaminated or it is a passivated surface. The poor wetting state limits the connection of surface adhesive bonds. The results of the laser surface treatment on S235 structural steel are summarized in *Table 1*.

*Table 1. Water contact angle (WCA) of S235 steel surfaces before and after laser surface treatment at different laser powers, pulse frequencies, and scanning speeds.*

Material	Average laser beam power (%)	Laser beam pulse frequency (kHz)	Scanning speed (mm/sec)	Water contact angle, WCA (°)
S235	Untreated			89.75
S235	Untreated			89.75
S235	50%	200	500	<5
S235	50%	200	500	<5
S235	50%	200	2,000	34.35
S235	50%	200	2,000	34.35
S235	60%	20	500	9.95
S235	60%	20	500	9.95
S235	60%	20	500	9.95
S235	80%	20	500	<5
S235	80%	20	500	<5
S235	80%	20	500	<5
S235	90%	20	500	<5
S235	90%	20	500	<5
S235	100%	20	500	<5
S235	100%	20	500	<5
S235	100%	20	500	<5
S235	100%	200	500	<5
S235	100%	200	2,000	16.3
S235	100%	200	2,000	16.3

The untreated S235 surface had a high water contact angle of approximately 89.8°. It has a hydrophobic and poorly wettable metallic surface. This high contact angle can be the presence of a thick iron oxide film ( $\text{Fe}_2\text{O}_3/\text{Fe}_3\text{O}_4$ ) combined with adsorbed hydrocarbons and organic contaminations. This creates a reduced surface energy and inhibits polar interactions with water.

After the laser surface activation the decrease of WCA was observed using nearly all laser surface treatment parameter combinations. It is confirming the strong influence of the laser treatment on surface wettability and polarity. In several cases using higher laser powers the contact angle decreased to below 5°. This impulse laser surface treatment can create a hydrophilic state on the S235. In these cases the water droplet spreaded instantaneously across the surface. It is preventing accurate contact angle measurement during the tests; therefore, such conditions were marked as “<5.°”

It is a signifying total spread of water on the surface. This hydrophilic phenomenon was observed for 80–100% laser power using both low (20 kHz) and high (200 kHz) pulse frequencies. This suggests that above a higher laser surface irradiation energy density the S235 surface becomes fully activated, which will be good for adhesive bonding.

At medium power laser surface parameters (60% power, 20 kHz, 500 mm/s) the contact angle values were still reduced (around  $10^\circ$ ) indicating that the surface wetting is partial. Higher WCA were measured at lower laser power or faster laser beam scanning speeds ( $34^\circ$  at 50% power and 200 kHz with 2000 mm/s). The reduced energy input limited the oxide layer modification and surface activation. This tendency shows that the energy density is the dominant parameter controlling the wetting behaviour on the S235 surface. This can be explained by a combination of surface cleaning, oxidation, and microstructural modification of the surface induced by the pulsed laser beam radiation. The high local temperature and rapid cooling creates a thin, homogenous, high-energy oxide layer. It can be enriched in hydroxyl ( $-OH$ ) and oxygen-containing functional groups. These modifications significantly increase the polar component of surface energy leading to increased wettability and high surface free energy. The micro and nano texturing and micro-roughness generated by the impulse laser beam irradiation creates the hydrophilic behaviour. It is increasing the real contact area between the water droplet and the surface (Wenzel effect).

The wettability test results for the DC01 steel substrates are summarized in *Table 2*.

**Table 2. Water contact angle (WCA) of DC01 steel surfaces before and after laser surface treatment at different laser powers, pulse frequencies, and scanning speeds.**

Material	Average laser beam power (%)	Laser beam pulse frequency (kHz)	Scanning speed (mm/sec)	Water contact angle, WCA ( $^\circ$ )
DC01	Untreated			72.9
DC01	Untreated			72.9
DC01	50%	200	500	<5
DC01	50%	200	500	<5
DC01	50%	200	2,000	7.3
DC01	50%	200	2,000	7.3
DC01	100%	20	500	<5
DC01	100%	20	1,000	<5
DC01	100%	20	1,000	<5
DC01	100%	20	2,000	<5
DC01	100%	20	2,000	<5
DC01	100%	200	500	<5
DC01	100%	200	500	<5
DC01	100%	200	2,000	<5
DC01	100%	200	2,000	<5

The DC01 mild steel specimens shows that the laser surface treatment can cause a change in the surface wettability. It can be seen by the significant reduction in the water contact angle (WCA) nearly in every laser treatment parameter. The untreated DC01 surface has an initial contact angle of  $72.9^\circ$  which is a bad wetting state and a hydrophobic surface. It is typical for cold-rolled steels containing a thin oxide layer and trace organic residues from rolling or handling processes.

The laser surface activation decreased the water contact angle across all tested parameter combinations. The WCA values went to below  $5^\circ$  in most cases. The reduction in contact angle confirms the strong activation effect of the laser treatment. The laser treatment cleaned, oxidized, and micro-textured the steel surface.

Using moderate (50%) laser power and high (100%) laser powers created a good wettability. The intermediate laser beam energy densities can be used to induce surface polarity changes in DC01 steels. Slight variations happened at the highest scanning speeds (2000 mm/s). In this case the water contact angle increased to around  $7^\circ$ . It shows only a little change because of the reduced local energy input. At lower scanning speeds (500–1000 mm/s) and higher pulse frequencies (200 kHz) the surfaces consistently had full surface wetting activation. This change is connected to a combination of thermal oxidation and remove of hydrocarbon contaminants and micro-scale surface roughening induced by the laser pulses. In this case too, like in the case of S235 the localized heating created a thin oxide layer enriched in hydroxyl ( $-OH$ ) groups.

S235 and DC01 steels both became highly hydrophilic and had a good wetting condition on its surfaces. After the laser treatments DC01 showed a faster decrease in water contact angle from  $\sim 73^\circ$  to below  $5^\circ$  even at medium laser beam power. It shows easier surface activation conditions. While the activation of S235 required higher laser beam energy to reach the same hydrophilic state. It had partial surface wetting activation ( $10\text{--}35^\circ$ ) at medium laser beam power level parameters. This difference could come from the more complex and more stable oxide layer on S235, which is harder to modify than the thin, easily oxidized surface of DC01.

## SHEAR STRENGTH OF THE JOINTS

For S235 steel the adhesive joint strength results can be seen in *Table 3*.

*Table 3. Effect of laser-induced surface activation on the water contact angle (WCA) and maximum shear strength of S235 steel joints bonded with acrylic and cyanoacrylate adhesives.*

Adhesive	Material	Average laser beam power (%)	Laser beam pulse frequency (kHz)	Scanning speed (mm/sec)	Water contact angle, WCA (°)	Average - Maximum shear force values (kN)	Scatter - Maximum shear force values (kN)
Acrylic	S235	Untreated			89.8	0.57	0.63
Acrylic	S235	50%	200	500	<5	3.95	0.46
Acrylic	S235	50%	200	2,000	34.4	3.11	0.69
Acrylic	S235	60%	20	500	10.0	3.59	0.40
Acrylic	S235	60%	20	500	10.0	3.43	0.66
Acrylic	S235	80%	20	500	<5	2.96	0.60
Acrylic	S235	80%	20	500	<5	3.12	0.29
Acrylic	S235	90%	20	500	<5	2.33	1.04
Acrylic	S235	90%	20	500	<5	3.16	0.50
Acrylic	S235	100%	20	500	<5	2.24	1.44
Acrylic	S235	100%	20	500	<5	1.92	1.77
Acrylic	S235	100%	200	500	<5	3.85	0.20
Acrylic	S235	100%	200	2,000	16.3	3.63	0.33
Cyanoacrylate	S235	Untreated			89.8	0.06	0.13
Cyanoacrylate	S235	50%	200	500	<5	5.64	0.63
Cyanoacrylate	S235	50%	200	2,000	34.4	5.07	0.78
Cyanoacrylate	S235	60%	20	500	10.0	2.21	1.17
Cyanoacrylate	S235	80%	20	500	<5	4.99	0.54
Cyanoacrylate	S235	90%	20	500	<5	4.33	0.79
Cyanoacrylate	S235	100%	20	500	<5	4.40	0.48
Cyanoacrylate	S235	100%	200	500	<5	6.15	0.66
Cyanoacrylate	S235	100%	200	2,000	16.3	5.33	1.54

These results show a clear and consistent correlation between surface wettability and maximum shear force. It confirms that laser improved wetting can change significantly the adhesive bonding performance for both adhesive types. For the untreated S235 surface which had a high contact angle (90°) and low surface energy both adhesives resulted in poor adhesion. The anaerobic acrylic adhesive achieved an average shear strength of 0.57 kN, while the cyanoacrylate adhesive showed 0.06 kN. The 0.06 kN comes from the fact that sometimes the force measurement was failed because the specimens were broke before the start of the measurement, they fractured only handling them.

After laser surface activation the shear strength increased in both cases. When the contact angle decreased below 5° and reached complete wetting the acrylic adhesive reached force values between 3.0–3.9 kN, and the cyanoacrylate adhesive between 5.0–6.2 kN. This resulted approximately a six times increase for the acrylic adhesive and nearly a two orders of magnitude improvement for the cyanoacrylate adhesive compared with the untreated S235 steel surfaces.

While both adhesives benefited from higher surface energy on the steels their effect to laser surface parameters is different. The acrylic adhesive showed higher strength at moderate to high laser power (50–100%) and 500 mm/s scanning speed. Its performance tended to slightly decrease at the highest laser power levels. This shows that the energy input can lead to local over oxidation on the surface producing thicker oxide films. It is reduce metal ion availability which is critical for the anaerobic curing mechanism.

The cyanoacrylate adhesive showed a more monotonic and stable improvement durring the tested laser parameter conditions. Since this adhesive cures using moisture-induced anionic reactions, its adhesion is primarily depend on surface polarity and wetting. The highest strength values (6.1 kN) were measured at 100% power, 200 kHz, and 500 mm/s, where the surface was fully hydrophilic.

The adhesive bonding results of DC01 mild steel confirms the strong correlation between laser surface activation, contact angle reduction and shear strength improvement for both adhesives. These results can be seen in *Table 4*.

**Table 4. Effect of laser-induced surface activation on the water contact angle (WCA) and maximum shear strength of DC01 mild steel joints bonded with acrylic and cyanoacrylate adhesives.**

Adhesive	Material	Average laser beam power (%)	Laser beam pulse frequency (kHz)	Scanning speed (mm/sec)	Water contact angle, WCA (°)	Average - Maximum shear force values (kN)	Scatter - Maximum shear force values (kN)
Acrylic	DC01	Untreated			72.85	0.29	0.31
Acrylic	DC01	50%	200	500	<5	2.10	0.84
Acrylic	DC01	50%	200	2,000	7.25	1.62	0.70
Acrylic	DC01	100%	20	500	<5	2.96	0.24
Acrylic	DC01	100%	20	1,000	<5	2.47	0.46
Acrylic	DC01	100%	20	2,000	<5	2.07	0.47
Acrylic	DC01	100%	200	500	<5	2.88	0.19
Acrylic	DC01	100%	200	2,000	<5	2.33	0.26
Cyanoacrylate	DC01	Untreated			72.85	2.03	1.23
Cyanoacrylate	DC01	50%	200	500	<5	5.62	0.54
Cyanoacrylate	DC01	50%	200	2,000	7.25	4.60	0.51
Cyanoacrylate	DC01	100%	20	1,000	<5	4.39	0.36
Cyanoacrylate	DC01	100%	20	2,000	<5	4.85	0.48
Cyanoacrylate	DC01	100%	200	500	<5	5.15	0.10
Cyanoacrylate	DC01	100%	200	2,000	<5	5.07	0.35

The untreated DC01 surface, had a water contact angle of 72.9°, showed poor wettability and correspondingly low adhesion strength. In this state, the anaerobic acrylic adhesive reached an average shear strength of only 0.29 kN, while the cyanoacrylate adhesive achieved 2.03 kN. These low values reflect the limited surface energy and the presence of organic residues and native oxides that inhibit wetting and chemical bonding.

After laser surface treatment, the adhesives demonstrated an increase in bond strength, directly associated with the reduction of the contact angle to below 5°, indicating a transition to a superhydrophilic surface state. The anaerobic acrylic adhesive showed an average shear strength between 2.1 and 2.9 kN, corresponding to roughly a ten-times improvement compared to the untreated condition. The highest adhesion (2.96 kN) was obtained at 100% laser power and 20 kHz, while slightly lower but still consistent results were observed across other parameter combinations. The improvement can be attributed to the removal of oxides and contaminants, exposure of catalytically active metal ions, and the formation of a micro-textured surface that enhances both chemical polymerization efficiency and mechanical interlocking.

The cyanoacrylate adhesive showed even greater sensitivity to surface activation. Upon laser treatment, the shear strength increased from 2.03 kN to values between 4.4 and 5.6 kN, representing approximately a 2.5-fold enhancement. The highest adhesion values (~5.6 kN) corresponded to surfaces with contact angles below 5°, confirming that the adhesive's performance is strongly governed by surface polarity and wetting. Unlike the anaerobic system, the cyanoacrylate adhesive did not depend on metallic ions for curing, and therefore achieved consistent strength across all activated surfaces, even at high scanning speeds.

#### CONNECTION BETWEEN THE CHEMICAL OF THE ADHESIVE, THE STEELS AND SURFACE TREATMENT

The combined analysis of laser-treated and untreated specimens shows that the interaction between adhesive chemistry, steel substrate, and surface wettability governs the final bonding performance. The summary and comparison *Table 5*. results show consistent trends across all measurements: laser-induced surface activation-manifested by a sharp reduction in water contact angle-produced significant increases in adhesive joint strength for both DC01 and S235 steels, though the extent and mechanism of improvement were strongly dependent on both the adhesive type and the substrate composition.

**Table 5. Average and individual shear strength values of acrylic and cyanoacrylate adhesive joints on DC01 and S235 mild steel substrates before and after laser-induced surface activation, including corresponding water contact angles and relative strength improvements compared to untreated surfaces**

Adhesive	Material	Average laser beam power (%)	Laser beam pulse frequency (kHz)	Scanning speed (mm/sec)	Water contact angle, WCA (°)	1. Repetition- Maximum shear force value (kN)	2. Repetition- Maximum shear force value (kN)	3. Repetition- Maximum shear force value (kN)	4. Repetition- Maximum shear force value (kN)	5. Repetition- Maximum shear force value (kN)	Average- Maximum shear force values (kN)	Scatter- Maximum shear force values (kN)	Average strength increase due to surface treatment to Untreated material
Acrylic	DC01	Untreated			72.85	0	0	0.72	0.27	0.47	0.29	0.31	Reference
Acrylic	S235	Untreated			89.75	0	1.06	1.39	0.39	0	0.57	0.63	Reference
Cyanoacrylate	DC01	Untreated			72.85	0.47	1.33	2.48	2.15	3.74	2.03	1.23	Reference
Cyanoacrylate	S235	Untreated			89.75	0	0	0.02	0	0.3	0.06	0.13	Reference
Acrylic	DC01	50%	200	500	<5	0.63	2.2	2.71	2.59	2.36	2.1	0.84	724%
Acrylic	S235	50%	200	500	<5	3.76	3.46	3.85	4.7	3.97	3.95	0.46	693%
Cyanoacrylate	DC01	50%	200	500	<5	4.89	5.66	5.45	5.71	6.39	5.62	0.54	277%
Cyanoacrylate	S235	50%	200	500	<5	6.29	5.27	5.08	6.36	5.18	5.64	0.63	9400%
Acrylic	DC01	50%	200	2,000	7.25	0.53	1.72	1.82	1.53	2.48	1.62	0.7	724%
Acrylic	S235	50%	200	2,000	34.35	3.81	3.35	3.08	1.97	3.36	3.11	0.69	546%
Cyanoacrylate	DC01	50%	200	2,000	7.25	5.46	4.5	4.59	4.28	4.15	4.6	0.51	227%
Cyanoacrylate	S235	50%	200	2,000	34.35	5.03	4.28	6.38	4.84	4.82	5.07	0.78	8450%
Acrylic	DC01	100%	200	500	<5	2.8	2.61	3.05	2.89	3.05	2.88	0.19	993%
Acrylic	S235	100%	200	500	<5	3.62	4.13	3.86	3.7	3.93	3.85	0.2	675%
Cyanoacrylate	DC01	100%	200	500	<5	5.17	5.09	5.19	5.02	5.27	5.15	0.1	254%
Cyanoacrylate	S235	100%	200	500	<5	5.98	6.31	6.54	5.1	6.81	6.15	0.66	10250%
Acrylic	DC01	100%	200	2,000	<5	2.36	2.49	2.03	2.12	2.65	2.33	0.26	803%
Acrylic	S235	100%	200	2,000	16.3	3.86	3.62	3.75	3.85	3.07	3.63	0.33	637%
Cyanoacrylate	DC01	100%	200	2,000	<5	5.19	4.93	4.55	5.2	5.48	5.07	0.35	250%
Cyanoacrylate	S235	100%	200	2,000	16.3	5.35	5.24	7.87	4.3	3.91	5.33	1.54	8883%

*Influence of Laser Activation on S235 Steel*

The untreated S235 structural steel showed a higher contact angle ~89.8°, which provides a very poor adhesion in its untreated state. Using the acrylic adhesive the untreated case achieved only 0.57 kN, while the cyanoacrylate adhesive failed to join the surfaces (0.06 kN), in this state the specimens fractured during handling for the strength test. These low joint strengths can be explained by the chemically inert and unremoved oxide layer on S235.

The laser surface activation improved the wettability of S235 with contact angles of under 5° using most conditions. The adhesion strength increased by several orders of magnitude. With the acrylic adhesive the average shear strengths were between 3.1 and 3.9 kN, it leads to a 700% improvement to the untreated surface. The cyanoacrylate adhesive, however, showed higher improvement with the strength values increasing from 0.06 kN to over 5.6 kN, equivalent of 9000% improvement.

This massive improvement can be because of the the chemical sensitivities of the two adhesive systems. The anaerobic acrylic adhesive cures on metal-ion activation and it has benefits from moderate oxidation and micro-roughening. The cyanoacrylate adhesive strengths depend mainly on the surface polarity and moisture.

#### *Influence of Laser Activation on DC01 Steel*

The untreated DC01 mild steel had a hydrophobic surface with a water contact angle of 72.9°, the untreated specimens showed low initial bonding strength. The anaerobic acrylic adhesive (Loctite 270) bonded only with 0.29 kN, while the cyanoacrylate adhesive (Loctite 496) reached 2.03 kN. This weak performance of the acrylic adhesive can be because of the the presence of a passive oxide film and adsorbed hydrocarbons. After the laser surface activation, the contact angle went below 5°. The adhesion strength of both adhesives increased very high. Using the acrylic adhesive the average joint strength values were between 2.1 and 2.9 kN, resulting of a 724–993% improvement compared to the untreated surfaces. The cyanoacrylate adhesives' bonding reached even higher strengths, it was between 5.0 and 5.6 kN, resulting of a 250–277% increase relative to its untreated surfaces. The measurement results showed that both adhesive joints improved with the wetting. These main effects can be:

The anaerobic adhesive strengths improvement reacts for oxide removal and exposure of active  $\text{Fe}^{2+}$ , creating efficient curing and stronger bonding.

The cyanoacrylate adhesive strengths improvement reacts for enhanced wetting and polarity.

#### *Comparative Analysis of DC01 and S235*

The DC01 steels had a cleaner and more homogenous surface chemistry. During the laser surface modification, the surface achieved hydrophilic activation even at medium laser power levels. While S235 steel containing thicker oxide layer which required higher laser surface energy densities to achieve similar good wetting, but once the activated surface was achieved, its adhesion strength exceeded the DC01 steels behaviour.

Main differences were found during the research in relative strength. Using DC01 the acrylic adhesive strengths improved 8–10 times, and in the cyanoacrylate case by 2.5 times. Using S235 the acrylic adhesive strengths increased by 6–7 times while the cyanoacrylate adhesive improved by around 100 times.

The wetting contact angles and strength results showed that the combined effects of surface activation and adhesive reaction and cure mechanism determine the final level of bonding performance.

DC01 steel showed a more reproducible activation, while S235 showed a wider but more parameter sensitive improvement range. The connection between the chemical nature of the adhesives, the steels surface conditions, and the effect of the surface treatment can be summarized as:

- Anaerobic acrylic adhesive (Loctite 270) showed strength increases, which are primarily happened because of the presence of metallic ions and the removal of the thick oxide layer.
- Cyanoacrylate adhesive (Loctite 496) showed that the adhesion correlates with surface polarity and wetting. When the surface became hydrophilic the adhesion strength reached high values.
- The DC01 steel responds well to laser surface treatment due to its simple oxide structure, and it achieved a good wetting surface activation even using lower laser power levels.
- The S235 steel required higher laser surface energy to break down the oxide layers, but in this case once the surface reached a wetting activated state it achieved exceptionally high adhesion strengths – with the cyanoacrylate adhesive - due to the adhesive strong polar curing response on the S235 surface.

These findings shows that laser surface activation processes can effectively create an improved chemical condition. This method can optimize the connection between the adhesive type and substrate reactivity.

## Conclusion

In this study the wettability and adhesive joint strength improvement were investigated using impulse laser induced surface activation on DC01 and S235 steels. Using the surface activation process the surfaces were hydrophilic, this creates a modified chemical condition on the surface compared to the untreated surface, which improves the adhesive bonding process. The main results are the following:

- The laser surface treatment decreased the water contact angle from the original untreated  $\sim 73^\circ$  (DC01) and  $\sim 90^\circ$  (S235) to below  $5^\circ$ . This confirms that hydrophilic surfaces can be created through oxide layer modification, surface carbon removal, and hydroxylation.
- Using different laser surface parameters when the contact angle decreased, the adhesive strength increased in all cases.
- Using anaerobic acrylic adhesive (Loctite 270) the joint strength increased from  $0.29 \rightarrow 2.9$  kN on DC01 (which is around 10 times improvement) and  $0.57 \rightarrow 3.9$  kN on S235 (which is around 6 times improvement). These improvements can be happed because of the laser created micro-roughness that enhanced both wetting and mechanical interlocking.

- Using cyanoacrylate adhesive (Loctite 496) the adhesive joint strength increased from 2.0 → 5.6 kN on DC01 and 0.06 → 6.1 kN on S235 (which is around 100 times improvement). The strength could be increased because of the surface polarity and moisture-induced polymerization efficiency on hydroxylated, hydrophilic surfaces.
- The laser surface activation method showed effective for two different adhesives and two different steels, demonstrating that its industrial applicability as a clean, repeatable, and primer-free pre-treatment process for structural adhesive bonding.

#### *Author Contributions*

Conceptualization, Z.W. and M.B.; methodology, M.B.; validation, M.B., investigation, M.B.; resources, Z.W.; data curation, Z.W.; writing—original draft, M.B.; writing—review and editing, Z.W.; visualization, M.B.; supervision, Z.W.; project administration, Z.W.; funding acquisition, Z.W. “All authors have read and approved the final version of the manuscript.

#### *Funding*

Project no. 2021-1.1.4-GYORSÍTÓSÁV-2022-00065 has been implemented with the support provided by the Ministry of Culture and Innovation of Hungary from the National Research, Development and Innovation Fund, financed under the 2021-1.1-4-GYORSÍTÓSÁV funding scheme.

#### *Conflicts of Interest*

The authors declare no conflicts of interest.

# *A study on the historical development of the transition to the metropolitan municipality system in turkish administrative history*

**Abstract:** This study aims to examine the historical development of municipal administration in Turkish administrative history and the transition process to the metropolitan municipal system from a comprehensive perspective. The study begins with traditional municipal practices based on local service delivery during the classical period of the Ottoman Empire and examines the modern municipal administration that emerged with the Tanzimat Era. The inadequacy of municipal services provided through institutions such as the kadı, waqf (foundation), guild, and neighborhood over time, the strengthening of the centralist state structure, and increasing relations with the West paved the way for the birth of the modern municipal organization. In this context, the Istanbul City Council, established in 1855, is considered the starting point of modern municipalism in Türkiye.

During the Republican Era, the concept of municipal administration was reshaped alongside the preservation of the centralized state structure; the legal and administrative framework of municipalities was defined for many years by the Municipal Law No. 1580 dated 1930. The study examines the areas of responsibility, financial structures, and democratization processes of municipalities from the early years of the Republic; it also touches upon the socialist and social municipalism practices that emerged after the 1960s. In the post-1980 period, it was found that the scope of municipal services expanded and local governments became more effective under the influence of neoliberal policies.

One of the main focal points of the article is the historical development of the transition to the metropolitan municipal system in Türkiye. In this context, the constitutional basis introduced by Article 127 of the 1982 Constitution, the 1984 regulations, Law No. 3030, and Laws Nos. 5216 and 6360 enacted thereafter have been analyzed in terms of the institutional transformation of metropolitan municipal administration.

\* Ağrı İbrahim Çeçen University,  
History Department  
Email: btunc@agri.edu.tr;  
ORCID: 0000-0001-5361-8494

As a result, the study reveals that the metropolitan municipal system in Türkiye was shaped as a result of population growth, urbanization dynamics, and the search for service efficiency.

**Keywords:** Municipality, metropolitan municipality, administrative regulation, law.

**Összefoglalás:** Ez a tanulmány a török közigazgatás-történeten belül a városi közigazgatás történelmi fejlődését és a nagyvárosi önkormányzati rendszerre történő átállás folyamatát vizsgálja átfogó perspektívából. A tanulmány az Oszmán Birodalom klasszikus korszakában a helyi szolgáltatások nyújtására épülő hagyományos önkormányzati gyakorlatokkal kezdődik, és a Tanzimat-korszakban kialakult modern városi közigazgatást vizsgálja. Az olyan intézményeken keresztül nyújtott városi szolgáltatások elégtelensége, mint a kadi, a waqf (alapítvány), a céhek és a szomszédság, a centralista államstruktúra megerősödése és a Nyugattal való kapcsolatok erősödése utat nyitott a modern városi szervezet megszületéséhez. Ebben az összefüggésben az 1855-ben létrehozott Isztambuli Városi Tanács tekinthető a modern municipalizmus kiindulópontjának Törökországban.

A köztársasági korszakban az önkormányzati igazgatás koncepciója átalakult a központosított állami struktúra megőrzése mellett; az önkormányzatok jogi és igazgatási keretét hosszú évekre az 1930. évi 1580. számú önkormányzati törvény határozta meg. A tanulmány a köztársaság kezdeti éveitől kezdve vizsgálja az önkormányzatok illetékességi területeit, pénzügyi struktúráit és demokratizálódási folyamatait; kitér az 1960-as évek után kialakult szocialista és szociális municipalizmus gyakorlatára is. Az 1980 utáni időszakban tapasztalható volt az, hogy a neoliberais politikák hatására kibővült az önkormányzati szolgáltatások köre, és a helyi önkormányzatok hatékonyabbá váltak.

A jelen tanulmány egyik fő fókuszpontja a nagyvárosi önkormányzati rendszerre való áttérés történelmi fejlődése Törökországban. Ebben az összefüggésben az 1982-es Alkotmány 127. cikkelye, az 1984. évi szabályozások, így a 3030. számú törvény, valamint az azt követően elfogadott 5216. és 6360. számú törvények által bevezetett alkotmányos alap a nagyvárosi önkormányzati igazgatás intézményi átalakulása szempontjából kerül elemzésre. Ennek eredményeként a tanulmány feltárja, hogy a törökországi nagyvárosi önkormányzati rendszer a népességnövekedés, a urbanizációs dinamika és a szolgáltatás-hatékonyág iránti megfogalmazott igények eredményeként alakult ki.

**Kulcsszavak:** Önkormányzat, nagyvárosi önkormányzat, közigazgatási szabályozás, jog.

## Introduction

Local governments have historically played important roles as the administrative units closest to the social needs of the state. The Mohaç Sanjak during the Ottoman period can be given as an example of these local administrations [1]. In Türkiye, the concept of municipal administration has undergone a continuous process of change and development alongside political, social, and economic transformations. During the classical period of the Ottoman Empire, municipal services were not provided by a single institutional structure as we understand it today, but rather through various institutions such as qadis, foundations, guilds, and neighborhood organizations. Although this structure met the needs of urban life for a long time, it began to fall short in the face of increasing population, commercial relations, and the pressure of urbanization.

In the 19<sup>th</sup> century, the Ottoman Empire's shift towards a centralized administrative structure during the Tanzimat Era and its exposure to institutional models in the West accelerated the emergence of modern municipal governance. Established in 1855, the Istanbul Municipal Council is considered the first concrete example of modern municipal governance in Türkiye. This development aimed not only to ensure the more orderly provision of urban services but also to increase the state's capacity for oversight and control at the local level.

During the Republican Era, the concept of municipal administration was restructured within the framework of the principle of strong central government. The Municipal Law No. 1580 dated 1930 formed the legal and administrative basis for municipalities in Türkiye for many years; the duties, powers, and control mechanisms of municipalities were determined by this law. Over time, social and economic changes, especially the rapid urbanization process, necessitated a redefinition of the role of municipalities. In this context, the transition to the metropolitan municipality system in Türkiye constitutes one of the most important turning points in the history of modern municipal administration.

Metropolitan municipalities, which gained constitutional support with the 1982 Constitution, were institutionalized with legal regulations issued after 1984 and transformed into a structure covering provincial boundaries with comprehensive reforms in the 2000s. This study aims to reveal the transformation of local governments by analyzing the historical development of municipal administration in

[1] Falus, O. (2021): "Tax Administration in the Sanjak of Mohacs in the 16<sup>th</sup> century Turkish Rule". In: Oğuz Kağan (Ed.): *Issues in local governance in Balkans*. Sarajevo: Dobra Knjiga, pp. 305–329.

[2] Tekeli, İ. (2010): *The Story of municipalities in the republic*. İstanbul: History Foundation Publications.

[3] Deniz, A.–Akarçay, P.–Karakaş, A. (2017): The development of municipality in the ottoman empire and its efforts towards modernization. *Academic Perspective International peer-reviewed social sciences journal*, (64.), pp. 314-325.

[4] İslamoğlu, A. (2012): *The legal institutionalization of the modern municipality in the ottoman empire*. (Unpublished Master's Thesis). Istanbul: Dokuz Eylül University–Istanbul University Institute of Social Sciences.

[5] Oktay, T. (2015): “The administration of Istanbul from the Tanzimat Era to the 21<sup>st</sup> century”. Coşkun Yılmaz (Ed.): *The great history of Istanbul from antiquity to the 21<sup>st</sup> century. Politics and Administration*, 2. Istanbul: Istanbul Metropolitan Municipality Cultural Publications, pp. 134–217.

[6] Singer, A. (1996): *Palestinian peasants and ottoman officials, rural administration around sixteenth-century Jerusalem*. Istanbul: History Foundation Domestic Publications.

[7] Uluçay, H.–Alp, Ş. (2020): The qadi in ottoman city administration. *Near East University Faculty of Theology Journal*, 6., (2.), pp. 329–358.

Turkish administrative history and the transition process to the metropolitan municipal system in its legal and administrative dimensions.

## The historical development process of municipal administration before the republican era

It can be said that the concept of municipal administration in the Republic of Türkiye was established in the 1930s with the successive enactment of the Municipalities, Public Health, Municipalities Bank, Construction and Roads, and Expropriation laws. The period between 1923 and 1930 was a kind of preparatory period. This period was not a static waiting period. The republican regime faced significant municipal and urban planning issues in its early years. The republic's municipal vision emerged from the solutions sought to these problems. The laws that emerged in the 1930s and symbolized the republic's municipal vision were enacted during the first term of the Grand National Assembly [2]. Before addressing this issue in detail, it is necessary to focus on how local administration worked in the Ottoman Empire.

The Ottoman Empire's approach to municipal administration was modern and systematic. Local administrative units and municipal services were carried out in various ways. The end of the traditional approach to municipal administration in the Ottoman Empire coincided with the Tanzimat period. The Western concept of municipal administration, along with the Tanzimat, also determined the form of local government in the Ottoman Empire. For this reason, the Ottoman concept of municipal administration should be considered in two parts [3]. The first of these parts is grouped as the classical period of Ottoman municipal administration and the post-Tanzimat concept of municipal administration.

In the context of the situation explained above, there were individuals and institutions responsible for local administration, i.e., municipal work, in the Ottoman Empire during the Classical period.

However, it is not possible to speak of a single institutionalized municipality in the Ottoman Empire during this period [4].

Instead of a single institution performing all municipal duties, there were various institutions or individuals that took on municipal responsibilities. These institutions primarily included the qadi, foundation, guild, and neighborhood institutions [5]. In this context, it is necessary to first examine the institutions that constituted the municipality in the Ottoman Empire during the Classical Period and then describe the historical process of transition from this classical structure to the modern structure.

During the Classical Period, judges were at the forefront of those who carried out municipal services. Based on Sharia law, qadis ruled according to both decrees and local customs. Qadis carried out municipal work in accordance with this, as well as judicial matters [6]. Essentially, until the Tanzimat period, the city was represented by the qadi and the kethüda in the eyes of the government. The qadi inspected the market and the city through the muhtesib. They ensured public order by making announcements (through the mubassir). In addition, qadis, who were active in the local administration of cities, monitored the inspection of tradesmen, the organization and supervision of prices, the prevention of hoarding and profiteering, the repair of sidewalks, the monitoring of mubassirs (people closely involved with the situation of students in schools and ensuring order), and teachers who mistreated students, ensuring that pack animals and porters were not overloaded, and keeping roads open and safe for travelers [7]. This indicates that municipal services were comprehensively administered in the Ottoman Empire.

According to İslamoğlu, during the Classical Period, the guild system was also responsible for municipal administration in the Ottoman Empire. In this context, guilds established certain standards in craftsmanship based on the principles they defined and adopted. This eliminated unfair competition, provided job opportunities for new apprentices, and alleviated livelihood concerns. Trade guilds were organized in specific trades, taking into account the economic resources and needs of the city they were located in. Guilds collectively carried out their production activities in shops belonging to their own trades. Large bazaars were formed when trades that were closely related to each other came together. There was no right to open a shop wherever one wanted. At the same time, shops belonging to trades that produced goods harmful to health were established at a designated location outside the city [8].

[5] Oktay, T. (2015): "The administration of Istanbul from the Tanzimat Era to the 21<sup>st</sup> century". Coşkun Yılmaz (Ed.): *The great history of Istanbul from antiquity to the 21<sup>st</sup> century. Politics and Administration*, 2. Istanbul: Istanbul Metropolitan Municipality Cultural Publications, pp. 134–217.

[6] Singer, A. (1996): *Palestinian peasants and ottoman officials, rural administration around sixteenth-century Jerusalem*. Istanbul: History Foundation Domestic Publications.

[7] Uluçay, H.–Alp, Ş. (2020): The qadi in ottoman city administration. *Near East University Faculty of Theology Journal*, 6., (2.), pp. 329–358.

[8] İslamoğlu, A. (2017): Guilds in the ottoman state. *Istanbul Law Journal*, (75.), pp. 447–456.

[9] Deniz, A.–Akarçay, P.–Karakas, A. (2017): The development of municipality in the ottoman empire and its efforts towards modernization. *Academic Perspective International Peer-Reviewed Social Sciences Journal* (64.), pp. 314–325.

[10] Yüksel, H. (1998): *The role of waqfs in ottoman social and economic life (1585–1683)*. Sivas: Dilek Printing House.

[11] Işık, H. (2009). The role of foundations as a public service unit in ottoman social life. *Academic Perspective: International Peer-Reviewed Social Sciences E-Journal*, (16.), pp. 1–10.

Thus, thanks to the careful work of the guilds and their activities in accordance with the law, harm to the public was prevented.

According to Deniz and Akarçay, the guild system, one of the institutions that provided municipal services during the Classical Period, served both as a public service and as a civil society organization. Consisting of hierarchical organizations of professional groups, the guild controlled production and consumption in city centers. Guilds ensured management among tradesmen. Guilds, which arose from professional groupings, were responsible for maintaining order and organization in their own workplaces; to fulfill this responsibility, members pooled their resources in a fund organized into sections. Thanks to this income, local tasks such as market maintenance, repair, and cleaning were carried out. Each guild had a designated guild master or guild steward. Those in this profession were selected by the guild master or guild steward parts [9]. These individuals were personally responsible for municipal services.

According to Yüksel, another institution involved in municipal services in the Ottoman Empire during the Classical period was the foundation. During the Ottoman period, foundations played an extremely important role in social life. In other words, foundations, which were present and active in many areas of social life, were one of the indispensable structures of normal life [10]. Foundations, which were such important structures, performed many of the duties carried out by municipal administrations today and were responsible for the cleanliness and transportation of cities.

In the context of municipal services, the most important role of foundations has been public works and city cleaning services. Within this framework, during the Classical Period of the Ottoman Empire, the construction and repair of roads, bridges, canals, dams, fountains, and sidewalks were carried out by foundations. Today, services such as roads, water, sanitation, street lighting, and the maintenance and landscaping of parks and gardens, which are part of municipal services, fall within the scope of foundations. For example, some philanthropists employed “lantern bearers” through the foundations they established and used foundation income to purchase lanterns and oil to illuminate the streets. Foundations were established for street cleaning. Guard salaries were paid from foundations [11].

These and similar examples demonstrate the extent to which foundations were effective in municipal services.

According to Çadırcı, there was no single institution in Ottoman cities before the Tanzimat that took on the municipal services of today. As explained above, the main tasks that municipalities were responsible for were carried out by government representatives, representatives of trade associations, judges, and city leaders. From the second half of the 19<sup>th</sup> century onwards, relations with European countries began to develop considerably, and Western merchants began to settle and establish colonies in many large cities, especially our coastal and port cities. Developing commercial relations increased the need for new services, job opportunities, transportation, and communication. Especially in port cities, quarantine and accommodation facilities for merchant ships and providing regular urban transportation became major problems [12]. This process, which led to progress in municipal administration, began with the Tanzimat Era.

Essentially, the state's move towards Western-style organization created a contradiction with the conventional/foundation-based organization of municipal services. The establishment of the Evkaf and İhtisab ministries meant a significant change in the provision of municipal services. The difficulties encountered in replacing the old, dysfunctional system with a new one also gave rise to major problems. The accommodation of large numbers of British, French, and Italian soldiers who came to Istanbul during the Crimean War and the lack of infrastructure for this purpose resulted in the establishment of the City Council in 1854, based on the French model. Municipal services, which were struggling under the outdated and dysfunctional traditional system, were attempted to be resolved through a new structure [13]. For this reason, the Tanzimat Period's efforts in municipal administration hold tremendous significance in Türkiye.

In the context of the information provided above, the Tanzimat Edict, considered a critical political threshold in Ottoman history, was an important step taken to re-centralize the state with new organizational tools. It is clear that every new reform following the Tanzimat Edict was largely aimed at strengthening central authority. During this period, the state sought to be represented throughout the country through new practices initiated in many areas such as law, the tax system, and education, thereby striving to make even the most remote regions of the country accessible and controllable. The municipal institutions introduced by the Tanzimat should also be evaluated from the same perspective [14]).

[12] Çadırcı, M. (1991): *Social and economic structures of anatolian cities during the tanzimat period*. Ankara: Turkish Historical Society Publications.

[13] Uyar, Hakkı (2004): Local governments in Türkiye and the world: a brief history. *Enlightenment* 1923, 8., (51.), pp. 31–38.

[14] Avci, Y. (2016): Comparative analyses on ottoman municipalism during the tanzimat period. *Pamukkale University Journal Of Social Sciences Institute*, ( 24 .), pp. 167–180.

[16] Ünal, F. (2011): Legal and structural transformation of local governments in Turkey from the tanzimat period to the republic. *Dumlupınar University Journal of Social Sciences*, (30.), pp. 241–248.

[15] Ortaylı, İ. (2018): *Ottoman local administrations during the tanzimat period (1840–1880)*. Ankara: Turkish Historical Society Publications.

[16] Ünal, F. (2011): Legal and structural transformation of local governments in Turkey from the tanzimat period to the republic. *Dumlupınar University Journal of Social Sciences*, (30.), pp. 241–248.

Indeed, the Tanzimat reformers established modern municipalities to consolidate, organize, and thus better control urban services, which were previously provided by various institutions and authorities.

According to Ortaylı, local government in Türkiye developed with a serious purpose in the 19<sup>th</sup> century. Municipal administration was at the forefront of this, and the birth of modern municipal administration in Türkiye coincided with the Tanzimat Era [15]. In this context, attempts to establish the first municipal administration in the Ottoman Empire as a local administrative unit in the modern sense emerged in the years following the Tanzimat reforms and particularly during the 1854-1856 Crimean War, as a result of increased contact with Western countries. Taking inspiration from French communal administrations, the first attempt to establish a municipal organization was made in Istanbul in 1855.

The decision-making and executive bodies of the established municipality (Şehremaneti) consisted of the mayor and the city council. The City Council, which abolished the Taxation Office, was responsible for ensuring the provision of essential goods for the city, setting and enforcing prices, constructing and repairing roads and sidewalks, cleaning, and controlling tradesmen. The establishment of the first modern municipal administration occurred during the Crimean War under the influence of the Ottoman Empire's allies. This was because, during the period in question, there were over 100,000 foreigners living in Istanbul, and European states wanted these nationals to live in a modern, well-maintained, clean city. Therefore, the City Council was established to perform similar duties to those undertaken by communes in Western countries, which were considered important at the time [16].

One of the most important events in the history of municipal administration in Türkiye is the establishment of the Istanbul City Council. It can be said that there were multiple factors that made the establishment of the City Council necessary. Firstly, the deterioration of the qadi, muhtesip, subaşı, foundation, guild, and neighborhood administrations seriously disrupted public services. By the time the City Council was established, these institutions were barely providing any public services, yet the people demanded that these services be provided. On the other hand, it is known that the segment of the population living in the Beyoğlu-Galata region, who were familiar with Europe and had greater economic and political power at the time, introduced the

concept of “local services/municipality” to the Ottoman Empire and made intense and effective demands in this direction with the support of Europe. In this context, it has been said that the Şehremaneti was the equivalent of the prefecture de la ville institution used in Europe [17]. On the other hand, it has also been said that Ottoman statesmen traveling to Europe confirmed the need for a regular and modern municipal organization.

According to Öner, in the context of the information provided above, after the Crimean War, relations with Europe increased and state departments attempted to model their organization and procedures on those of Western civilized countries. It was deemed necessary to establish a separate department exclusively to deal with municipal affairs in Istanbul. To this end, by a decision of the Meclis-i Âli-i Tanzimat dated 27 Ramadan 1271 (June 13, 1855), the İhtisap Nezareti was abolished and replaced by a new office in Istanbul called the Şehremâneti, and a city council was established under the authority of the person appointed to this office, called the şehremîni [18]. The city council consists of individuals selected from among the people and reputable merchants of Dersaâdet.

After the Istanbul City Council was established (1855), public order was transferred to the Zaptiye Nezareti (Public Order Directorate). With this arrangement, the City Council began to perform the duties of the İhtisap Nezareti (Tax Directorate). It would ensure the easy procurement of items that were essential to the people of Istanbul, oversee pricing, build roads and sidewalks, oversee the city's sanitation, supervise the bazaars and markets, and collect state taxes and fees that had previously been collected by the Ministry of Revenue and transfer them to the treasury [19].

In its early years, the City Council, which did not have its own budget, had its annual accounting books inspected by the Accounting Council within the Ministry of Finance. The financial structure of the City Council was similar to that of the abolished Ministry of Taxation. Taxes collected from merchants under the official name of taxation were collected by the City Council and transferred to the central treasury. A small portion of these revenues remained with the City Council. In addition, there were taxes collected from the public for the use of animals in transportation and for the construction of sidewalks and roads. In this early period, the revenues of the Municipal Administration were only sufficient to cover personnel expenses.

[17] Argunhan, B. (2022): İstanbul city administration (1855–1858). *Kırkkale Law Journal*, 2., (1.), pp. 149–80.

[18] Öner, E. (2008): *The establishment of the Istanbul city administration (municipality) and its 1917 budget*. Ankara: Ministry of finance, strategy development department.

[19] Toprak, Z. (1999): The administration of Istanbul from the Tanzimat Era to the republic: Şehremâneti. *Tom-bak*, (29.), pp. 32–40.

[20] Oktay, T. (2015): "The administration of Istanbul from the Tanzimat Era to the 21<sup>st</sup> century". In: Coşkun Yılmaz (Ed.): *The Great History Of Istanbul From Antiquity To The 21st Century. Politics And Administration (Volume 2)*. Istanbul: Istanbul Metropolitan Municipality Cultural Publications, pp. 134–217.

[21] Gençoğlu, M. (2011): Restructuring in ottoman provincial administration according to the 1864 and 1871 provincial regulations. *Çankırı Karatekin University Journal of Social Sciences Institute*, 2., (1.), pp. 29–50.

[22] Sunay, C. (2002): Ottoman legacy in the process of the birth of municipalities. *Kocaeli University Journal Of Social Sciences*, (3.), pp. 113–133.

The institution's financial deficits were covered by the central government treasury. The financial resources of the institution, which was established with high expectations regarding local issues in Istanbul, were not established on the same strong footing [20].

It is very clear In the context of the situation explained above, the 1857 Regulation divided Istanbul into 14 municipal districts. The Sixth District covered the Beyoğlu and Galata areas. This extremely dense district was seen as a model structure. With the 1868 Dersaadet Municipal Decree, other districts were also established and became operational. The 1864 Provincial Regulation, on the other hand, covered the rural areas in the context of municipal affairs. Finally, with the 1877 Municipal Law, the Dersaadet Municipal Law was enacted. As a result, the Istanbul Municipality was divided into a total of 20 districts [19]. The same process was implemented in municipalities in other cities.

During the final period of the Ottoman Empire, two significant legal regulations played a crucial role in the historical development of municipal administration. These are the Provincial Regulations of 1864 and 1871. In this context, the provincial regulations enacted in 1864 and 1871 brought about a fundamental administrative reorganization of the municipal system. Compared to previous temporary measures, these regulations addressed provincial administration and local governance from the ground up, establishing a new and comprehensive provincial structure. In this organization, new administrative units replacing the old ones were defined in detail, the duties and powers of provincial administrators from top to bottom were determined, and new representative institutions were established [21]. Consequently, the 1864 and 1871 regulations marked a turning point in the history of Turkish municipal administration. According to Sunay, the widespread establishment of municipal organizations in cities and towns during the final period of the Ottoman Empire was realized through the Provincial Municipalities Law, which came into effect on October 5, 1877. Article 112 of the Kanun-i Esasi (Fundamental Law) stipulated that municipalities in Istanbul and the provinces would be administered by elected councils; the formation, duties, and method of determining the members of municipalities would be regulated by law. The Provincial Municipalities Law of 1877 remained in force until the adoption of the Municipalities Law No. 1580, which is still in effect today, in 1930. The Provincial Municipalities Law also granted municipalities legal personality [22]. The law explicitly regulates the authority to expropriate for the city's development and imposes certain new duties on municipalities.

## The historical development process of municipal administration in the Republic Era in Türkiye

The beginning of modern municipal administration in Türkiye parallels the processes of modernization and Westernization. It can be said that municipal organization, which was supported by examples from the West, particularly during the Tanzimat Era, was a new experience in Türkiye's history. With the establishment of the Republic, a rapid process of revolution took place. In the state organization, which underwent rapid transformation with various revolutions, it is seen that regulations related to municipalities were not prioritized. One reason for this situation is that the Turkish municipal organization structure is based on the French Model, where central authority is maintained. The newly established Republic, especially in its early years, did not prioritize democratization and local services [23]. The primary priorities in the early years of the Republic were to consolidate the reforms, prevent ethnic and religious uprisings, and strengthen central authority.

The main characteristics of municipalities during the early period of the Republic can be summarized as follows: the improvement of relevant legislation inherited from the Ottoman Empire in line with priority needs; the drafting of a new municipal law; the reconstruction of cities in Western Anatolia that had been devastated during the occupation and whose populations had declined after the population exchange; the filling of the resulting gaps in production and services; the declaration of Ankara as the capital and its development in line with its new status [24]. During this period, there were also various factors that negatively affected municipal regulations. Some of these factors included the existence of a rigid centralist approach in state administration, constraints created by the potential for political opposition in the country to organize and gain strength in municipalities, and the decline in tax values due to the effects of inflation during and after World War I, which led to a decrease in municipal revenues [25].

The fundamental law concerning municipalities during the Republican era is the Municipalities Law No. 1580 dated 1930. This law remained in force for 54 years as the sole law concerning municipalities. Article 1 of this Law defines a municipality as “a legal entity responsible for organizing and settling the local and civil needs of the town and its residents.” The provision of local public services during the Republican era was based on Article 1 of the relevant law.

[23] Ökde, F. (2023): The ottoman influence on municipal structure in the founding years of the republic. *Academic Sensitivities*, 10., (Republic Special Issue), pp. 511–536.

[24] Oktay, T. (2020): Development of metropolitan municipality administration in Türkiye in the period 1855–2020. *Strategic Public Management Journal*, 6., (12.), pp. 1–41.

[25] Oktay, T. (2023): “The development of municipalities in Türkiye during the period 1920–1960”. Erbay Arıkboğa (Ed.): *Local governments and urbanization in the 100<sup>th</sup> year of the republic*, Istanbul: Marmara Municipalities Union Publication, pp. 90–111.

[26] Arslaner, H.–Yavan, S. (2016): Differences in local public service delivery introduced by law No. 6360. *Anadolu University Journal Of Social Sciences*, 16., (Special Issue), pp. 277–290.

[27] Şinik, B.–Yılmaz Uçar, A.–Dik, E. (2016): The municipal law drafts of 1924 and 1926: founding steps of the republican understanding of municipalities. *Contemporary Local Governments*, 25., (2.), pp. 1–27.

Article 15 of the Municipalities Law No. 1580 lists the duties of municipalities in 77 items. When general duties are grouped, municipalities are assigned urban planning and public works, agriculture and livestock, health and social services, security, culture and education, and various other duties in the provision of local public services. The fundamental characteristics of this law include treating all municipalities except those of Ankara and Istanbul as equal, keeping municipalities under central government control, and granting municipalities broad authority to provide public services [26].

Prior to the Municipalities Law No. 1580, there were municipal draft laws dated 1924 and 1926 within the scope of municipal work. In this context, the drafts bear great similarities to the Municipal Law No. 1580, which established municipal administration in Türkiye; it can be easily said that the spirit of the Municipal Law of 1930 is also present in the drafts of 1924 and 1926. The appointment of municipal mayors and the preservation of central control over municipal bodies reflect this centralist spirit.

In other words, Law No. 1580 “grants local governments broad authority under the strict and strong supervision of the central government, [to local administrations] broad authority and also imposing civil and social duties on municipalities - which even our municipalities would not be able to perform for a long time -,” are not products of 1930; they were already present in the 1920s. Considering all these characteristics, it can be concluded that the Republic's approach to municipal administration continued along the same lines throughout the post-Republic period, but its implementation had to wait for the Regime's appropriate political and social circumstances [27].

The 1940s are extremely important in the history of municipal administration in Türkiye, as this period marked the beginning of the democratization of municipalities. In this context, when Türkiye entered a multi-party political era, the Turkish Municipal Administration Association was established on July 17, 1945, with close ties to the government, to create a movement by ensuring unity and solidarity among municipalities. The association sought to have mayors elected by the people and approved by administrative authorities.

According to Kaya, municipal council elections were completed in approximately one week on dates announced in advance, in accordance with Law No. 1580, but with Law No. 4748, enacted in 1946, the aforementioned procedure was changed so that elections could be completed in one day.

Furthermore, Law No. 5669, enacted on July 7, 1950, completely amended the provisions of Law No. 1580 relating to elections. Similarly, Articles 149 and 153 of Law No. 1580 treated the Special Administration and the municipality as a single entity in Istanbul, meaning that the Governor of Istanbul was also the Mayor. To resolve this issue, a new law enacted on April 10, 1954, separated municipalities from provinces [28].

According to Kılavuz and Yüksel, the most important development in Turkish municipal history in the 1960s [29] was the emergence of the concept of social municipalism. Social municipalism in Türkiye was fundamentally shaped by the rapid and uncontrolled urbanization that resulted from the economic growth and industrialization policies implemented in the 1960s, which brought local governments to the forefront. The rural-to-urban migration that occurred during this period also brought serious problems related to urban social life to the fore. These increasingly deepening problems led to local governments taking on more effective roles [30]. On the other hand, the relatively liberal environment that emerged after the 1961 Constitution [31] and the subsequent social, economic, and political changes that affected the entire world in the 1970s played a role in shaping the “New Municipalism Approach” in Türkiye, in other words, the principles of social municipalism.

The development of social municipalism in Türkiye began in the 1970s [26]. During this decade, municipalities implemented new municipal practices by increasing participation through associations, cooperatives, companies, and neighborhood representation, and by involving civil society, trade unions, and professional associations in governance.

Since the mid-1980s, local governments, particularly municipalities, have sought to address social issues and urban poverty by implementing temporary solutions. They have attempted to tackle this significant problem through in-kind and cash assistance for the urban poor. These practices gained momentum in the 1990s. Some municipalities saw an increase in their revenues compared to previous periods. Consequently, they placed greater emphasis on social service-centered policies to meet the needs of a population whose educational level was rising and whose demand for urban and social services was growing and diversifying, on the one hand, and of urban masses who had migrated to the city and were becoming increasingly impoverished, on the other [32].

[26] Arslaner, H.–Yavan, S. (2016): Differences in local public service delivery introduced by law No. 6360. *Anadolu University Journal Of Social Sciences*, 16., (Special Issue), pp. 277–290.

[28] Kaya, O. (1997): Local Governments In The Republican Era. (Unpublished Master's Thesis). Istanbul University, Atatürk Principles And History Of The Revolution.

[29] Tunç, B.–Yıldırım, S.–Falus, O.–Tuğrul Kara, Ö.–Czukur, K. (2023): Developments in industry in Türkiye in the democrat party Era (1950–1960) and its contribution to the private sector as the economic basis for the civil progression. *Civil Szemle*, 20., (7.), pp. 107–122.

[30] Kılavuz, F.–Yüksel, C. (2017): Social municipalism within the framework of local government finance: the case of Fatsa and Ovacık. *Society And Democracy*, 11., (23.), pp. 121–138.

[31] Köse, R.–Falus, O.–Czukur, K. (2023): From the 1961 constitution to the present day social services in Türkiye. *Civil Szemle*, 20., (7.), pp. 95–106.

[32] İpek, S.–Çiplak, B. (2016): Social municipalism and social budget practices in Türkiye: The case of Çanakkale municipality. *Journal Of Management Sciences*, 14., (27.), pp. 201–215.

[33] Beki, A. (2021): *Social Municipalism Practices in Turkey*. Istanbul: Üsküdar University Publications.

[34] Kaymal, C. (2017): Metropolitan municipality reform in terms of local autonomy and local democracy. *Ulakbilge*, 5., (13.), pp. 1137–1159.

In summary, the historical development of municipal administration can be outlined as follows: The period from 1855 to 1930 marks the beginning of municipal administration in the Western sense (Phase I). The period between 1930 and 1950 is the second phase and a period of serious work on municipal administration. The period between 1950 and 1980 is a lost period for municipal administration. The period after 1980 is a period of development for municipal administration. In this period, which could also be called the New Liberal Period, local governments were given significant opportunities [33]. Especially since 2004, a new era has begun in municipal administration. With the Municipalities Law No. 5393, the direction of municipal administration has changed again, and a significant restructuring has taken place.

### The Historical Development of the Transition to the Metropolitan Municipality System

The main starting point for the metropolitan municipality experiment in Türkiye was the provision added to Article 127 of the 1982 Constitution concerning local administration, which stated that “special forms of administration may be established for large settlements” [34]. This provision does not require that special forms of administration be established in the provincial capital or in a single province; it also allows for multiple large settlements within a province to be subject to special forms of administration. The government exercised its authority to establish a special form of administration for large urban centers in 1984 with Decree Law No. 195, which established a special form of administration called the metropolitan municipality that could be established in provincial centers.

The Decree Law No. 195, which regulates the establishment and administration of metropolitan municipalities in Istanbul, Ankara, and Izmir, was issued just two days before the local elections on March 25, 1984. According to Article 4 of this Decree Law, metropolitan municipalities are established under the name of the metropolitan city, and district municipalities bearing the names of the districts included in the metropolitan city are also established in those districts.

According to the Law amending Law No. 2972 of January 1984 on local elections in metropolitan municipalities, if there is more than one district within the boundaries of a provincial capital municipality, a metropolitan municipal council is established in the provincial capital and district municipal councils are established in the districts. Law No. 3030 of July 1984 amended Decree Law No. 195 of March 1984, reorganizing metropolitan municipality administration, and the relevant Regulation came into force in December 1984 [35].

According to Oktay, the metropolitan municipality system introduced in 1984, while benefiting from 20 years of accumulated experience, was designed as two separate tiers with legal personality rather than a municipal union model, as a result of the broad flexibility provided by the constitution. The lower tier consisted of district municipalities within the boundaries of the metropolitan municipality, while the upper tier consisted of the metropolitan municipality itself. The two-tier structure applied in Istanbul between 1858 and 1912 was thus reintroduced. The law defined metropolitan municipalities as cities with more than one district within their municipal boundaries, and district municipalities as districts within the boundaries of metropolitan municipalities. The boundaries of metropolitan municipalities were accepted as the municipal boundaries of the city from which they took their name. District municipalities were included within the boundaries of the metropolitan municipality. Although the law introduced a metropolitan management model, it did not foresee any expansion of boundaries. It was a model that included the continuation of provincial special administrations as a result of the metropolitan municipality being responsible for a limited part of the province [25].

As explained above, in the local elections held on March 25, 1984, metropolitan municipality elections were held for the first time in Istanbul, Ankara, and Izmir, and there was significant interest in these elections in the aforementioned cities.

In these elections, votes were cast not only for metropolitan mayors but also for district municipal councils and district mayors [36]. Subsequently, other provinces besides these three also gained metropolitan municipality status. Following these developments, cities that had become “major population centers” were granted metropolitan status through various laws or decrees with the force of law.

[25] Oktay, T. (2023): “The development of municipalities in Türkiye during the period 1920–1960”. Erbay Arıkboğa (Ed.): *Local governments and urbanization in the 100<sup>th</sup> year of the republic*, Istanbul: Marmara Municipalities Union Publication, pp. 90–111.

[35] Özgür, H.–Savaş Yavuzçehre, P. (2016): Türkiye's metropolitan municipality system: 1982–2015. *Çankırı Karatekin University Journal Of Social Sciences Institute*, 7., (1.), pp. 903–926.

[36] Yeter, E. (1991): Opinions on the metropolitan municipality system in Turkey. *Public Administration Journal*, 24., (3.), pp. 155–188.

[37] Tekin, Ö. F. (2018): Metropolitan administration in Turkey and the changes brought about by law No. 6360: The Konya Example. *Dumlupınar University Journal Of Social Sciences*, (55.), pp. 84–105.

[38] Peker, A. E. (2023): A Spatial Analysis Of The Determinants Of Crop Production Value In The Agricultural Sector In Turkey. *International Academic Journal*, 6., (3.), pp. 354–368.

Meanwhile, between 1984, when three major cities gained metropolitan status under Law No. 3030, and 2004, when Law No. 5216 was enacted, 16 provincial municipalities were converted into metropolitan municipalities through legal regulations. The 16 metropolitan municipalities continued until the first local elections held under Law No. 6360, enacted in 2012. In the 2014 local elections, 14 provinces were added, bringing the number of metropolitan municipalities to 30 [37]. This situation is explained in more detail below.

The year 1986 is extremely important in terms of metropolitan municipal administration in Türkiye, as five more provinces were incorporated into the metropolitan municipal administration system between that year and 1988. In this context, the five metropolitan municipalities established between 1986 and 1988 were, in order, Adana (1986), Bursa (1987), Gaziantep (1988), Konya (1988), and Kayseri (1988) [35]. Thus, by 1988, there had been a significant increase in the number of metropolitan municipalities in Türkiye. This clearly represents an important turning point in the history of Turkish municipal administration.

In the context of the information provided above, Adana was granted metropolitan status in 1986 under Law No. 3306, Bursa in 1987 under Law No. 3391, Gaziantep under Law No. 3398, Konya under Law No. 3399, and Kayseri in 1988 under Law No. 3508. Adana, Bursa, and Konya had three metropolitan districts, while Gaziantep and Kayseri had two. The high rate of population growth and urbanization in Türkiye has resulted in significant increases in city populations. Therefore, the main reason for including the aforementioned five cities within the scope of metropolitan municipalities was the population growth in these areas [38].

According to Peker and Şanlı Güleğül, the high rate of population growth and urbanization in Türkiye has resulted in significant increases in urban populations.

Along with population growth, seven more metropolitan municipalities were established by 1993. These municipalities are Antalya, Diyarbakır, Eskişehir, Erzurum, Mersin, Kocaeli, and Samsun. Among these seven metropolitan municipalities, Mersin shows a strong diffusion effect from the center to the periphery, while Erzurum shows a weak diffusion effect from the center to the periphery [38]. It is very clear that the other seven metropolitan municipalities have not sufficiently expanded into the agricultural sector in recent years.

In 1993, artificial districts were also established to overcome the district problem that arose after the establishment of metropolitan municipalities, in the context of the information provided above regarding cities that became metropolitan municipalities. Subsequently, a Decree Law was issued, abandoning the procedure for estab-

lishing metropolitan municipalities based on district municipalities and by law, for economic reasons. As mentioned above, in 1993, the cities of Mersin, Diyarbakır, Eskişehir, Antalya, Samsun, İzmit, and Erzurum were made metropolitan municipalities, and the rule requiring at least two districts within the boundaries of the central municipality was abandoned. Instead, a structure called the “lower level” was created. Thus, lower-level municipalities were established in these newly established metropolitan municipalities [34]. It is understood that this is also an important regulation in the context of local governments in Turkish administrative history.

Another development in 1993 regarding the evolution of metropolitan municipal administration in Türkiye was the postponement of the establishment of district municipalities until 2008, with the creation of first-tier municipalities in metropolitan areas established by Decree Law No. 504 instead of district municipalities. Within this scope, until the relevant articles of Law No. 5747, which established new districts and converted lower-level municipalities into districts, came into force, the number of lower-level municipalities was three in Antalya, Diyarbakır, Mersin, and İzmit, and two in Eskişehir, Erzurum, and Samsun. In 2000, with Decree Law No. 593, both district and first-tier (town) municipalities existed simultaneously in the Adapazarı Metropolitan Municipality established in the center of Sakarya province [35].

In the context of the above explanation, the Decree Law No. 504 dated 02.09.1993 on the Establishment of Metropolitan Municipalities in Seven Provinces provided a legal basis for a new local administration unit called “lower-level municipality” and facilitated the establishment of metropolitan municipalities. Henceforth, it would no longer be necessary for a municipality to have multiple districts within its boundaries in order to establish a metropolitan municipality; lower-tier municipalities would be sufficient [39].

In brief, Law No. 3030, enacted to enable local governments in metropolitan areas to provide more effective services, has been distorted and misused through various practices. One of the significant reforms in the history of the formation of metropolitan cities in Türkiye has been the establishment of metropolitan districts. As is well known, Law No. 5747 on the Establishment of Districts Within the Boundaries of Metropolitan Municipalities and Amendments to Certain Laws was adopted in 2008. With this law, the legal entities of first-tier municipalities located within metropolitan areas were abolished or converted into districts, following a process of consolidation.

[34] Kaymal, C. (2017): Metropolitan municipality reform in terms of local autonomy and local democracy. *Ulakbilge*, 5., (13.), pp. 1137–1159.

[35] Özgür, H.–Savaş Yavuzçehre, P. (2016): Türkiye’s metropolitan municipality system: 1982–2015. *Çankırı Karatekin University Journal Of Social Sciences Institute*, 7., (1.), pp. 903–926.

[39] Polatoğlu, A. (2015): Reflections on the metropolitan municipality model and its implementation in Türkiye. *Ydu Journal Of Social Sciences*, 8., (1.), pp. 43–62.

[37] Tekin, Ö. F. (2018): Metropolitan administration in Turkey and the changes brought about by law No. 6360: The Konya Example. *Dumlupınar University Journal Of Social Sciences*, (55.), pp. 84–105.

[40] Eryiğit, B. H. (2018): An examination of metropolitan municipality legislation in Turkey based on theories regarding the management of metropolitan areas. *Tesam Academy Journal*, pp. 51–76.

With this law, not only metropolitan areas but also first-tier municipalities throughout the country were converted into district municipalities or incorporated into district municipalities through a merger method. Again, in addition to the district municipalities that were closed due to scale, some town municipalities lost their legal personality and became neighborhoods, while others became villages [40]. In terms of metropolitan areas, the purpose of this regulation was to ensure not only the integrity and harmony of the metropolitan area, but also that of the metropolitan municipality system.

In 2012, a highly significant regulation was implemented in Türkiye regarding metropolitan municipal administration. Within the scope of this regulation, Law No. 6360, enacted in 2012, introduced new criteria for metropolitan municipal boundaries. With the new regulation, the population threshold for metropolitan municipalities was lowered to 750,000. Through this law, the areas of responsibility of metropolitan municipalities were expanded to include the entire provincial administrative boundaries, bringing all affiliated districts under the jurisdiction of metropolitan municipalities [37].

Essentially, prior to Law No. 6360, the Metropolitan Municipality Law in Türkiye expanded municipal boundaries while simultaneously making the conditions for establishing a metropolitan municipality more demanding. Article 3 of the law stipulates that at least three districts or first-tier municipalities must exist in a province for a metropolitan municipality to be established. Under the previous regulation, Law No. 3030, it was sufficient for there to be “more than one district” within the boundaries of the provincial municipality. According to Article 4 of Law No. 5216, provincial municipalities with a total population of more than 750,000, based on the latest census, within municipal boundaries and within a maximum distance of 10,000 meters from these boundaries, were planned to be converted into metropolitan municipalities.

According to Oktay, the legislature has opted for metropolitan municipal structures with higher population levels and density. Based solely on the district requirement, the population-based criterion was a much more concrete standard. Considering the populations of provincial centers in Türkiye at that time, the 750,000 population threshold represented a balanced level that was neither excessively high nor low. With the expansion of metropolitan municipi-

pality boundaries, all district and town municipalities in Istanbul and Kocaeli were included in the scope, while in other metropolitan provinces, district and town municipalities within the expanded boundaries were included. The main goal of the boundary expansion was to bring developed or potentially developing areas around metropolitan cities under the management and supervision of metropolitan municipalities, to prevent problems that had arisen or were likely to arise in these areas, particularly in terms of zoning and licensing, due to the institutional capacity deficiencies of small-scale municipalities, and to achieve comprehensive and planned urban development [41].

In 2011, many provinces in Türkiye were granted metropolitan municipality status. Under the new regulations, 14 municipalities with a population of 750,000 became metropolitan municipalities. In this context, Law No. 6360 applies to the 14 newly established metropolitan municipalities, such as Istanbul and Kocaeli, as well as the 14 existing metropolitan municipalities (Adana, Ankara, Antalya, Bursa, Diyarbakır, Eskişehir, Erzurum, Gaziantep, İzmir, Kayseri, Konya, Mersin, Sakarya, and Samsun). This means that in 28 more provinces, the service authority of local administrations has been extended to the remotest corners of the provinces, and municipal services have been extended to the remotest corners of the provinces [42]. This situation has been an important step forward in terms of the expenditure dimension of fiscal decentralization in Türkiye.

In the 14 provinces that have become metropolitan municipalities, 25 new districts have been established within the scope of metropolitan municipalities and changes in affiliations have been made, increasing the total number of metropolitan district municipalities from 143 to 519. In particular, the regulation provides for the establishment of transfer, liquidation, and distribution commissions for municipalities and villages that have been closed and converted into neighborhoods. Furthermore, provincial special administrations have been abolished in thirty metropolitan municipalities, and Investment Monitoring and Coordination Presidencies (YİKOB) affiliated with the governor's offices have been established in these provinces to replace the abolished provincial special administrations [34].

After the establishment of metropolitan cities, it was envisaged that provincial special administrations within the boundaries of 29 metropolitan municipalities would be abolished, and their powers and responsibilities would

[34] Kaymal, C. (2017): Metropolitan municipality reform in terms of local autonomy and local democracy. *Ulakbilge*, 5., (13.), pp. 1137–1159.

[41] Oktay, T. (2016): Understanding and interpreting the metropolitan municipality reform based on law No. 6360. *Journal of the Faculty of Political Science*, 1., (1.), pp. 71–131.

[42] Temel, R.–Karagöz, B. (2018): Evaluation of law No. 6360 from the perspective of local government economics. *Karadeniz Technical University Social Sciences Institute Social Sciences Journal*, 8., (15.), pp. 117–132.

[43] Atmaca, Y.–Yarar, Y. (2025): Administrative change in van metropolitan municipality after law No. 6360. *Beykoz Academy Journal*, 13., (2.), pp. 334–359.

[44] Doğan, A. (2018): A general review on the history of mersin harbour and mersin city. *Journal Of Current Researches On Social Sciences*, 8., (1.), pp. 117–150.

[45] Saydam, A. (2020): *Change in the villages which turned into a neighborhood with the metropolitan municipality law No 6360: An evaluation on the ceylan district*. (Unpublished Master's Thesis). Harran University Institute Of Social Sciences.

[46] Narin, R. (2014): *From Ada To Pazar, Sakarya*. Sakarya: Sakarya Chamber Of Commerce And Industry Publications.

be transferred to metropolitan municipalities. In addition, 1,592 municipalities and 16,082 villages were converted to neighborhood status. As a result of this transformation, approximately 36% of provincial special administrations, 53% of municipalities, and 47% of villages were abolished [43]. These structural changes were implemented to increase the institutional capacity of local governments and to ensure efficiency and effectiveness in service delivery.

After metropolitan cities were established, new regulations were also made regarding the names of the provincial centers of some metropolitan cities. As is well known, provincial capitals are generally known by the names of the provinces, but there are exceptions to this. In three of the metropolitan cities, the names of the center and the province were different until recently. This situation could also cause confusion in the use of the metropolitan city name. To eliminate this confusion, certain adjustments were made in Mersin, Kocaeli, and Sakarya.

In the context of the information provided above, on June 28, 2002, the name of İçel was changed to Mersin by a regulation in Law No. 4764 [44]. Similarly, the city of İzmit was the provincial capital of Kocaeli. With Law No. 5747 on the establishment of new metropolitan districts, the name of the metropolitan municipality was changed to Kocaeli Metropolitan Municipality [45]. The name İzmit was given to one of the metropolitan municipalities (Saraybahçe). Finally, under Law No. 5747, the name of Adapazarı was changed to Sakarya Metropolitan Municipality [46]. With the establishment of the Sakarya Metropolitan Municipality in the provincial center, the Adapazarı Municipality was also established.

## Conclusion

This study examines the historical development of municipal governance in Turkish administrative history and the transition to the metropolitan municipal system from the Ottoman Empire to the present day, offering a comprehensive perspective. The analysis clearly demonstrates that municipal governance in Turkey is not a static structure but rather a dynamic process that is constantly reshaped alongside political, social, and economic transformations.

During the classical period of the Ottoman Empire, municipal services were carried out through numerous institutions such as the kadı (judicial office), vakıf (endowment), guilds, and neighborhood organizations; however, this fragmented and traditional structure proved inadequate in the face of increasing urbanization, population movements, and commercial relations. With the Tanzimat Era, steps were taken to centralize municipal services in line with the goals of modernization and centralization. The establishment of the Istanbul City Council in 1855 marked a turning point in this process. Thus, the institutional foundations of modern municipal administration in Turkey were laid.

During the Republican Era, the concept of municipal administration was restructured within the framework of a strong centralist state structure. The Municipal Law No. 1580 of 1930 established the duties, powers, and responsibilities of municipalities for many years, bringing stability to the local government system. However, rapid urbanization, migration, and social transformations, particularly since the 1960s, have necessitated that municipalities move beyond being institutions that merely provide infrastructure services and shift toward social and community-oriented municipal practices. In the post-1980 period, under the influence of neoliberal policies, local governments experienced a process of expanding their service areas and attempting to increase their financial and administrative capacities.

One of the main focal points of the study, the metropolitan municipality system, emerged as a natural consequence of urbanization and population growth in Turkey. Metropolitan municipalities, which gained constitutional support with Article 127 of the 1982 Constitution, became institutionalized with the legal regulations issued after 1984; they underwent a fundamental transformation in terms of scope and authority with Laws No. 3030, 5216, and especially 6360. The expansion of metropolitan municipality boundaries to provincial boundaries has provided significant advantages in terms of comprehensive planning and economies of scale in service delivery.

In conclusion, the metropolitan municipal system in Turkey is not merely an administrative restructuring; it also reflects the transformation of the state's approach to urbanization, public service delivery, and local governance. This system offers significant opportunities in terms of service efficiency and resource utilization. In this respect, metropolitan municipal governance should be regarded as one of the most comprehensive and effective local governance reforms in Turkish administrative history.



## *Hallgatói vélemények az MI felhasználásával és oktatásával kapcsolatban*

**Összefoglalás:** Nem lehet tudni még pontosan, hogy milyen technológiai fejlesztéseket tartogat az emberiség számára a 21. század, de az biztos, hogy a mesterséges intelligencia területén nagy előrelépés történt. Ez nem más, mint a nagy nyelvi modellek megalkotása (LLM – Large Language Model) és ennek köszönhetően a generatív MI alkalmazások tömeges megjelenése. Jelen tanulmány azt a célt tűzte ki, hogy a Dunaújvárosi Egyetem hallgatóinak körében végzett kérdőíves kutatás eredményeként ismerteti a hallgatók MI felhasználási területeit. A vizsgálat kiterjed arra is, hogy mi a véleményük a kitöltésben résztvevőknek a mesterségesintelligencia-alkalmazások tananyagban való meg megjelenésével kapcsolatban. A dolgozat végén az eredmények összefoglaló értékelése jelenik meg.

**Kulcsszavak:** Oktatás, mesterséges intelligencia, felhasználás.

**Abstract:** It is still unclear what technological developments the 21<sup>st</sup> century will bring to humanity, but it is certain that great progress has been made in the field of artificial intelligence. This is none other than the creation of large language models (LLM) and, as a result, the mass emergence of generative AI applications. The aim of this study is to present the areas of AI use among students at the University of Dunaújváros based on the results of a questionnaire survey. The study also covers the opinions of the respondents regarding the inclusion of artificial intelligence applications in the curriculum. A summary evaluation of the results is presented at the end of the paper.

**Keywords:** Education, artificial intelligence, use.

\* *Dunaújvárosi Egyetem, Informatikai Intézet*  
*Eszterházy Károly Katolikus Egyetem, Neveléstudományi Doktori Iskola*

Email: farkasi@uniduna.hu

ORCID: 0009-0009-6666-8007

[1] Szuromi B.  
(2023, április 21.):  
Az EU-ban növekvő  
szerep jut az oktatás  
digitalizációjának.  
*Ludovika*. [https://  
www.ludovika.hu/  
blog/ot-perc-euro-  
pa-blog/2023/04/21/  
az-eu-ban-novekvo-  
szerep-jut-az-oktatas-  
digitalizaciojanak/](https://www.ludovika.hu/blog/ot-perc-europa-blog/2023/04/21/az-eu-ban-novekvo-szerep-jut-az-oktatas-digitalizaciojanak/)

## Bevezetés

2022. november 30-a óta nagyot változott a tudás, ismeret beszerzésének a módja, eszköze. Mindenki számára elérhető közelségbe kerültek olyan technikák, melyek azonnal, szaknyelvezetében tökéletes kifejezéssel rendelkezve, az élet bármely területén adnak valamilyen megbízhatóság mellett választ. A válasz megbízhatósága az elmúlt három évben állandóan növekedett. Az alkalmazások folyamatos fejlesztése, és a tényleg gyors, általában jól használható, eredmény nagy mértékben elősegítette, hogy ezen eszközök az oktatásban való használata is előtérbe kerüljön. Eleinte a hallgatók és oktatók feladatok elvégzésének megkönnyítésére használták csak, de napjainkra ennek oktatása is elvárttá nőtte ki magát. Az Európai Unió egyik fő stratégiai célja, hogy az unió polgárai fel legyenek készítve az MI korszakra. Az Európai Bizottság etikai irányelveket tett közzé a feltörekvő mesterséges intelligencia és az adatok tanításban való felhasználásáról. [1] Ezek az irányelvek annyira itt vannak a napjainkban, hogy a felsőfokú oktatási intézmények (egyenlőre csak ők) mindent megtesznek azért, hogy a mesterséges intelligencia etikus, célravezető használatát szabályozzák, tanítsák. Cikkünk azt mutatja be, egy 2025 tavaszán végzett kérdőíves felmérés alapján, hogy a Dunaújvárosi Egyetem hallgatói mit gondolnak a mesterséges intelligencia használatának tanításáról és felhasználási területeiről.

## Az MI használata az oktatás területén

Az oktatás tartalmában (pár éves késéssel) mindig is jelen voltak a kor meghatározó technológiai eszközei, fejlesztési irányai. A mesterséges intelligencia megjelenése az oktatásban nem néhány évre nyúlik vissza, mert az informatika, robotika, autonóm rendszerek tanítása során megkerülhetetlen volt az emberi intelligencia utánzásának lehetősége. Eleinte az oktatás tartalmaként gondoltunk a mesterséges intelligenciára és úgy is jelent meg, esetleg különböző tudáslapú, szakértői rendszerek támogatták az oktatást. A 21. században nyílt lehetőség arra, hogy az oktatási folyamat támogatója, irányítója, kiegészítője is lehet a mesterséges intelligencia. Számos hazai és nemzetközi tanulmány számol be arról, hogy milyen módon alkalmazzák a mesterséges intelligenciát az oktatás területén, miért fontos annak tanítása.

Vannak, akik úgy gondolják, hogy a tanároknak nagy szerepe van abban, hogy a jövő nemzedéke hogyan tud majd alkalmazkodni az életben megjelenő kihívásokhoz [2; 3]. „Az oktatás alapvető feladata, hogy az életre készítse fel a diákokat, használható tudást adjon át számukra. Az ismeretek, amelyek az MI-ben rejlő lehetőségekről, illetve veszélyekről szólnak lassan bekerülnek a tananyagba, ennek első feltétele, hogy a tanárok is megfelelően képzettek legyenek ezen a területen” [4].

Tehát szükség van olyan oktatókra, akik maguk is jól tudják alkalmazni az új technikát azért, hogy a megszerzett tapasztalatok lapján felvértezzék a növendékeket a közel hibamentes használatra.

Az MI oktatása jelenleg a felsőoktatásban merül fel leginkább, mint lehetséges tananyag, hiszen itt kerül előtérbe legjobban a szabad alkotás lehetősége. Ezek megvalósulhatnak kutatások elvégzésében, tanulmányok megírásában, vagy csak egyszerű tantárgyi esszék létrehozásában is. „Az MI-integrálást támogató elvi keretek konkrét tartalommal való megtöltése a tanulási-tanítási folyamat legfőbb ágenseire, az oktatókra és hallgatókra hárul. A témával foglalkozó hazai pedagógusok a mesterséges intelligencia átgondolt, célorientált integrálását javasolják a tanítási-tanulási folyamatba, szem előtt tartva a lehetséges nehézségeket és az előnyöket egyaránt” [5]. Nyilván a felsőoktatás elég nehéz batyut vesz a vállára, ha az MI naprakész oktatását komolyan gondolja. Elég csak abba belegondolni, hogy milyen változások mentek végbe az elmúlt három évben ezen a területen. Az MI-t integráló alkalmazások számának rohamos növekedése nehezíti egy-két megvalósulás előnyben részesítését.

Egyes kutatók joggal teszik fel a kérdést, hogy vajon a mesterséges intelligencia mennyire forgatja fel a tanítás-tanulás folyamatát? Milyen hatással lehet az oktatásra és annak szereplőire? „A legújabb MI-technológiák terjedése forradalmasíthatja a különböző oktatási rendszereket, ezáltal új kihívásokat teremtve a felsőoktatás szereplőinek” [6]. Nem olyan egyszerű ennek előrejelzése, hiszen míg eleinte csak egyszerű felhasználás volt jelen, addigra mára már igen mély összefüggések kimutatása is megtörtént az egyes kutatók részéről. Ez köszönhető annak, hogy nem csak a publikációk, tanulmányok, kutatások száma nőtt meg a területen, hanem a kutatók nagyszámú növekedése is megfigyelhető. Igyekszik mindenki olyan szemszögből vizsgálni az MI-hatását, amit addig még nem tett meg előtte senki, ezzel újabb ötleteket adva másoknak. A tömegesen megjelenő tanulmányok elősegítik azt is, hogy az összefüggések olyan mélységekbe menjenek, amelyekre azelőtt nem volt lehetőség, szükség.

[2] Varga A. (2023): *Az intelligens települések kihívásai és a fenntarthatóság biztosításának közös metszetei*. Dunakavics, 11., (7.), pp. 21–32.

[3] Varga A. (2024): *Cselekvő egyetemek – innovatív kezdeményezések – minőség-biztosítás*. In: Falus O.–Németh I. P. (Szerk.): *Innovációs terek*, pp. 169–183. DUE Press.

[4] Zábrátszky É. (2025): *Az MI oktatásának szükségessége. Különleges Bánásmód-Interdiszciplináris folyóirat*, 11., (2.), pp. 65–76.

[5] Nagy J. T.–Rajki Z.–Dringó-Horváth I. (2025): *Mesterséges intelligencia a felsőoktatásban – oktatói hozzáférés, attitűd és felhasználási gyakorlat*. *Iskolakultúra*, 35., (7.), pp. 3–20.

[6] Dornics, S. (2025): *Merre tovább, oktatás? Előnyök és félelmek a mesterséges intelligencia tükrében. Különleges Bánásmód-Interdiszciplináris folyóirat*, 11., (2.), pp. 77–87.

[7] Berényi C.–  
Csiszárik-Kocsir Á.  
(2025): Mestersé-  
ges intelligencia a  
mindennapokban:  
alkalmazási területek  
és generációs sajá-  
tosságok egy primer  
kutatás eredményei  
alapján. *Biztonságtu-  
dományi Szemle*, 7.,  
(3.), pp. 179–191.

Egyes tanulmányok olyan vizsgálatokat mutatnak be, melyek a mesterséges intel-  
ligencia felhasználási területeire fókuszálnak a korosztályok függvényében.

„A generációs különbségek egyértelműen megfigyelhetők: míg a Z-generáció az  
összes vizsgált területen intenzívebben alkalmazza az MI-t, addig az X- és Y-generá-  
ciók elsősorban szakmai és kutatási célokra használják ezeket a technológiákat” [7].  
Ez a felsőoktatással kapcsolatban azért fontos, hiszen a felhasználási területek között  
számos olyan jelenik meg, melyek ott jellemzők és ezek alapján érdemes az oktatott  
tantárgy (MI-alkalmazások használatát tanító) tartalmát a legtöbbet használt terület  
irányába elmozdítani. Valamint az intézményekre való könnyebb bejutás miatt a  
hallgatói életkor nagyon széles skálán mozog.

A megjelent tanulmányokból való szemezgetést lehetne folytatni nagyon sokáig,  
de talán ezekből is érezhető, hogy milyen erőteljesen jelenlévő téma a mesterséges  
intelligencia alkalmazása az oktatása. A megközelítések, a vizsgálat területei külön-  
böznek, de három alapvető kijelentésben megegyeznek. Az egyik, hogy az MI hasz-  
nálatának oktatása, szabályozása nem megkerülhető és folyton változó tartalmú fel-  
adat lesz. A másik, hogy az alkalmazás kézzelfogható előnyei mellett annak veszélyeit  
is ismernie kell a felhasználónak. A harmadik pedig az, hogy az előző kettő részletes  
és alapos ismertetése alapvetően az oktató feladata.

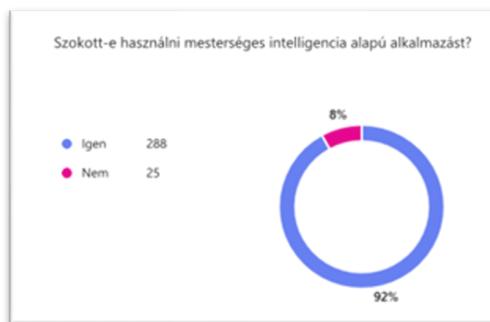
## A vizsgálat módszere

A vizsgálat a Dunaújvárosi Egyetem hallgatói körében került elvégzésre. A kérdőívet  
a Microsoft Forms felületén készítettük, hozzáférését a Neptun rendszeren keresztül  
küldtük ki a hallgatók számára. A célzott minta az egyetem teljes hallgatósága, nap-  
pali és levelezős tagozaton egyaránt. A kitöltésben 313 hallgató vett részt. A kérdőív  
kitöltése saját bevalláson alapuló, önkéntes, anonim volt. A kérdőív egy egyszerű,  
nem validált űrlap, mely 5 demográfiai és 15 érdemi kérdésből állt. A 20 kérdésből  
jelen vizsgálat csak azok elemzésével foglalkozik, melyek a mesterséges intelligencia  
használatával, felhasználási területeivel és az MI oktatásával kapcsolatosak. Az  
eredmények feldolgozásához és a grafikonok elkészítéséhez a Microsoft Excel, Forms  
alkalmazásokat használtuk.

## A mesterséges intelligencia területei egyetemi hallgatók körében

Az ismertett szakirodalmak alapján jól látható, hogy a felsőfokú intézmények a húzóerők az MI alkalmazásában, ha az oktatásról van szó. Nagyon kis hányada van csak a hallgatóknak, akik ne használtak volna ilyen alkalmazásokat. A jelen felmérésben ez az alábbiak szerint alakult.

### 1. ábra MI-alkalmazások használatának gyakorisága



Forrás: Saját szerkesztésű ábra.

A vizsgált populációra is igaz a kijelentésünk, hiszen a válaszadók 92% használ rendszeresen ilyen alkalmazásokat. A kérdés, hogy szokott-e használni ilyeneket, ezért a válasz a rendszeres és nem az egyszeri használatra utal. Az alkalmazás területeit már nehezebb megadni, hiszen napjainkban talán nincs is olyan területe az életnek, ahol az MI használata ne jelent volna már meg. Hallgatói szempontból természetesen a tanulmányok lefolytatásához kapcsolódó területek kerültek felsorolásra a kérdésnél.

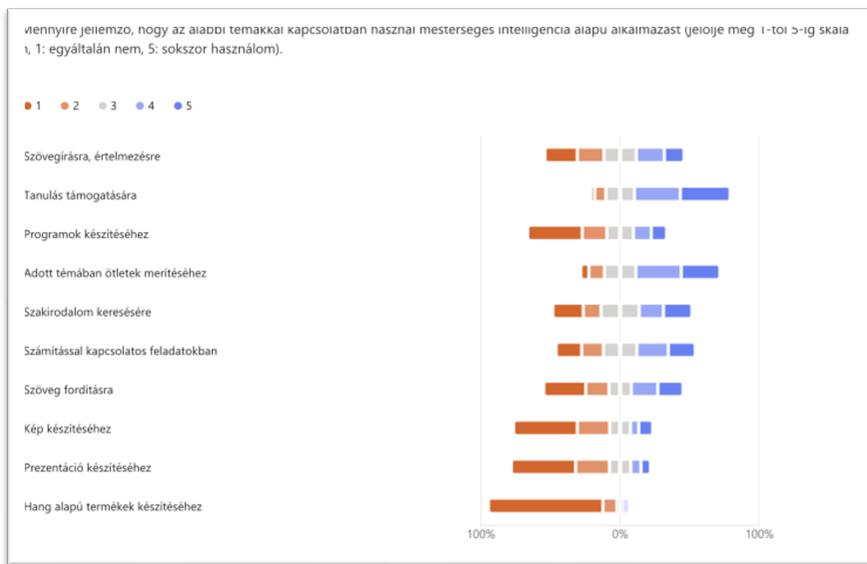
Ezek a területek a következők:

- szövegírás, értelmezés;
- tanulás támogatás;
- programok készítése;
- adott témában ötletek merítése;
- szakirodalom keresése;
- számítással kapcsolatos feladatok;
- szövegfordítás;

- képzésítés;
- prezentáció készítése;
- hangalapú termékek készítése.

A kérdés ötfokozatú Likert-skála formájában fogalmaztuk meg. A válaszok eredményét a 2-es ábra mutatja.

2. ábra. MI használatának erőssége az adott területen



Forrás: Saját szerkesztésű ábra.

Az ábrából jól kiolvasható, hogy a megadott területek az MI használatának szempontjából három csoportra oszthatók. A leggyakrabban használt területnek mutatkoznak a tanulás támogatása és az adott témában ötletek merítése. A legkevésbé használt területek egy termék elkészítéséhez köthetők. Ilyen a hanganyag, prezentáció-, kép- és a program készítése. A harmadik csoportot a szövegkészítés, értelmezés, a szövegfordítás, számítással kapcsolatos feladatok és a szakirodalom-keresés került.

A területek közül a legtöbbet a tanulás támogatása kapta. Talán a témák kijelölésénél ezt jobban meg kellett volna vizsgálni, mert a másik kilenc egyaránt alkalmas a tanulás támogatására, és így lehettek olyanok a kitöltők között, akik ezt összefoglaló területnek gondolták. A kérdező eredeti szándéka ezzel a téma-megjelöléssel arra vonatkozott, hogy magyarázatadóként a használják-e a mesterséges intelligenciát a hallgatók a számukra nehezen értelmezhető, problémát jelentő területeken.

A szakirodalom ismertetésénél az egyik tanulmány azt vizsgálta egy nagymintás kutatásban (N=6524), hogy a felhasználási területek mennyire jellemzőek egy adott generációra. Ezt a jelen tanulmány esetében azért érdemes vizsgálni, mert azon korú csoportoknak, akik a felsőoktatásban részt vehetnek, az érdeklődési körét jól mutatja, és az oktatási tananyag irányát meg is határozhatja.

**1. táblázat. Az AI alkalmazási területei és az alkalmazási gyakoriságának átlaga generációs bontásban**

	Nyelvtanulás	Kutatás és adatgyűjtés	Egészség és fitness tanácsok	Utazás szervezés	Adott anyag összefoglalása	Házi feladat megírása	Irodalmi források keresése	Fordítási feladatok	Szerepjáték	Dolgozat, esszé írás
BB generáció (1940 - 1964)	2,064	2,338	2,268	2,329	2,317	2,223	2,284	2,448	2,049	2,171
X generáció (1965-1979)	2,108	2,339	2,011	2,150	2,266	1,945	2,138	2,403	1,766	1,954
Y generáció (1980-1994)	2,422	2,635	2,226	2,311	2,516	2,225	2,279	2,573	1,988	2,261
Z generáció (1995 - 2007)	2,413	3,013	2,261	2,256	2,997	2,779	2,554	2,598	1,997	2,698
Alfa generáció (2008-)	2,728	3,054	2,594	2,585	2,951	2,871	2,683	2,701	2,478	2,897
Total	2,342	2,763	2,212	2,259	2,711	2,467	2,402	2,548	1,965	2,434

Forrás: Berényi és Csiszárík-Kocsir 2025-ös tanulmánya.

A táblázatból jól kiolvasható, hogy a legnagyobb értékeket a Z- és Alfa-generáció adta a *Kutatás és adatgyűjtés* témára, valamint második helyen az *Adott anyag összefoglalása* téma szerepel. Ez szinte egybeesik azokkal a témákkal, melyeket a Dunaújvárosi Egyetem hallgatói is megjelöltek.

## Az MI használatának oktatásával kapcsolatos hallgatói vélemény

Mindkét vizsgálat esetén a tanuláshoz erősen köthető tématerületek kapták a legnagyobb értéket a Likert-skálán. Ha ezt elfogadjuk valós kimentnek, akkor a mesterséges intelligenciát felhasználó alkalmazások tananyagba helyezése nem csak elvárt, hanem szinte kötelező is, mert ezzel is elő lehet segíteni a hallgatói sikerességet.

Az egyetemen végzett felmérésben erre vonatkozóan három kérdés is szerepelt (hatfokozatú Likert-skálát tartalmaztak), melyek eredményei a következőkben kerülnek bemutatásra. Az ezzel kapcsolatos első kérdés arra vonatkozott, hogy az MI-nek nagyobb szerepet kell-e játszania az oktatásban? Az eredményt a 4. ábra mutatja.

**3. ábra. Mi nagyobb szerepet kell-e játszania az oktatásban**



Forrás: Saját szerkesztésű ábra.

A kapott szám inkább abba az irányba mutat, hogy a hallgatói vélemény szerint, nagyobb szerepet kellene játszani a mesterséges intelligenciának az oktatásban. Igaz a 3,99-os eredmény nem olyan nagy, de a gyakorisági görbe ferdesége is ezt mutatja, hogy szükségesnek érzik ennek oktatását.

A második kérdés arra vonatkozott, hogy az MI alkalmazások használatát kellene-e oktatni.

**4. ábra. Az MI-alkalmazások oktatásának szükségessége a hallgatók szerint**



Forrás: Saját szerkesztésű ábra.

Az eredmény talán nem is szorul magyarázatra, annyira egyértelmű. A 6-os Likert-skálán a 4,94-es érték eléggé biztos irányt mutat. Meg lehet állapítani azt, hogy a hallgatók véleménye szerint, szükséges lenne az MI-alkalmazások oktatásának beemelése a tantárgyak közé. Ez jelenthet némi tudatosságot is hiszen, ha a használat nem kérdéses, akkor a minél jobb eredményű, céltudatos alkalmazás a kívánatos, mely elérése a hallgatók szerint az oktatásban rejlik.

A harmadik kérdés arra vonatkozott, hogy az oktatást esetleg az általános iskolában már el kellene kezdeni vagy sem.

**6. ábra. MI oktatásának megkezdése az általános iskolában**



Forrás: Saját szerkesztésű ábra.

Az eredmény egyáltalán nem mondható egyértelműnek. Igaz, hogy a legtöbbet választott érték a 6-os, de ennek ellenére az átlag csak 3,84 lett, ami nem olyan jó.

Ha átgondoljuk azt a tényt, hogy a 18 év felettiak már több tapasztalattal rendelkeznek ahhoz, hogy kritikusán tudják kezelni az MI-alkalmazások által kapott eredményeket, és az adaptációs képességük is jobb, akkor egyáltalán nem meglepő az eredmény. Egy általános iskolai tanuló még gond nélkül elfogadna minden választ az MI-től és kész tényként venné azt, még akkor is, ha az nagymértékű hallucinációt tartalmazna.

## Összegzés

Egyértelműen megállapítható a felmérésből, hogy a hallgatók nagy számban használják a mesterséges intelligenciát a tanulási folyamatban. Az a tény is levonható, hogy az alkalmazásokat jobbra az oktatással kapcsolatban használják. Ezek egyenes következménye az, hogy részükről felmerül annak az igénye, hogy ezen alkalmazások használata jelenjen meg a képzések tantárgyi hálójában, vagy ha önálló tantárgyként nem is, de integrálva egy másik tantárgyban mindenféleképpen. Ez lesz a közeljövő egyik feladata, hogy ennek a gyorsan változó tudományterületnek teret találjanak a kutatók, oktatók a felsőoktatásban, ahol a tananyag tartalma mellett, az eredmények kritikával való fogadása, adaptált felhasználása is nagy hangsúlyt kell, hogy kapjanak. Ehhez még számos kutatásra, mintaprojektekre lesz szükség, hogy egy jól alkalmazható recept álljon elő.

## *Fenntarthatóság – értékmódszertan*

**Összefoglalás:** A „Fenntarthatóság” megvalósítása és folyamatos fejlesztése új keretrendszer kialakítását igényli. Új feladatnak javasolható a jelenlegi ipari technológiák fejlesztése, kiemelten a „Fenntarthatóság” követelményei szerint. Az elmúlt évtizedekben forradalom játszódott le a menedzsment területén, és kialakultak olyan új menedzsment módszerek, amelyek alapvetően a szellemi tudást alkalmazva, hasznos eszközzé váltak az innováció területén. Ezen módszerek közül bemutatjuk az értékelemzés (Value Analysis) alkalmazását egy ipari technológia fejlesztésében.

**Kulcsszavak:** Fenntarthatóság, új keretrendszer, új menedzsment módszerek, innováció, értékelemzés.

**Abstract:** The implementation and continuous development of "Sustainability" requires the creation of a new framework. The development of current industrial technologies can be proposed as a new task, especially according to the requirements of "Sustainability". In recent decades, a revolution has taken place in the field of management, and new management methods have emerged, which basically use intellectual knowledge and have become a useful tool in the field of innovation. Among these methods, Value Analysis is presented in the development of an industrial technology.

**Keywords:** Sustainability, new framework, new management method, innovation, Value Analysis.

\* *Dunaiújvárosi Egyetem, Társadalomtudományi Intézet*  
Email: keszia@uniduna.hu  
ORCID: 0009-0004-2888-0967

\*\* *Dunaiújvárosi Egyetem, Társadalomtudományi Intézet*  
Email: nadasdi.ferenc@gmail.com  
ORCID: 0009-0007-6557-8910

[1] Pataki Béla (2005): *A technológia menedzselése*. Budapest: Typotex.

[2] Nádasdi F.–Keszi-Szeremlei A. (2022): *Értékelemzés – innováció – gazdasági növekedés. Globalizáció a 21. században*. Keszi-Szeremlei Andrea–Rajcsányi-Molnár Mónika (Szerk.). Dunaújváros: Dunaújvárosi Egyetem, pp. 9–22.

## Bevezetés

Kutatásaink szerint az értékmódszertan alkalmas a „Fenntarthatóság” követelményeit beépíteni az értékelemzés rendszerébe.

A gépiparban elsősorban a következő területek kiemelése célszerű:

- A gépiparban előállított termékek feleljenek meg a „Fenntarthatóság” indikátorainak.
- A „Fenntarthatóság” követelményeinek betartása a technológiáknál már nehezebb feladat. Az ipari technológiák életciklusa általában 15–20 év, tervezésük, létrehozásuk, fejlesztésük hatalmas beruházást igényel [1].

Tapasztalataink szerint a gépiparban a gyártmánytervezés/gyártmányfejlesztés és a technológiatervezés/technológiafejlesztés egymásra épül. A gyártmány igényhalmaza mintegy 80%-ban a vevőigényből származik, a fennmaradó mintegy 20% a hazai és a nemzetközi szabályokból, törvényekből, a stakeholderek (befolyásos személyek, csoportok stb.) igényeiből vezethetők le. A gyártmányfejlesztés általában együtt jár a technológia fejlesztésével is. Ha a változtatások a technológia „határain belül” valósíthatók meg, akkor a gyártmányfejlesztés megvalósítható.

A technológiák igényrendszere mintegy 80%-ban a gyártmányból vezethető le. A további mintegy 20% a gyártmánynál megadott feltételek szerint valósulhat meg.

A következőkben egy technológia elemzése kerül bemutatásra. Magyarországon a politikai–gazdasági vezetés a „Fenntarthatóság” megvalósítását támogatja a rendelkezésre álló erőforrásokkal. Az elemzésben kísérletet tettünk „Fenntarthatóság” egyes indikátorainak megjelenítésére. (A fenntartható fejlődés indikátorai Magyarországon. /12 Felelős fogyasztás és termelés) SDG: Sustainable Development Goals. [www.ksh.hu/s/kiadvanyok/fenntarthato-fejlodes-indikatorai-2022/ffi](http://www.ksh.hu/s/kiadvanyok/fenntarthato-fejlodes-indikatorai-2022/ffi) (Letöltés dátuma: 2023. 07. 21.) [2]

## Présgép tengely csapágyhelyek felújításának fejlesztése az értékelemzés módszerének alkalmazásával

### A PROJEKT CÉLJA

A tengely kopását termikus fémszórással állítja helyre a cég. A technológia értékelemzéssel történő fejlesztésével a következő célok elérését tűzte ki a vezetés:

- Felületi hibák megszüntetése.
- A helyreállítási technológia munkaerő, anyag- és energiafelhasználásának csökkentése.
- A karbantartás fejlesztése a helyreállítási technológia alkalmazásának ütemezésére.
- A piaci versenyhez történő hatékonyabb alkalmazkodás biztosítása.

A vezetés a következő kérdésekre kért választ:

K1: A tengely kopása esetén mi a célszerűbb, új tengely legyártása, vagy a tengely javítása? (Új tengely vásárlása nem volt lehetséges.)

K2: Hogyan lehet elkerülni a tengely kopása miatti váratlan leállásokat?

K3: A tengely felújítását milyen más módszerrel lehet megoldani? [3; 4; 5; 6; 7]

### A PROJEKT TÁRGYA

Az értékelemzés tárgya a termikus fémszórás fejlesztése.

A termikus szórások az egyes alkatrészek javításában fontos technológiának tekinthetők. Az új fedőréteg és az alkatrész felülete között kohéziós vagy adhéziós kapcsolat alakul ki a fémes, vagy nemfémes jellegtől függően. Az új fedőréteg lehet fém, fémötvözet, karbid vagy műanyag. Az ilyen jellegű új típusú fedőréteg alkalmazása lehetővé teszi az adott alkatrész élettartamának jelentős meghosszabbítását.

[3] Bytheway, Charles W. (2007): *FAST Creativity & Innovation*. New York: J. Ross Publishing.

[4] Clancy, D. F. – Dennnis L. M. (2004): *The Innovation and Application of the Value – Based Design Charette – Start Your Project Right to Ensure a Successful Completion*. SAVE International Conference, pp. 1–8.

[5] Kaufman, J. J.– Woodhead, R. (2006): *Stimulating Innovation in Products and Services with Function Analysis and Mapping*. New York: Wiley Interscience.

[6] Nádasi F. (Szerk.) (2012): *Az értékelemzés alapjai*. Dunaujváros: Dunaujvárosi Főiskola Kiadó Hivatala.

[7] Nádasi F.–Zarándné Vámosi K. (2016): *Innovációs projektek kockázatának csökkentése a Value Methodology alkalmazásával*, pp. 25–34. IV. IRI Társadalomtudományi Konferencia, 2016. április 24–25. Štúrovo, Szlovákia. INTERNATIONAL RESEARCH INSTITUTE s.r.o., Komárno, Szlovákia. Konferencia Kiadvány: Társadalom, kulturális háttér, gazdaság. Szerk.: Karlovitz János Tibor. Komárno: International Research Institute, s.r.o., pp. 1–488.

[8] Ambrusné Alady M.–Árva J.–Nagy P. S.–Pap A. (2011): *Gyártási eljárások*. Budapest: Műszaki Könyvkiadó, pp. 110–118., 214–218.

[9] Keszi–Szeremlei A.–Nádasdi F. (2023): *Présgép excenter tengelyének csapágyhelyei felújításának fejlesztése az érték-elemzés módszerének alkalmazásával*. Esettanulmány. Dunaiújvárosi Egyetem, 2023.

[10] Nádasdi F. – Zarándné Vámosi K. (2018): *Innováció fejlesztése a Value Methodology (érték-elemzés) módszerrel alkalmazásával*. Budapesti Kereskedelmi és Iparkamara, TANÁCSADÓK A KKV-K SZOLGÁLTÁBAN Konferencia, 2018. október 30.

A technológia 3 fő szakaszra tagolható:

- előkészítés (szórandó felület előkészítése),
- anyagfelvitel (alapozó réteg szórása, fedőréteg szórása), készre gyártás [8; 9; 10].

A felvitt réteggel szemben a következő igények merültek fel:

*IFR1* Az alapanyaggal azonos vagy nagyobb keménység.

*IFR2* Megfelelő kopásállóság.

*IFR3* Kis súrlódási tényező.

*IFR4* Kis repedési hajlam.

*IFR5* Hőállóság biztosítása üzemi hőmérsékleten.

*IFR6* Jó hővezető képesség és a hőtágulás jó illeszkedése az alapanyag azonos tulajdonságaihoz.

*IFR7* Korrózióállóság a korróziót létrehozó közeggel szemben.

#### A TERMÉKKEL KAPCSOLATOS FUNKCIÓELEMZÉS (EXCENTER TENGYEL)

*F0* Nyomatékot átad.

*F1* Forgó mozgást végez.

*F2* Tartóssági követelményeket kielégít.

*F21* Mechanikai hatásoknak ellenáll.

*F22* Korróziós hatásoknak ellenáll.

*F3* Szerelhetőséget biztosít.

*F4* Méreteket betart.

#### A TECHNOLÓGIÁVAL SZEMBENI IGÉNYEK A KÖVETKEZŐK

*I1* Betartani a felújítandó munkadarab előírt méreteit.

*I2* Szennyeződést távolítsa el a felszórandó felületről.

*I3* A szórt réteg tapadását tegye lehetővé.

*I4* A zsugorodási feszültségeket csökkentse.

*I5* A felületre esetleg lecsapódott párát távolítsa el.

*I6* Az alapozó- és a fedőréteg feljuttatása közti időt minimalizálja.

*I7* Biztosítsa a bevonat egyenletességét.

I8 Szabályozható legyen az eljárás.

I9 A minőség ellenőrizhető legyen.

I10 Méretpontos megmunkálást tegyen lehetővé.

I11 A fenntartható fejlődés indikátorait érvényesíti.

(12. Fenntartható fejlődési cél: Felelős fogyasztás és termelés)

I12 Környezetvédelmi előírásokat betart.

(A fenntartható fejlődés indikátorai Magyarországon. /12 Felelős fogyasztás és termelés (SDG: Sustainable Development Goals.

[www.ksh.hu/s/kiadvanyok/fenntarthato-fejlodes-indikatorai-2022/ffi.](http://www.ksh.hu/s/kiadvanyok/fenntarthato-fejlodes-indikatorai-2022/ffi.), Letöltés dátuma: 2023. 07. 21.)

## A TECHNOLÓGIA FUNKCIÓI

*A technológia funkciói:*

F0 Csapágyhelyet felújít.

F1 Alkatrészt előkészít.

F11 Szennyeződést eltávolít.

F12 Felületet lemunkál.

F2 Felületet érdesít – korundot felszór.

F3 Alapozó réteget felvisz.

F31 Alapozó anyagot biztosít.

F32 Alapozó réteget felvisz.

F4 Fedőréteget felvisz.

F41 Fedőréteget biztosít.

F42 Fedőréteget felvisz.

F43 Fedőréteget készre munkál

F5 Visszaszerelést lehetővé tesz.

F51 Méretet ellenőriz.

F52 Felületet vizsgál

F6 Szállításra alkalmassá tesz.

F61 Sérüléstől véd.

F62 Környezeti hatásoktól megóv.

F7 Irányítást végez.

F71 Anyagot mozgat.

[9] Keszi-Szeremlei A.–Nádasdi F. (2023): Présgép excenter tengelyének csapáshelyei felújításának fejlesztése az értékelemzés módszerének alkalmazásával. Esettanulmány. Dunaújvárosi Egyetem, 2023.

[10] Nádasdi F.–Zarándné Vámosi K. (2018): *Innováció fejlesztése a Value Methodology (értékelemzés) módszercsalád alkalmazásával*. Budapest: Budapesti Kereskedelmi és Iparkamara, *Tanácsadók a KKV-k szolgálatában* Konferencia, 2018. október 30.

[11] Sato, Y.–Kaufman, J. J. (2005): *Value Analysis Tear – Down: A New Process for Product Development and Innovation*. New York: Industrial Press Inc. and Society of Manufacturing Engineers.

[12] SAVE (2020): *VM Guide. A Guide to the Value Methodology Body of Knowledge. A production of SAVE International*.

[13] Stewart, R. B. (2005): *Fundamentals of Value Methodology*.

[14] Vámosi K. (Szerk.) (2002): *Értékelemzési projektek*. Budapest: Medic-Tour 2002. Kft.

[15] Nádasdi F.–Tőkés N.–Bányai M.–Mészáros Á. (2019): *Évközi feladat a „Termékmenedzsment és értékelemzés” c. tantárgyból*. Dunaújváros: Dunaújvárosi Egyetem, pp. 1–22.

*F72 Környezetet véd.*

*F8 Karbantartást biztosít.*

*F9 Környezetvédelmi előírásokat betart.*

*F10 Munkavédelmi előírásokat betart.*

*F11 Hulladékot kezel.*

*F12 Hulladékot eltávolít.*

Az elektromos fémszórás fázisait az *1. sz. melléklet* tartalmazza.

[10; 11; 12; 13; 14] (Az ATIX Plus Kft. hivatalos weboldala. <http://mobilhomok-fuvas.com/korundos-tisztitas/>. Letöltés dátuma: 2023. 07. 22.),

(A KASAMAS Hungária Hegesztéstechnológiai Kft. hivatalos weboldala. <http://www.KASAMAS.hu/termek.php?mid=2&id=23>, Letöltés dátuma: 2023. 07. 22.),

WELDTECH Hegesztéstechnológiai Kft. hivatalos weboldala. <http://weldtech.hu/elektromos-femszoras/>, Letöltés dátuma: 2023. 07. 22.

## Gyenge pontok meghatározása

### KÖLTSÉGKRITIKUS PONTOK

Költségkritikus pontnak tekinthető a tengely javítása és a legyártása közötti választás. Az új tengely gyártásának és a tengely helyreállításának mutatóit az *1. táblázat* tartalmazza.

#### *1. táblázat. Új tengely gyártásának és a tengely helyreállításának mutatói*

Mutatók	Új tengely gyártása	Tengely helyreállítása
Időszükséglet óra/db	43,6	6,7
Költség %	465%	100 %

Forrás: [9; 15]

### FUNKCIÓKRITIKUS PONT

A tengely felújítására többféle technológia áll rendelkezésre. Javasolható az egyes technológiák mérlegelése, esetleg a jelenlegi technológia lecserélése.

A működés váratlan leállása nehéz helyzetbe hozhatja a vállalatot, például határidős munka esetén.

### Javaslatok a technológiai folyamat fejlesztésére

- A tengely meghibásodása esetén a javítást célszerű alkalmazni.
- A váratlan leállások elkerülése érdekében a karbantartás fejlesztése javasolható. Statisztikai felmérés alapján meghatározható az a működési időtartam (működés órában), amikor a berendezés még működik, de célszerű a javítást elvégezni.
- A tengely javítására többféle eljárás alkalmazható, ezért célszerű több eljárást kipróbálni.
- A javítások során – és a berendezés használata során – veszélyes hulladék keletkezhet. Gondoskodni kell a hulladék összegyűjtéséről és a gyűjtőhelyre történő elszállításról.

### Eredmények

Az értékelemzés alkalmazása elősegítette, hogy elemezzünk egy technológiát. Egy tengely javítása nem tűnik túlságosan bonyolult feladatnak. A gyakorlat azonban azt bizonyítja, hogy egy berendezés nem tervezett, váratlan leállása jelentős problémát jelenthet egy megrendelés teljesítésében. A funkcióelemzés lehetővé tette, hogy a fenntartható fejlődés indikátorai megjelenjenek az adott technológiában. A költségelemzés rámutatott arra, hogy egy tengely javítása jelentősen olcsóbb, mint egy új tengely legyártása. Úgy ítéljük meg, hogy az értékelemzés innovációs javaslatok kidolgozását tette lehetővé. A bemutatott javaslatok megvalósítása elősegítheti a vállalat hatékonyabb működését.

### Összegzés

Magyarországon is folyamatosan be kell vezetni a fenntartható fejlődés keretrendszerét. A fenntartható fejlődés bevezetése igényli a hatékonyabb innovációs tevékenységet. Az innováció egyik leghatékonyabb eszköze az értékelemzés.

A funkcióelemzés elősegítette, hogy a fenntartható fejlődés indikátorai megjelenítésre kerüljenek a technológia elemzésénél. Ugyanakkor a funkcióelemzés és a költségelemzés elősegítette, hogy olyan javaslatokat kapjanak a vállalat vezetői, amelyek elősegíthetik az adott technológia fejlesztését.

## Melléklet

### 1. MELLÉKLET. AZ ELEKTROMOS FÉMSZÓRÁS FÁZISAI



Forrás: WELDTECH Hegesztéstechnológiai Kft. hivatalos weboldala. <http://weldtech.hu/elektromos-femszoras/>, Letöltés dátuma: 2023. 07. 22.

# *Galéria*

Bogáti Vivien: W.W.

























DO YOU  
SEARCH for  
MEANINGS  
in your life?

WHAT  
IS  
A  
LIFE?

WERE THE  
WEBS of YOUR  
EXISTENCE <sup>already</sup>  
BOUND UP in  
FEAR?

ARE YOU  
A LIVING THING  
THAT'S DYING  
or A DYING  
THING THAT'S  
LIVING?

ARE YOU  
CAUGHT UP  
in your life  
THAT'S  
DIEING?





