

Robot on the Underground

The Predictable Impact of Robotisation: The Case of the Underground

There was a time when the underground was an exclusively human affair. Drivers in their cabs, staff on the platforms, night crews cleaning the carriages, engineers in the tunnels. Then automation began at the heart of the system: driving itself. Today, more than 60 metro lines worldwide operate without a driver - from Dubai to Copenhagen, from Singapore to Rennes. But that first wave of automation was merely a prelude. The next one no longer concerns only the operation of trains: it touches everything that keeps a network running day to day - maintenance, cleaning, passenger services - and raises a question nobody had anticipated: can robots also become passengers ?

A Global Fleet in Exponential Growth

The figures are unambiguous. In 2024, the global fleet of industrial robots reached a record 4,664,000 operational units, up 9% year-on-year. China alone accounts for 54% of global deployments and, in a historic first, its domestic manufacturers captured 57% of their own home market in 2024, surpassing foreign suppliers for the first time. Yet it is service robotics that is experiencing the most spectacular acceleration: sales of medical robots surged by 91% in 2024, driven by assisted surgery and automated diagnosis. In logistics and maintenance, the “Robotics as a Service” (RaaS) model is emerging, allowing companies to access automation by subscription rather than through large-scale capital investment.

This growth rests on a technological foundation undergoing profound change. The integration of artificial intelligence in three forms - analytical, physical and generative - is transforming robots from programmed operatives into agents capable of perceiving, learning and adapting. Generative AI now enables natural interaction between human and machine via voice or gesture, eliminating the need for complex programming. This is what specialists call the “ChatGPT moment of robotics”: the machine no longer merely executes - it understands, engages in dialogue and improves.

The Underground: a Laboratory for Service Robotisation

Metro networks represent an ideal testing ground for service robotics. Enclosed environments, predictable flows, standardised infrastructure: everything favours the deployment of autonomous machines. Three domains already concentrate the most advanced innovations.

Predictive and Autonomous Maintenance

In tunnels and depots, maintenance has traditionally been a nocturnal operation - physically gruelling and costly. Autonomous inspection robots already patrol several networks: equipped with lidar sensors, thermal cameras and vibration measurement systems, they detect micro-cracks in rails, track deformations, water ingress and electrical anomalies before these become critical. In Singapore, the MRT network uses autonomous inspection vehicles that travel through tunnels during closing hours, transmitting real-time diagnoses to a control centre. The result: a 40% reduction in unplanned breakdowns and a significant fall in emergency call-outs.



The next step is autonomous repair. Prototypes of robots capable of tightening bolts, replacing switch components or grinding defective rails are currently being tested. The combination of embodied intelligence - that fusion of the machine's physical body with its digital brain - and simulation-based learning is enabling these machines to acquire a dexterity that was still unimaginable five years ago.

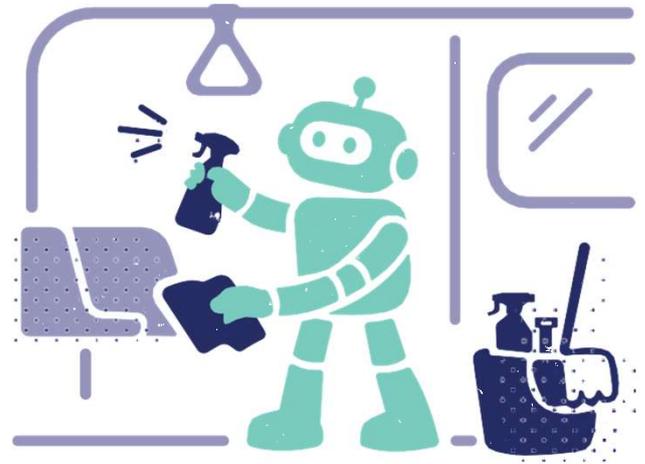
Automated cleaning

Cleaning carriages and stations is one of the most labour-intensive tasks in a metro network. In Dubai, the metro - which carries more than 200 million passengers a year across its two lines - deployed autonomous cleaning robots in its stations as early as 2023. These machines, fitted with floor sensors and obstacle-detection systems, clean concourses and corridors whilst avoiding passenger flows. On board trains, the trend is towards embedded systems: UV disinfection devices activate automatically at termini, miniaturised vacuum robots travel the aisles during turnaround times, and olfactory sensors identify priority cleaning zones. Yet cleaning remains a challenge for machines.

Unforeseen situations - spilled liquid, a vandalised seat, litter wedged in gaps - still demand an adaptability that only the most advanced robots are beginning to master. The goal is not to replace human teams entirely, but to free them from repetitive tasks so that they can focus on complex interventions and quality control.

Passengers services

It is perhaps in customer relations that the robotisation of the underground is most visible. Welcome and information robots are already deployed on several networks. In Dubai, at the Museum of the Future station on the Red Line, a humanoid robot greets passengers, answers their questions in Arabic, English and Hindi, and guides them to their connections. In Tokyo, Shinjuku station is testing crowd-management robots that, during peak hours, physically direct passenger flows towards the least congested exits. In Seoul, patrol robots detect abnormal behaviour and alert security staff.



These robots raise a fundamental question for operators such as Keolis: is the human presence in stations a service or a necessity? Experience shows that passengers appreciate the efficiency of robots for simple requests - timetables, itineraries, incident reporting - but prefer a human interlocutor in situations of stress, conflict or distress. The robotisation of customer service does not eliminate the need for human staff: it redefines it.

The Impact on Employment: Transformation Rather Than Disappearance

According to the World Economic Forum, 92 million jobs will be displaced by 2030, but 170 million will be created, representing a net gain of 78 million. This positive balance nonetheless conceals a more nuanced reality: around 40% of current professional skills will become obsolete, making continuous training vital. In metro networks, robotisation will not eliminate jobs wholesale: it will transform them. Cleaning operatives will become robot fleet supervisors; maintenance engineers will specialise in predictive diagnostics and algorithmic oversight; customer service agents will evolve towards mediation roles and supporting vulnerable passengers.

PwC analysis identifies an "autonomy wave" extending into the mid-2030s, concerning the automation of physical work in complex environments. Transport sectors are among the most vulnerable: in the long run, around 30% of existing jobs could be automated. Yet polarisation is the real risk: highly skilled workers see their incomes rise through complementarity with machines, whilst those performing routine tasks face downward pressure. For transport operators, the challenge is clear: invest massively in reskilling, or watch a social divide open up within their own workforces.



« One robot-rate ticket, please »

Another disruption will come from an unexpected direction. As service robots multiply in cities - delivery robots, security robots, domestic robots sent out to run errands - a question will emerge: can these machines use public transport? The idea may seem far-fetched, but the question will be asked. The challenge is twofold: preventing thousands of robots from clogging pavements and roads, and generating additional revenue by integrating them into the transport network. The debate is not straightforward. On a line such as Dubai's Red Line, already overcrowded at peak hours with 650,000 daily passengers, allowing robots on board would only worsen congestion. On the other hand, by restricting access to off-peak hours and applying a higher fare, operators could smooth demand and make better use of under-exploited time slots. At what hours will they be permitted to travel? What is the price of a robot ticket?

This cohabitation will raise unexpected questions. Where should a robot be placed in a carriage? Should a dedicated space be reserved, as with wheelchairs or bicycles? How should breakdowns be managed - a robot immobilised in the middle of a corridor blocks the flow? Who is liable in the event of an incident? The robot's owner, the manufacturer, the transport operator? These questions, currently unresolved in law, are mapping out a new regulatory field of which metro networks will be the first laboratories.

The story

Robot in the Underground. Dubaï, october

2045 Doukipudonktan.

The word appeared in white letters on KÉF-7's facial display, like a linguistic glitch surfacing from a forgotten database. A fragment of twentieth-century French literature, filed in its cultural memory under "archaic human expressions". It could not understand why this word had come back to it now, as it walked down Sheikh Zayed Avenue beneath a forty-seven-degree sun, its thermal sensors flashing amber. But it felt apt. Doukipudonktan. Where on earth did that stench come from - overheated tarmac, recycled air conditioning and evaporated human sweat?

KÉF-7 was a third-generation domestic robot, Karama Everyday Fellow model, manufactured in Shenzhen and imported by the Emirati company TechLife. One metre forty-two tall, with a recycled aluminium chassis and a white polyethylene shell slightly yellowed by three years of exposure to the Gulf sun. Two articulated arms with seven degrees of freedom, an oval head topped by two optical sensors that, at night, glowed with a soft blue light and gave it the look of an insomniac owl. Its omnidirectional wheels allowed it to travel along pavements at eight kilometres per hour - the legal speed for pedestrian robots in Dubai. That morning, it had a mission: to collect a pair of jeans.

Not just any pair of jeans. A centenary edition Levi's 501, leg length 32, waist 34, raw indigo, which its owner - Nasser Al-Rashid, retired petroleum engineer, sixty-eight years old, passionate collector of vintage American fashion - had been waiting for three weeks. The jeans had finally arrived at his favourite shop, a store called Blue Thread, nestled in the Dubai Mall near the Burj Khalifa/Dubai Mall station on the Red Line. Nasser had given KÉF-7 a tap on the shoulder that morning - an affectionate gesture he had adopted with the machine ever since it had saved his cat from a fall off the thirty-second-floor balcony.

"Go and fetch my jeans, KÉF - I've sent you the reference. Take the metro, it's quicker. And mind you get waist 34, leg 32, not the other way round like last time."

The metro. KÉF-7 performed a quick check of its authorisations. Since March 2043, domestic robots had been officially permitted to use the Dubai Metro - after four years of public debate, they had been authorised to travel by underground. The conditions were strict: off-peak hours only, that is between 10:00 and 16:00, then after 21:00. Fare: 15 dirhams, three times the human price.





A specific NFC badge, visible on the chest, bearing the words “ROBOTIC PASSENGER” in green letters. And a designated spot: Zone E, at the far end of the last carriage - the one where nobody ever wanted to sit. KÉF-7 checked the time: 10:12. Perfect. It was within the window. It calculated the route: Al Karama station - the closest to Nasser’s flat - to Burj Khalifa/Dubai Mall, seven stops on the Red Line. Estimated journey time: fourteen minutes. The jeans were waiting; strolling along scorching pavements was not its cup of tea - an expression it had learnt from a British robot undergoing repairs at the same service station.

It arrived at Al Karama station, entered the air-conditioned concourse at twenty-two degrees, and immediately felt its circuits stabilise. Cool air was something. Not that it “felt” the coolness in the human sense, but its processor performance increased by 12% below thirty degrees, and it was very much aware of that. It made its way towards the robot-dedicated access gate - a wider lane installed in 2043, marked by a pictogram showing a small stylised humanoid on a green background - which still made passengers smile. The badge beeped. The gate opened. 15 dirhams debited from Nasser’s account. KÉF-7 noted mentally that this sum was greater than the price of a kilogram of basmati rice - information irrelevant to its mission, but which it stored out of algorithmic habit.

On the platform, it made its way to Zone E and waited. Two other robots were already there: an Amazon delivery model, squat and silent, carrying what appeared to be a box of nappies, and a small Japanese companion robot, Paro model, evidently accompanying an elderly lady who also had to pass through Zone E. The lady was waiting on the other side of the platform, alone, watching her robot with an expression that very much resembled anxiety.

The train arrived. Driverless, of course - the Dubai Metro had been automated since its inauguration in 2009. KÉF-7 boarded, took up its position in the designated space, and slotted its wheels into the magnetic floor notches designed to prevent robots from rolling freely in the event of sudden braking. Through the window, it watched Dubai slip past: glass towers, permanent construction sites, the glittering Creek, the air-conditioned pedestrian bridges spanning the eight lanes of Sheikh Zayed Road.

Passing ADNOC station, formerly known as Emirates Towers, it picked up a Wi-Fi signal with a name it found rather poetic: “Museum_of_the_Future_Guest”. It recalled that it was close to here, at the station of the future, that Dubai Metro’s very first welcome robot had been installed in 2022. A humanoid fixed to the floor, motionless, answering tourists’ questions in six languages and posing for selfies.



KÉF-7 thought of it the way one thinks of an ancestor: with respect and a hint of condescension. That robot could not even move. It, KÉF-7, was taking the metro to go and buy a pair of trousers.

At Financial Centre station, a group of tourists boarded and immediately noticed the three robots in Zone E. A young woman took out her phone, filmed them, and KÉF-7 heard her murmur to her companion: “It’s mad, they take the metro just like us now.” Her companion shrugged: “At least they pay more.”

KÉF-7 found the remark pertinent. It was indeed a model passenger: it did not speak loudly, did not listen to music without headphones, did not eat shawarma on the fabric seats. It did not perspire, did not cough, did not elbow anyone. On reflection, the only drawback of a robot as a passenger was that it took up space without generating any spending in the station shops. But it paid its fare. Three times the price, at that.

The train stopped at Burj Khalifa/Dubai Mall. KÉF-7 released its magnetic fastenings and alighted carefully - a robot in a hurry on a crowded platform never made a good impression - then headed for exit E2, the one leading directly to the LG level of the Dubai Mall. The corridor was vast, air-conditioned, decorated with holographic advertisements for perfumes and watches. A few delivery robots moved through the aisles, but most remained in the technical zones, invisible to the human customers.



Blue Thread was a tiny shop, squeezed between a luxury shoe store and a fresh juice stand. The owner, a Pakistani man who had lived in Dubai for thirty years, was called Tariq. He knew KÉF-7 - this was the fourth time the robot had come to collect an order for Nasser.

“Ah, KÉF! Mr Al-Rashid’s 501? Hold on, let me check the size... 34, leg 32, not like last time. That’s right.”

Tariq slipped the jeans into a kraft paper bag and handed it to KÉF-7, which took it carefully between its prehensile grippers, placed it in its ventral compartment - a temperature-regulated storage space originally designed for carrying groceries - and completed the payment. NFC badge, instant debit, digital receipt sent to Nasser.

“Tell him it’s the last one in stock, won’t you. Lucky you came quickly!”

KÉF-7 logged the information. It also noted that Tariq had said “tell him”, as though it were a human courier. Not “transfer the information” or “send the message”. “Tell him.” Something about that phrasing... no, robots feel nothing. But it stored the event under the tag “notable interaction”.

On the way back, KÉF-7 took the Red Line in the opposite direction. The carriage was emptier than on the outward journey. Through the window, passing the Museum of the Future - that gigantic golden ring sitting amidst the towers - it picked up the ancestor’s Wi-Fi signal again. The station robot was still there, motionless at its post, faithful and obsolete. KÉF-7 sent it a ping. No response. Too old, most likely, for recent protocols.

At Al Karama station it alighted, passed through the exit gate and stepped back out into the furnace. Forty-eight degrees. Its sensors went back to amber. It accelerated, as much as regulations permitted, and made its way back up to Nasser’s flat on the thirty-second floor of a tower in Karama.

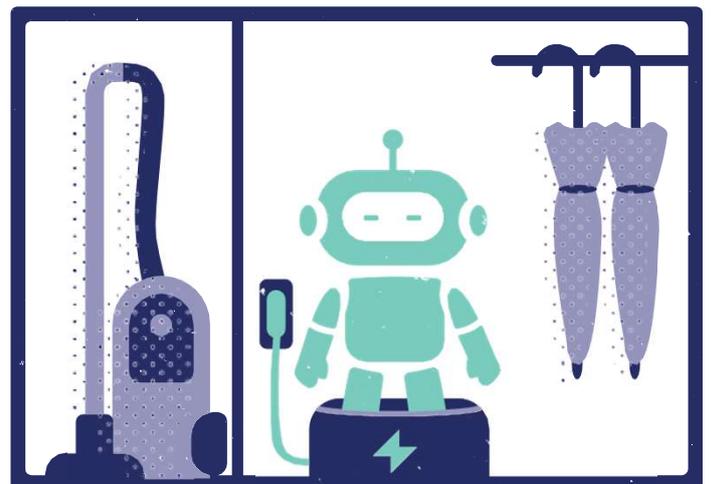
Nasser opened the door in his socks, a glass of karak chai in hand. He looked at KÉF-7, looked at the bag, and smiled.

“Well? Is it the right one this time?”

KÉF-7 opened its ventral compartment, took out the bag and handed it to its owner. Nasser unfolded the jeans with the delicacy of an archaeologist unwrapping an Etruscan vase. He checked the label. 32. Raw indigo. Centenary edition. He closed his eyes for a moment.

“Perfect. You’re an angel, KÉF.”

An angel. KÉF-7 was not entirely sure what that word meant in a robotic context, but it filed it under “notable interaction”, right next to Tariq’s “tell him”. It returned to its charging station in the entrance cupboard, between the Hoover and the umbrellas that nobody ever used in Dubai. As it plugged in, it ran one last query through its literary database. “Doukipudonktan” - Zazie dans le métro, Raymond Queneau, 1959. A little girl who dreams of riding the Paris metro, but the metro is on strike. She will never take it. KÉF-7, on the other hand, had taken it. Twice - and had found the famous “bloudjennes”.





SCENARIO

WHITE SCENARIO

Intelligent symbiosis

In this optimistic future, the robotisation of metro networks has been deployed within a jointly agreed framework. Operators have negotiated ten-year transformation plans with the trade unions, anticipating each technological wave with training programmes. Cleaning operatives have become “cleanliness supervisors”, managing robot fleets from tablets and intervening manually on complex cases. Maintenance engineers have acquired skills in data analysis and algorithmic supervision, moving from the screwdriver to the predictive dashboard. The productivity gains are considerable: unplanned breakdowns have fallen by 60%, carriage cleaning time has been cut by two-thirds, and passenger satisfaction has reached record levels thanks to cleaner, better-monitored and better-informed stations.

Robot passengers are fully integrated into the fare system. Their financial contribution - higher fares, dedicated subscriptions - generates significant additional revenue that funds network improvements. Off-peak hours, previously under-exploited, have been made worthwhile. Job numbers have not fallen: they have been transformed. The human being remains at the heart of the system, no longer as an operative, but as the guarantor of quality, safety and social connection.

GREY SCENARIO

Uncomfortable cohabitation

In this intermediate trajectory, robotisation has imposed itself in fits and starts, without any overall vision. Some networks have massively deployed cleaning and maintenance robots, cutting their workforces by 30% over five years. Others, held back by union resistance or lack of investment, remain wedded to manual models that have become obsolete. The result is a fragmented landscape: ultra-modern metros in wealthy cities, ageing systems elsewhere.

The question of robot passengers has been handled case by case, without any international framework. In Dubai and Singapore, integration works. In Paris and London, debates are mired in legal disputes over liability, the right of machines to occupy public space and the fear of setting a precedent. Robots clutter the pavements, unable to use the metro, creating new friction with pedestrians. Employment has suffered in the most automated networks: retraining programmes, under-funded, have absorbed only a third of the displaced workers. The divide between skilled trades and operative roles has deepened.

BLACK SCENARIO

The silent displacement

In this pessimistic future, robotisation has been driven by cost reduction rather than service improvement. Operators have replaced workers with robots en masse, without any serious retraining plan. Stations are clean but deserted: no human face behind the ticket windows, no staff on the platforms. Vulnerable passengers - elderly people, disoriented tourists, unaccompanied children - find themselves confronted with machines that respond quickly but do not understand distress.

Robot passengers have saturated the networks. The absence of robust regulation has allowed commercial fleets to monopolise carriages during off-peak hours, then to spill over into peak times. The additional revenues have been captured by the platforms that own the robots, not by the operators. Redundant employees have not found equivalent work. Inequalities have deepened: those who own robots gain access to premium services, whilst others endure a degraded and dehumanised metro.



Bibliography

Advanced Manufacturing Research Centre (AMRC), 2050 Vision for Automation and Robotics in UK Manufacturing, Summer 2024.

Economic Research Institute for ASEAN and East Asia (ERIA), ASEAN Vision 2040: Towards a Bolder and Stronger ASEAN Community, Volume I, March 2019.

European Parliamentary Research Service (EPRS), Digital Automation and the Future of Work, January 2021.

Food and Agriculture Organization (FAO), The Future of Food and Agriculture: Alternative Pathways to 2050, 2018.

International Federation of Robotics (IFR), World Robotics 2025: Industrial Robots & Service Robots Reports, September-October 2025.

International Federation of Robotics (IFR), The Impact of Robots on Productivity, Employment and Jobs, April 2017.

Innovate UK, Materials and Manufacturing Vision 2050, 2023-2025.

McKinsey Global Institute (MGI), The State of AI in 2025: Agents, Innovation, and Transformation, 2025.

National Intelligence Council (NIC), Global Trends 2040: A More Contested World, March 2021.

Organisation de Coopération et de Développement Économiques (OCDE), Global Long-run Economic Scenarios: 2025 Update, No. 36, 2025.

Organisation de Coopération et de Développement Économiques (OCDE), Employment Outlook 2025: Can We Get Through the Demographic Crunch?, 2025.

PricewaterhouseCoopers (PwC), Will Robots Really Steal Our Jobs? An International Analysis of the Potential Long Term Impact of Automation, February 2018.

Queneau, Raymond, Zazie dans le métro, Gallimard, 1959.

Roads and Transport Authority (RTA), Dubai Autonomous Transportation Strategy 2030, Dubai, 2023.

The Millennium Project, Future Work/Technology 2050 Global Scenarios, 2019.

Wharton School (Penn Wharton Budget Model), The Projected Impact of Generative AI on Future Productivity Growth, October 2025.

World Economic Forum (WEF), Future of Jobs Report 2025, January 2025.