



डी एम आर सी अकादमी

(सी.बी.सी. के राष्ट्रीय मानकों के अंतर्गत प्रत्यायित)
(आई.एस.ओ. 9001:2015 प्रमाणित)
(एनसीबीईटी द्वारा दोहरी श्रेणी में मान्यता)

आधारशिला

28^{वां} संस्करण, जनवरी 2025



दिल्ली मेट्रो रेल कॉर्पोरेशन लिमिटेड



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मेट्रो भवन में कार्यकारी निदेशक और उच्च अधिकारियों के लिए “चैटजीपीटी” पर आधे दिन की कार्यशाला का आयोजन।

09 अक्तूबर 2024 को प्रबंध निदेशक द्वारा मेट्रो भवन के सम्मेलन कक्ष में कार्यकारी निदेशक एवं उच्च अधिकारियों के लिए आयोजित चैटजीपीटी पर आधे दिन की कार्यशाला का उद्घाटन किया गया। यह आयोजन कार्यकारी निदेशक और उच्च अधिकारियों के लिए किया गया था। कार्यशाला में नेतृत्व संबंधी निर्णय लेने की क्षमता को बढ़ाने, कम्युनिकेशन को सुव्यवस्थित करने तथा नवाचार को बढ़ावा देने के लिए एआई-संचालित टूल, विशेष रूप से चैटजीपीटी के एकीकरण पर ध्यान केंद्रित किया गया। अपने उद्घाटन भाषण में, प्रबंध निदेशक ने कृत्रिम बुद्धिमत्ता के बढ़ते महत्व पर प्रकाश डाला और वरिष्ठ अधिकारियों को गहरी अंतर्दृष्टि हासिल करने, परिचालन दक्षता में सुधार करने और अपनी टीमों के भीतर रचनात्मकता को बढ़ावा देने के लिए एआई को एक शक्तिशाली टूल के रूप में अपनाने के लिए प्रोत्साहित किया। कार्यशाला में वर्तमान संदर्भ में चैटजीपीटी के रियल वर्ल्ड एप्लीकेशंस प्रदर्शित करने वाले इंटरैक्टिव सत्र शामिल थे, जो प्रतिभागियों को रणनीतिक विकास और संगठनात्मक सफलता के लिए एआई का लाभ उठाने की जानकारी देते हैं। यह पहल नेतृत्व के उच्चतम स्तरों पर प्रौद्योगिकी अपनाने को बढ़ावा देने के लिए हमारी प्रतिबद्धता को रेखांकित करती है।



डीएमआरसी अकादमी ने इनक्यूबेशन सेंटर पर बैठक आयोजित की

डीएमआरसी अकादमी ने 7 दिसंबर, 2024 को अपने आगामी इनक्यूबेशन सेंटर के लिए रणनीतियों पर चर्चा करने के लिए एक उच्च स्तरीय बैठक आयोजित की। बैठक में महानिदेशक/डीएमआरसी अकादमी और नवाचार में निपुण लीडर, श्री आनंद कन्नन और नवाचार निदेशक, श्री शिवकिरण एस मक्कम ने भाग लिया। मुख्य चर्चा सेंटर के बुनियादी ढांचे को बढ़ाने, नए स्टार्टअप को आकर्षित करने और उद्यमिता को बढ़ावा देने पर केंद्रित रही। चर्चा का विषय में संसाधन आवंटन, मेंटरशिप के अवसरों और बुनियादी ढांचे के विकास पर जोर दिया गया। बैठक का उद्देश्य नवाचार को बढ़ावा देने और अधिक गतिशील और सहायक इको सिस्टम बनाने के लिए मूल्यवान सुझाव प्राप्त करना था। दोनों पक्ष नवाचार को बढ़ावा देने और महत्वाकांक्षी उद्यमियों के लिए प्रभावशाली अवसर बनाने के लिए एक साझा दृष्टिकोण पर सहमत हुए।



आधारशिला

28^{वीं} संस्करण, जनवरी, 2025



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प्राचार्य

डीएमआरसी अकादमी

सह संपादक

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एवं पुस्तकालय प्रभारी
डीएमआरसी अकादमी

प्रकाशक

शास्त्री पार्क, दिल्ली-110053



डी एम आर सी अकादमी



नववर्ष पर प्रबंध निदेशक का संदेश



प्रिय साथियों,

आज जब हम नए वर्ष का स्वागत कर रहे हैं, तो यह अवसर, विगत वर्ष की शानदार यात्रा और आपसी सहयोग से हासिल उपलब्धियों पर एक नज़र डालने का भी क्षण है। वर्ष 2024 अप्रतिम प्रगति, नवाचार और सामूहिक प्रयासों का वर्ष रहा है, जिसकी वजह से दिल्ली मेट्रो, शहरी परिवहन के एक भरोसेमंद माध्यम के रूप में अपनी प्रतिष्ठा को और अधिक सुदृढ़ कर सकी है।

बीते वर्ष में हम, ऐसे अनेक अभूतपूर्व क्रियाकलापों के साक्षी रहे हैं जो हमारे लाखों दैनिक यात्रियों को मिलने वाली सेवाओं के रूप में परिलक्षित हो रहा है। हमने क्यूआर-आधारित टिकट, नेशनल कॉमन मोबिलिटी कार्ड (एनसीएमसी), कॉन्टेक्टलेस पेमेंट और डीएमआरसी मोबाइल ऐप को उन्नत बनाकर डिजिटल टिकटिंग के विभिन्न तरीकों की शुरुआत की है, जिससे स्टेशनों पर टिकट खरीदने वालों की भीड़ कम हुई है और यात्रा करना आसान हुआ है।

डीएमआरसी की प्रतिष्ठा और इसके प्रति विश्वास में तब चार चांद लग गए, जब भारत की महामहिम राष्ट्रपति श्रीमती द्रौपदी मुर्मु ने पिछले वर्ष दिल्ली मेट्रो में यात्रा की। इसके अलावा, माननीय प्रधानमंत्री श्री नरेंद्र मोदी ने फेज-IV के दो महत्वपूर्ण कॉरिडोरों (इंद्रलोक-इंद्रप्रस्थ और लाजपत नगर-साकेत जी ब्लॉक) की आधारशिला रखी। ये विकास कार्य न केवल दिल्ली मेट्रो के लिए बल्कि, भारत के शहरी परिवहन के, बुनियादी ढांचे के लिए भी महत्वपूर्ण उपलब्धियां हैं।

कंसलटेंसी के क्षेत्र में दिल्ली से बाहर भी अपनी विशेषज्ञता का विस्तार करते हुए, डीएमआरसी ने, दिनांक 5 अक्टूबर, 2024 को मुंबई मेट्रो की लाइन-3 का, आंशिक परिचालन शुरू किया। परिचालन एवं अनुरक्षण का अगले 10 वर्षों तक प्रबंधन, दिल्ली मेट्रो द्वारा किए जाने वाली यह परियोजना, देशभर में एक अग्रणी मेट्रो सलाहकार के रूप में हमारे बढ़ते प्रभाव को प्रकट करती है।

यात्री सुविधाएं बढ़ाने, टिकट प्रणाली को एकीकृत करने तथा घरेलू और अंतर्राष्ट्रीय विशेषज्ञता के साथ शहरी परिवहन में सुधार लाने के लिए डीएमआरसी ने पिछले वर्ष एसआई, एनसीआरटीसी, राइट्स आदि के साथ पारस्परिक सहयोग सहित कई समझौता ज्ञापनों पर हस्ताक्षर किए हैं।

इन उपलब्धियों को रेखांकित करने तथा टीम के प्रत्येक सदस्य के योगदान का सम्मान करने के लिए, डीएमआरसी ने अपनी स्थापना दिवस के अवसर पर 03 मई को और अपने परिचालन दिवस के अवसर पर 23-24 दिसंबर को, सांस्कृतिक उत्सव का आयोजन किया। इस दौरान जिस प्रकार की उत्साहपूर्ण भागीदारी दिखी उससे हमारी जीवंत और गतिशील भावनाएं साकार हो उठीं, जो डीएमआरसी को गति प्रदान करती है।

ये उपलब्धियां हमारे कर्मचारियों की समग्र निष्ठा, समर्पण और सामूहिक प्रयत्न का परिणाम है। आप ही डीएमआरसी की श्रेष्ठता और सफलता के मूल हैं। आपका अथक परिश्रम और आपकी प्रतिबद्धता हमें नित नए आयामों को स्पर्श करने के लिए प्रेरित करती हैं।

ये उपलब्धियां हमारे कर्मचारियों की समग्र निष्ठा, समर्पण और सामूहिक प्रयत्न का परिणाम है। आप ही डीएमआरसी की श्रेष्ठता और सफलता के मूल हैं। आपका अथक परिश्रम और आपकी प्रतिबद्धता हमें नित नए आयामों को स्पर्श करने के लिए प्रेरित करती हैं।

आज जब हम 2025 में प्रवेश कर रहे हैं, इस अवसर पर मैं आप से आग्रह करता हूं कि आप उत्कृष्टता की इस संस्कृति को कायम रखें। आइए, हम सब मिलकर भावी चुनौतियों का सामना करें, नवीन लक्ष्यों को हासिल करें और नए मानक स्थापित करें। डीएमआरसी की अनवरत यात्रा का अभिन्न अंग बनने के लिए आप सभी का हार्दिक धन्यवाद।

“अप्राप्यं नाम नेहस्ति धीरस्य व्यवसायिनः।”

(अर्थात्, जिसके पास धैर्य और लगन है, उसके लिए कुछ भी अप्राप्य नहीं है।)

!! नववर्ष 2025 की हार्दिक शुभ कामनाएं !!

विकास कुमार

(डॉ. विकास कुमार)

प्रबंध निदेशक



डी एम आर सी अकादमी



Message from Director (Operations & Services)



DMRC has made significant strides in digitalizing its services, enhancing commuter convenience, and aligning with the Government of India's 'One India – One Ticket' initiative. DMRC partnered with IRCTC and CRIS to launch the beta version of a QR code-based ticketing system for seamless travel across Main Line Railways and Metro. Further advancing digital solutions, DMRC introduced a QR ticketing system in collaboration with Amazon Pay for a quick, contactless experience. Additionally, the corporation launched international flight check-in facilities at metro stations, partnered with Airtel Payments Bank for open-loop digital payments, and signed MoUs with NCRTC and ASI to offer integrated travel and cultural experiences through a unified ticketing platform. DMRC also introduced features like Multiple Journey QR Tickets (MJQRT) and bike taxi bookings via the official app, making travel even more accessible. By embracing innovation, DMRC continues to simplify commuting and create a modern, digital travel ecosystem for its passengers.

Happy New Year 2025, to all DMRC Family

(Dr. Amit Kumar Jain)

Director (Operations and Services)

आधारशिला

28^{वीं} संस्करण, जनवरी, 2025

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महानिदेशक / डीएमआरसी अकादमी की कलम से...



नववर्ष 2025 के आगमन के साथ डीएमआरसी अकादमी की अर्धवार्षिक पत्रिका का 28वां अंक आपके समक्ष प्रस्तुत है। यह पत्रिका एक तरफ लेखकों और रचनाकारों के लिए बेहतरीन प्लेटफॉर्म है तो दूसरी तरफ पाठकों के लिए ज्ञानवर्धक और रोचक भी है। आशा है, यह संस्करण भी आपको पसंद आएगा।

भारत में तेजी से बढ़ते शहरीकरण और परिवहन आवश्यकताओं के बीच, मेट्रो रेल प्रणाली एक अद्भुत समाधान के रूप में उभरी है। दिल्ली मेट्रो ने निरंतर 22 वर्षों की सेवा के जरिए, इस सफल परिवहन व्यवस्था को साकार रूप देने में ऐतिहासिक प्रगति की है। इन जटिल प्रणालियों का कुशल परिचालन और अनुरक्षण सुनिश्चित करना न केवल समय की मांग है, बल्कि यात्रियों की सुरक्षा और विश्वसनीयता के लिए भी अत्यंत महत्वपूर्ण है।

डीएमआरसी अकादमी, इस आवश्यकता को भलीभांति समझती है और इसमें निरंतर सुधार कर नवीनतम तकनीकी साधनों जैसे ऑगमेंटेड रियलिटी (एआर) और वर्चुअल रियलिटी (वीआर) के उपयोग से प्रशिक्षण में क्रांति ला रही है। एआर और वीआर तकनीक वास्तविक समय की चुनौतियों और जटिल तकनीकी प्रक्रियाओं को समझने में महत्वपूर्ण भूमिका निभाती हैं। ये तकनीक प्रशिक्षुओं को एक ऐसा वर्चुअल वातावरण प्रदान करती हैं जहां वे वास्तविक समय में मेट्रो संचालन और अनुरक्षण की प्रक्रिया को बिना किसी जोखिम के अनुभव कर सकते हैं। हालांकि, अकादमी में मेट्रो संचालन और अनुरक्षण से संबंधित प्रशिक्षण के लिए सिमुलेटर उपलब्ध हैं, जो प्रशिक्षण के लिए काफी कारगर हैं, परन्तु एआर और वीआर तकनीक के जरिए प्रशिक्षु उस तकनीक को और अच्छे तरीके से सीख सकते हैं।

मेट्रो अकादमी की यह पहल न केवल देश की मेट्रो सेवाओं को और अधिक विश्वसनीय और कुशल बनाएगी, बल्कि यह भारत को विश्व स्तरीय मेट्रो संचालन और प्रबंधन में अग्रणी बनाने की दिशा में एक महत्वपूर्ण कदम साबित होगी।

बदलते समय के साथ, अकादमी आधुनिक तकनीक और नवाचार के साथ कदम से कदम मिलाकर चलने को तत्पर है। इनक्यूबेशन सेंटर और चैटजीपीटी जैसे अत्याधुनिक साधन इस दिशा में नए आयाम जोड़ रहे हैं। बहुत जल्द डीएमआरसी अकादमी एक आधुनिकतम अकादमी के रूप में आप सबके सामने होगी।

घनश्याम बंसल

(घनश्याम बंसल)

महानिदेशक / डीएमआरसी अकादमी



From Principal's Desk



Preface to a Technical Editorial

We are pleased to share with you, full technical edition of Adharshila from DMRC Academy, a premier academy that stands as a beacon of excellence in the field of Metro Railway education. As the premier Metro Academy in India, we are uniquely positioned to bridge the gap between cutting-edge Metro Railway technology and the skilled professionals needed to build, operate and maintain.

The Delhi Metro Rail Corporation (DMRC) has long been a symbol of excellence in public transportation, and DMRC Academy serves as a platform for those seeking to make impactful contributions to this dynamic sector. Our approach blends rigorous academic training with hands-on technical experience, ensuring that trainees not only master the principles of engineering but also understand how these concepts apply to the real-world challenges faced by the rapidly expanding metro systems.

At DMRC Academy, we recognize that the future of metro systems depends on the adaptive integration from automation to sustainable energy solutions. Both automation and sustainability play vital and integral role to the future of metro railways. Automation helps streamline operations, improves safety, and can increase the energy efficiency of train systems. One of the most ground-breaking technological advancements in metro systems is the development of automated trains or driverless metro systems and Delhi Metro proudly possesses the technology in around 100 km of its network. Sustainability, on the other hand, ensures that metro railways have a minimal environmental footprint, reduce emissions, and are part of a broader strategy for sustainable urban transport. Sustainability has become a buzz word globally of late and Delhi Metro stand tall to claim its status in the arena.

We at DMRC Academy are eagerly looking forward to the inauguration of "Centre of Excellence in Tunnelling" (CoE in Tunnelling) including Tunnel Model and Cutter Head. "CoE in Tunnelling" will bring a unique learning experience to the trainees. The Centre will run various Short-Term courses which are designed for professionals seeking to upgrade their skills in areas such as tunnel boring machines (TBMs), risk management, etc.

We are truly thankful to all those who have contributed their insightful articles for this technical edition. Your valuable expertise has played a crucial role in enriching our edition.

Thank you for being a part of this exciting journey. Together, we will continue to drive excellence in metro education and shape the future of urban mobility.

Happy New Year 2025

(Mahendra Singh)
Principal, DMRC Academy



डी एम आर सी अकादमी



सह-संपादक की लेखनी से...



आधारशिला पत्रिका का 28वां संस्करण आपके समक्ष प्रस्तुत करते हुए मुझे अत्यंत हर्ष की अनुभूति हो रही है। किसी पत्रिका को पठनीय बनाने में लेखकों के विचार और मौलिकता की भूमिका महत्वपूर्ण होती है। पत्रिका के माध्यम से लेखक अपने विचार और अनुभव पाठकों तक पहुंचाते हैं। आधारशिला के इस अंक में तकनीकी लेख तथा नई-नई जानकारियां समाविष्ट करने का सदैव प्रयास किया गया है ताकि इसे सुरुचिपूर्ण बनाया जा सके।

दिल्ली मेट्रो के विकास और इसकी श्रमशक्ति को प्रशिक्षित करने में डी एम आर सी अकादमी का योगदान स्वर्णाक्षरों में सबसे पहले आएगा। दिल्ली मेट्रो ने परिचालन के 22 वर्ष पूरे होने के अवसर पर 23 से 24 दिसंबर, 2024 को परिचालन दिवस का आयोजन किया। प्रकृति पार्क में इस दौरान भव्य समारोह में विभिन्न सांस्कृतिक कार्यक्रमों का आयोजन हुआ जिसमें प्रबंध निदेशक महोदय और दिल्ली मेट्रो महिला कल्याण संगठन की माननीय अध्यक्ष की गरिमामयी उपस्थिति में विभिन्न कार्यक्रमों में बड़े पैमाने पर मेट्रोकर्मियों की सहभागिता भी रही। ऐसे कार्यक्रमों से हम सभी स्वयं को एकता के सूत्र में बंधा पाते हैं।

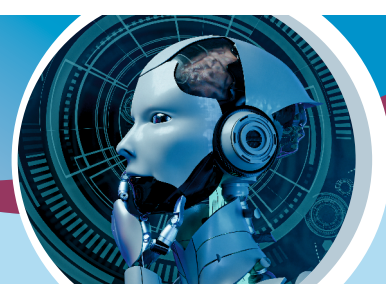
यदि हम समय और मनुष्य का जीवन-स्तर उठाने की बात करें तो अनेक उतार-चढ़ाव सामने आते हैं। आज की नई पीढ़ी समझ नहीं पा रही है कि 'कैसे जिया जाए'। वह एक ऐसी जीवन पद्धति की तलाश में है जो व्यवसायिक सफलता देने के साथ-साथ मानसिक शांति भी दे। पुरानी जीवन पद्धति इस तकनीकी युग में व्यवहारिक भी प्रतीत नहीं होती। जहां लोग पारिवारिक जीवन का आनंद लेना चाहते हैं, वहीं परिस्थितियों और सांसारिक कठिनाइयों से वे बेबस नज़र आते हैं। युवाओं की सारी शक्ति करियर बनाने तथा नई कुशलता अर्जित करने में निकल जाती है। जीने के लिए जीविका भी आवश्यक है। व्यस्तता इतनी है कि उनके मुंह से यही सुनेंगे समय नहीं है, इस कारण सांस्कृतिक एवं नैतिक मूल्यों की स्थापना, रिश्तों में सामंजस्य तथा सामाजिक दायित्व निभाना आदि धीरे-धीरे विलुप्त होने के कगार पर है। इस संदर्भ में एक अंग्रेज़ कवि, विलियम वड्सवर्थ ने ठीक ही लिखा है — "the world is too much with us, we have no time to stand and stare" अर्थात् हम संसार में इतने खो गए हैं कि हमारे पास ज़िंदगी की खूबसूरत चीज़ों को देखने का समय भी नहीं है। आज छोटी उम्र में भी शारीरिक व मानसिक समस्याएं देखी जा रही हैं। मेरे विचार से इन कठिनाइयों को कुछ कम करने के लिए आध्यात्मिक पुस्तक गीता को अपने जीवन में अमल में लाना चाहिए, जो जीवन के हर पहलू को छूती है। इसके साथ मधुर कहानियां, कविता, उपन्यास, नाटक आदि जीवन में शांति एवं आनंद की धारा बहा सकते हैं। आधुनिक उपकरणों के उपयोग के साथ-साथ, आज जीवन में मानवीय भावनाओं और समन्वय का होना बहुत आवश्यक है। मशहूर शायर मजरूह सुलतानपुरी का एक शेर है :

मैं अकेला ही चला था जानिबे-मंज़िल मगर,
लोग साथ आते गए और कारवां बनता गया।

नव वर्ष 2025 में आप सभी के जीवन में नई ऊर्जा और स्फूर्ति का संचार हो, इन्हीं शुभकामनाओं के साथ सभी साथियों के प्रति आभार व्यक्त करती हूं।

(डॉ. अरुमिका सिन्हा)

उप महाप्रबंधक / राजभाषा
एवं पुस्तकालय प्रभारी



Cutterhead of a Tunnel Boring Machine (TBM)



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Tunnel Boring Machines (TBMs) are giant “Tunnel Production Factory” with all parts of production line installed within its 80 to 100 m length. The primary function of TBM is to excavate tunnels through different types of soil. However, these modern machines are now self-equipped to remove the excavated soil into the muck trolleys, install different segments of tunnel ring (preferably in RCC) as per the alignment and carry out the external grouting of tunnel linings, in a fully automated process.



Fig. 1: Tunnel Boring Machine (TBM)

The Cutterhead is a single most critical component of Tunnel boring machine (TBM), which has the functions of excavation, stabilizing the tunnel face and stirring the muck.

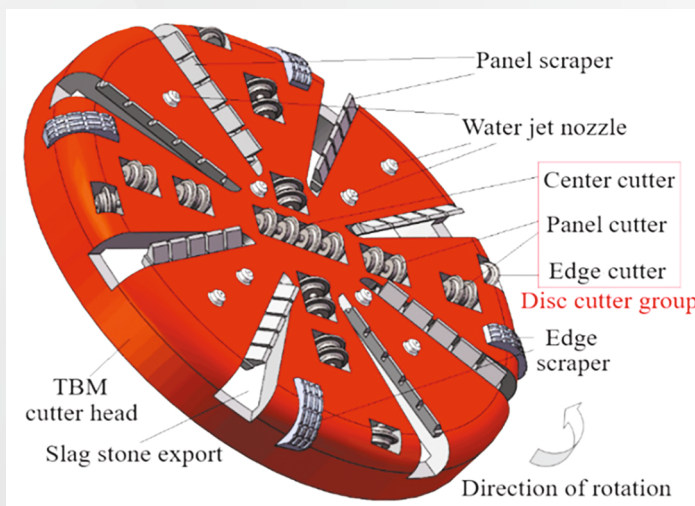
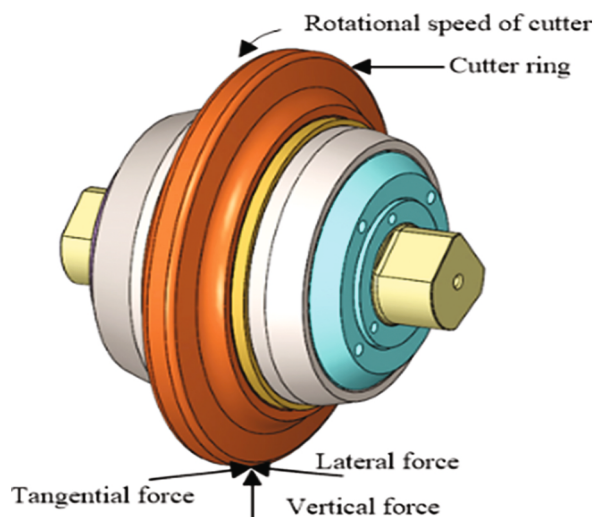


Fig. 2: Cutterhead.

TBM cuts rock with a three-direction interaction between the cutter ring blade and rock: **(a)** The normal pushing force points to the excavation surface provided by thrust of cutter head. **(b)** The tangential rolling cutting force provided by the torque of cutter head and **(c)** The lateral force on the edge of the disc cutter generated by the squeezing force of the disc cutter on the rock and the centrifugal force of the rotation of the TBM roller cutter head.

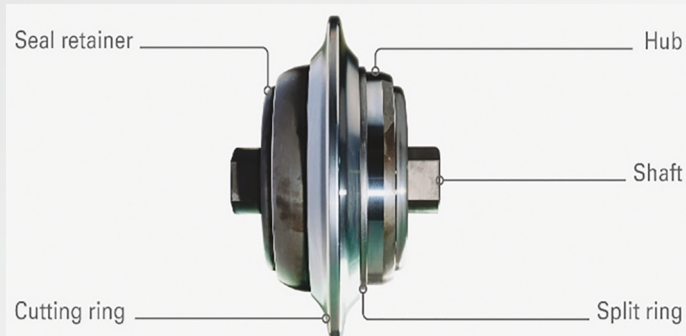
When the cutterhead is working, the disc cutter first contacts the excavation surface, and is pressed





against the rock surface under the action of thrust. With the rotation of the cutterhead, the TBM disc roller cutter revolves around the central axis of the cutterhead on the one hand, and revolves around its own axis at the same time.

TBM disk cutter cuts a series of concentric grooves on the palm surface under the joint action of the thrust and torque of the cutter head. When the cutter rotates and



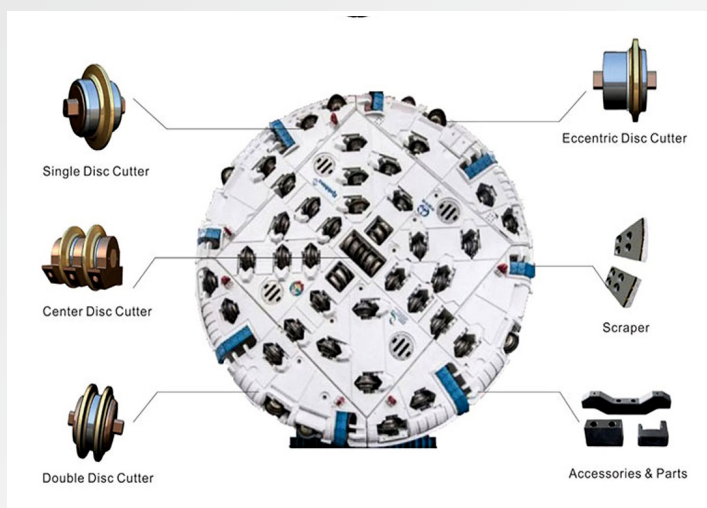
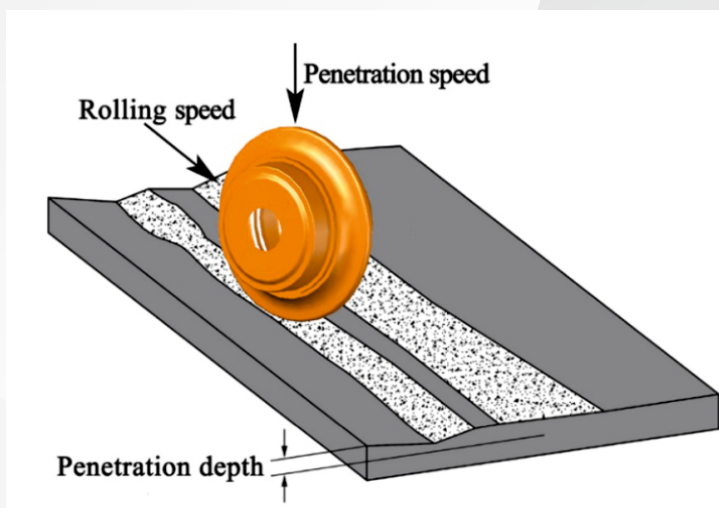
presses into the rock, the TBM disc cutter will produce comprehensive effects such as extrusion, shear and tensile cracking on the rock. The slag thus formed is composed of crushed body and rock fragments, and

the proportion of each part depends on the rock properties, cutter ring geometry, pushing pressure and cutter spacing.

The TBM cutter disc usually has three types- single disc, double disc and triple disc. The arrangement of the TBM roller cutter on the cutter head should facilitate the formation of sequential rock breaking.

Double disc cutters and the triple disc cutters cannot well meet the requirements of rock breaking in sequence, and are prone to uneven wear, resulting in deterioration of cutter force and cutter waste, so the face cutter and gauge cutter should choose single disc cutter as far as possible. In order to save the space of the cutter head, Tunnel boring machine are mostly equipped with double disc cutters or triple disc cutters in the centre of the cutter head.

Without a properly designed cutter head, production of Tunnel can be slow or non-existent. Best results come from a cutter head design that is specific to the project's ground conditions.





Panto Flashover Protection Relay

INTRODUCTION

Panto flashover protection relay is a protection relay that is specifically provided for eliminating the risk of flashover at insulated overlap at 25 kV feeding post on the mainline.

REQUIREMENT

Whenever there is a tripping of the 25 kV feeder circuit breaker due to an intermittent or transient fault on one of the sides of the feeding post insulated overlap (IOL) and an electric train enters (say from live to the dead section) of the FP IOL, there will be a heavy flashover when the pantograph leaves the IOL. Depending upon the intensity of current being drawn by the pantograph at that point of time, the extent of damage would be cutting of a few strands of catenary or parting of the contact wire.

BENEFIT

The pantograph flashover protection relay eliminates the risk of damage to the insulated overlap and pantograph of the train because of flashover at the 25 kV feeding post. Panto flashover protection relay is employed in the protection scheme for a traction network wherever insulated overlaps (IOL) are involved.

FEEDING ARRANGEMENT

Mostly at 25 kV feeding posts on the main line, OHE is divided into four sections from the electrical isolation point of view and charging scheme, called sectors. These sections of OHE can be further nomenclated as UP-1, UP-2, DN-1, and DN-2. These sectors are fed through the 4 distinct feeder circuit breakers installed at the Traction Substation (TSS). At the feeding post location, two insulated overlaps are formed, i.e., one on the UP line and another on the DN line. 2 nos. sectioning interrupters (normally open) are provided on UP and DN lines to extend the feed from UP-1 to UP-2 & vice versa and DN-1 to DN-2 & vice versa. In addition to the above, UP and DN lines remain electrically connected through paralleling interrupter (normally closed) at SSP-1 & 2 as shown in fig. 1.



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WORKING PRINCIPLE

In case of an intermittent or transient fault in any of the sectors (say, on UP-1) on the 25 kV OHE, both UP-1 and DN-1 circuit breakers will trip, as both UP-1 and DN-1 are connected through a paralleling interrupter, and one side of OHE becomes dead and the other side remains charged (i.e., UP-2 and DN-2) as shown in fig. 2. The problem arises when the train pantograph bridges the charged and dead section and then leaves the overlap portion. At that instant, a heavy flashover occurs, resulting in the parting of the catenary wire or contact wire and damage to OHE.

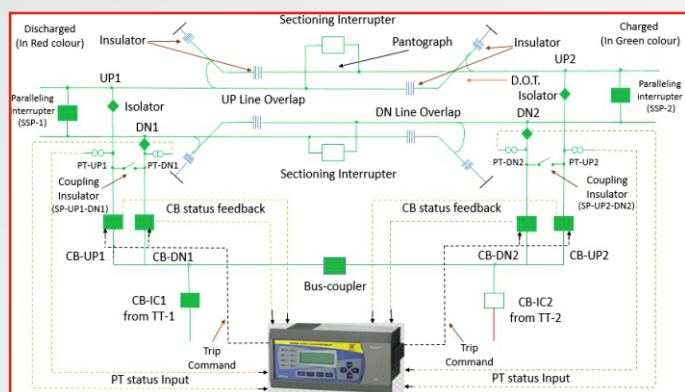
To avoid such a scenario, the Panto Flashover protection Relay has been introduced in the traction system. The relay continues to monitor the status of all four feeder circuit breakers and output voltage through potential transformers. Considering the above case, if UP-1 and DN-1 OHE are dead and, the respective circuit breakers are open, then zero/low potential is shown by PT-UP1 and PT-DN1. This indicates the OHE dead status of the respective side of the insulated overlap. Now, if the pantograph of the train bridges or tends to bridge the charged and uncharged portions, the PT of the OHE dead section starts showing voltage, if the PT voltage is $>30\%$ and the corresponding circuit breakers are in open condition (it is only possible when the pantograph enters at overlap portion), then relay generates a trip command for UP-2 and DN-2 feeders to make the OHE dead within 100 ms as shown in fig. 3.



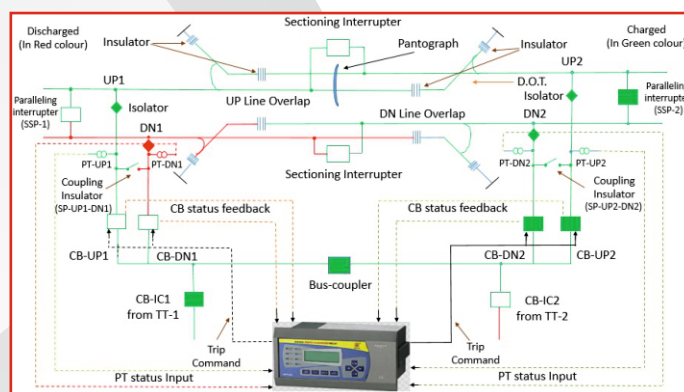
All the main line feeders become open as shown in fig. 4, thereby eliminating the risk of flashover as voltage disappears at complete feeding post.

The same logic of PFR protection holds for the other combination of breakers and direction of train traffic. This scheme is employed in phase-1 and 2 TSS.

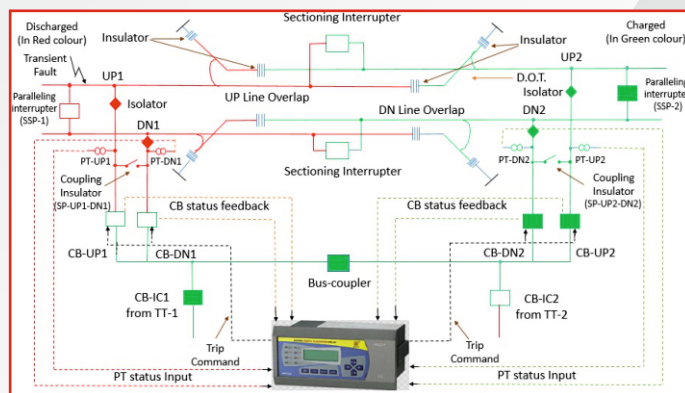
For any type of extension of Feed, PFR should be manually bypassed by Traction Power Controller (TPC) from Operation Control Center (OCC) or through Receiving Sub Station (RSS) before power extension.



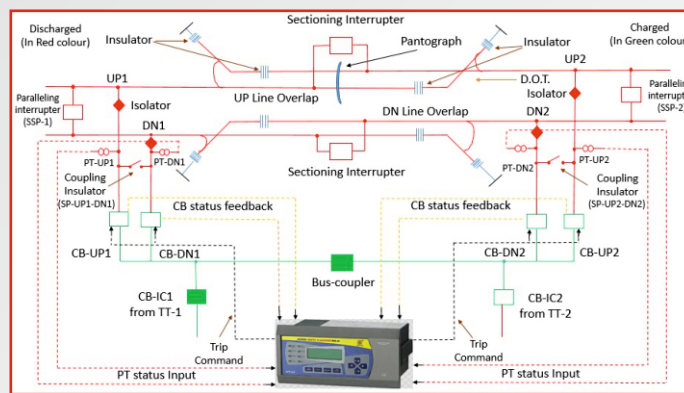
(Fig 1: Normal Feeding Arrangement under no Fault Condition)



(Fig 3: Panto entering in discharged OHE and tends to bridge both charge and discharge section)



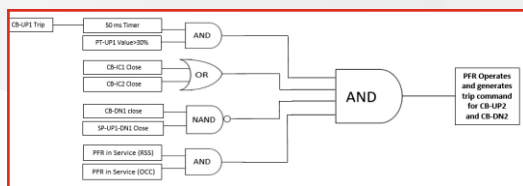
(Fig 2: Tripped OHE on one side of IOL under Transient Fault Condition)



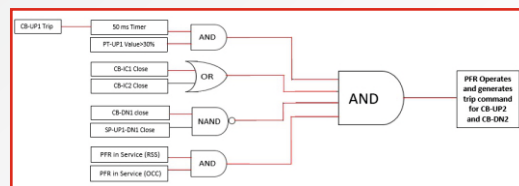
(Fig 4: Complete OHE in Dead condition)

In phase-3, panto flashover scheme is modified and achieved by the below-mentioned logic as shown in fig. 5(a). PFR protection will not be available when the feed is extended from other RSS.

The input/output to the Logic Gates shown below is '1' when the status as mentioned in the Logic Diagram comes true, otherwise '0'. Considering the same case as discussed before, the logic will work as shown in the diagram below, fig. 5(b).



(Fig. 5(a): PFR logic Diagram, under no fault condition)



(Fig. 5(b): PFR logic Diagram, under fault condition)



डी एम आर सी अकादमी



सुर्खियों में अकादमी...

नाइजीरिया के लागोस राज्य के प्रतिनिधिमंडल ने डीएमआरसी अकादमी का दौरा किया

डीएमआरसी अकादमी ने 01 जुलाई, 2024 को नाइजीरिया के लागोस राज्य सरकार की सचिव सुश्री बिम्बोला सालू-हुंडेयिन के नेतृत्व में एक अंतरराष्ट्रीय प्रतिनिधिमंडल की मेजबानी की। महानिदेशक/डीएमआरसी अकादमी ने उनका स्वागत किया, जिसके बाद अकादमी पर एक संक्षिप्त प्रस्तुति दी गई और उन्नत ड्राइविंग और रखरखाव सिम्युलेटर का दौरा किया गया, जिससे उन्हें अकादमी की प्रशिक्षण क्षमताओं का ज्ञान हुआ और काफी सराहना भी की गई।



मंगोलिया के अंतरराष्ट्रीय प्रतिनिधिमंडल ने डीएमआरसी अकादमी का दौरा किया

डीएमआरसी अकादमी ने 31 जुलाई, 2024 को मंगोलिया से आए एक अंतरराष्ट्रीय प्रतिनिधिमंडल का स्वागत-सत्कार किया। इस प्रतिनिधिमंडल में मंगोलिया की राष्ट्रीय अकादमी के संकाय सदस्य और आईआईपीए, दिल्ली के अधिकारी शामिल थे। महानिदेशक/डीएमआरसी अकादमी ने उनका स्वागत किया, जिसके बाद अकादमी पर एक संक्षिप्त प्रस्तुति दी गई। डिजिटल लाइब्रेरी, विभिन्न प्रदर्शन कक्ष, उन्नत ड्राइविंग और रखरखाव सिम्युलेटर जैसी विभिन्न सुविधाओं का प्रतिनिधि मंडल द्वारा दौरा किया गया, जिससे उन्हें अकादमी की प्रशिक्षण क्षमताओं से अवगत कराया गया।

इस यात्रा के दौरान, महानिदेशक/डीएमआरसी अकादमी ने डीएमआरसी की उन्नत मेट्रो तकनीक के बारे में जानकारी दी और मेट्रो संचालन और प्रशिक्षण में संभावित भावी सहयोग पर संवाद की सुविधा प्रदान की। प्रतिनिधियों ने विचारों और दृष्टिकोणों के समृद्ध आदान-प्रदान में भाग लिया और डीएमआरसी अकादमी के आतिथ्य, अनुभवी संकायों और प्रभावशाली प्रशिक्षण सुविधाओं की सराहना की।



ऑस्ट्रेलिया के मोनाश इंस्टीट्यूट ऑफ रेलवे टेक्नोलॉजी के निदेशक का डीएमआरसी अकादमी दौरा

प्रोफेसर रवि रविथरन, निदेशक, मोनाश इंस्टीट्यूट ऑफ रेलवे टेक्नोलॉजी, ऑस्ट्रेलिया ने 18 सितंबर, 2024 को डीएमआरसी अकादमी का दौरा किया। महानिदेशक/डीएमआरसी अकादमी ने उनका स्वागत किया और अकादमी पर एक संक्षिप्त प्रस्तुति दी गई। इसके उपरान्त अकादमी के प्रमुख क्षेत्रों का दौरा कराया गया, जिसमें ड्राइविंग और मेटेनेंस सिम्युलेटर, विभिन्न डेमोस्ट्रेशन रूम और अन्य विशेष प्रशिक्षण सुविधाएं शामिल थीं। प्रोफेसर रवि रविथरन डीएमआरसी अकादमी में तैनात अनुभवी और पेशेवर संकायों से अत्यधिक प्रभावित हुए, जो अपने-अपने क्षेत्रों में व्यापक व्यावहारिक ज्ञान रखते हैं। उन्होंने अकादमी में उपलब्ध अत्याधुनिक आधारभूत संरचना की भी प्रशंसा की।





डी एम आर सी अकादमी

डायरेक्टर, इस्त्राइल मेट्रो रेल, डीएमआरसी अकादमी के दौरे पर

डायरेक्टर, इस्त्राइल मेट्रो रेल, 29 नवम्बर, 2024 को डीएमआरसी अकादमी के दौरे पर आई। महानिदेशक/डीएमआरसी अकादमी ने उनका स्वागत किया और अकादमी पर एक संक्षिप्त प्रस्तुति दी गई। इसके उपरांत अकादमी के प्रमुख क्षेत्रों का दौरा कराया गया, जिसमें ड्राइविंग और मेंटेनेंस सिम्युलेटर, विभिन्न डेमोस्ट्रेशन रूम और अन्य विशेष प्रशिक्षण सुविधाएं शामिल थीं। वो डीएमआरसी अकादमी में तैनात अनुभवी और पेशेवर संकायों से अत्यधिक प्रभावित हुईं और उपलब्ध अत्याधुनिक आधारभूत संरचना की भी प्रशंसा की।



दक्षिण कोरिया के अंतरराष्ट्रीय प्रतिनिधिमंडल ने डीएमआरसी अकादमी का दौरा किया

डीएमआरसी अकादमी ने 10 दिसंबर, 2024 को सियोल मेट्रो और हानयांग विश्वविद्यालय, दक्षिण कोरिया के एक अंतरराष्ट्रीय प्रतिनिधिमंडल की मेजबानी की। महानिदेशक/डीएमआरसी अकादमी ने 20 सदस्यों वाले प्रतिनिधिमंडल का गर्मजोशी से स्वागत किया, इसके बाद डीएमआरसी अकादमी और इसकी सुविधाओं पर एक संक्षिप्त प्रस्तुति दी गई और अकादमी के उन्नत ड्राइविंग और रखरखाव सिम्युलेटर का दौरा कराया गया, जिससे उन्हें अकादमी की प्रशिक्षण क्षमताओं की समझ प्राप्त हुई।



यात्रा के दौरान, अकादमी ने डीएमआरसी की उन्नत मेट्रो तकनीक के बारे में जानकारी दी और मेट्रो संचालन और प्रशिक्षण में संभावित भविष्य के सहयोग पर बातचीत की सुविधा प्रदान की। प्रतिनिधियों ने विचारों और दृष्टिकोणों के समृद्ध आदान-प्रदान में भाग लिया और अकादमी के आतिथ्य, अनुभवी संकायों और प्रभावशाली प्रशिक्षण सुविधाओं की सराहना की।

अंतरराष्ट्रीय सार्वजनिक परिवहन संघ (यूआईटीपी) के प्रतिनिधियों का डीएमआरसी अकादमी का दौरा

अंतरराष्ट्रीय सार्वजनिक परिवहन संघ (यूआईटीपी) के ऑपरेशंस प्लेटफॉर्म तथा ऑटोमेटेड मेट्रो प्लेटफॉर्म के प्रतिनिधियों ने 11 सितंबर, 2024 को डीएमआरसी अकादमी का दौरा किया। डीएमआरसी अकादमी पर एक संक्षिप्त प्रस्तुति के उपरांत, प्रतिनिधियों को अकादमी की अत्याधुनिक सुविधाओं का मार्ग दर्शित दौरा कराया गया, जिसमें ड्राइविंग और मेंटेनेंस सिम्युलेटर, डेमोस्ट्रेशन और मॉडल रूम शामिल थे।



ऑस्ट्रेड टीम ने डीएमआरसी अकादमी का दौरा किया

ऑस्ट्रेड टीम के 03 सदस्यों ने 03 अक्टूबर, 2024 को उन्नत प्रशिक्षण सेटअप के बारे में जानकारी प्राप्त करने के लिए डीएमआरसी अकादमी का दौरा किया। डीएमआरसी अकादमी के अधिकारियों ने एक व्यापक पावर प्वाइंट प्रेजेंटेशन दिया, जिसमें अकादमी की अत्याधुनिक सुविधाओं, प्रशिक्षण कार्यक्रमों और मेट्रो प्रणालियों में परिचालन उत्कृष्टता के प्रति प्रतिबद्धता पर प्रकाश डाला गया। इसके बाद प्रतिनिधिमंडल को प्रशिक्षण सिम्युलेटर का दौरा कराया गया। इस यात्रा का उद्देश्य मेट्रो प्रशिक्षण और संचालन को बढ़ावा देने में ऑस्ट्रेलियाई संगठनों और डीएमआरसी अकादमी के बीच ज्ञान साझा करने और संभावित सहयोग के अवसरों की तलाश करना था।





Predicting Failures in Multilayer PCBs in Metro Signalling Systems



Introduction

Metro systems are the lifeline of any metro city. The Signalling systems used in Metros are highly complex in design and functionality. These systems are required to maintain high reliability and availability under various environmental conditions.

The metro signaling systems are modular in nature and essentially include several Multilayer Printed Circuit Boards (MPCBs) for ensuring smooth operations and safety of metro trains.

These PCBs (cards) are inserted into a prewired motherboard rack that makes it convenient to quickly replace it in case of any failure.

Failure prediction in such systems is essential to prevent operational disruptions and ensure passenger safety.

A Cause for Concern:

The 'difficult to predict' nature of PCB failures is a potential threat to the reliability and availability of Signaling systems in metros and a cause for concern to all signal engineers the world over.

This paper discusses the challenges and the difficulties in predicting failures in multilayer PCBs within metro signaling systems and explores potential methods for effective failure prediction.

Difficulties and Challenges:

- 1. Complexity of Systems:** Metro signaling systems involve multilayer PCBs with intricate circuitry and dense component placement. This complexity makes it challenging to pinpoint potential failure points and predict failures accurately.
- 2. Environmental Factors:** These systems are exposed to harsh environmental conditions, including temperature variations, vibrations,

humidity, and corrosive environments. Such factors can lead to material degradation, mechanical stress, and electrical failures.

- 3. Incomplete Technology Transfer:** Often these systems are provided by international system suppliers without or incomplete transfer of the technology. The absence of design documents of these PCBs makes the testing difficult even in the labs.
- 4. Limitation in Developing Testing Facilities:** These complex PCBs require specific test benches and facilities which are difficult to develop in absence of proper technical knowhow due to limited information sharing by manufacturers and proprietary nature of these PCBs.
- 5. Signal Integrity Issues:** High-density multilayer PCBs are prone to signal crosstalk and electromagnetic interference (EMI), which can degrade signal quality and cause intermittent functional failures that are difficult to predict.
- 6. Lack of Meaningful Data:** The real time data generated by these PCBs provide inadequate and limited information on the cause of failure and thus makes it difficult to analyze and identify potential failures in real-time.
- 7. Detection Limitations:** Early signs of failure are often subtle and may go unnoticed until the failure becomes significant. Additionally, internal layers of multilayer PCBs can have hidden defects that are not easily detectable through conventional inspection methods.

Probable Methods to Make the Prediction Possible

- 1. Advanced Monitoring Techniques:** Implementing advanced monitoring techniques such as X-ray imaging, acoustic microscopy, and thermography can help



detect hidden defects and anomalies in multilayer PCBs in Labs.

- **X-ray Imaging:** Non-destructive testing method to detect internal defects such as cracks and voids.
- **Acoustic Microscopy:** Uses high-frequency sound waves to detect delaminations and other defects within the PCB layers.
- **Thermography:** Infrared imaging technique to identify hot spots and potential thermal issues in real-time.

2. Real Time In-Use Monitoring Techniques:

Using real time monitoring of various environmental factors such as temperature, humidity, mechanical stress, vibrations and capturing the data for analytics can help predict defects and anomalies in multilayer PCBs.

3. Predictive Maintenance Models:

Using predictive maintenance models that incorporate machine learning and deep learning algorithms can help predict failures before they occur.

- **Machine Learning and AI:** Developing models that use machine learning and artificial intelligence to predict failures based on historical data and real-time monitoring.
- **Multi-Task Learning Models:** Utilizing models that can simultaneously identify multiple failure modes and assess the health of the system.

4. Data Analytics:

Leveraging data analytics to process and analyze the vast amounts of data generated by sensors. Trend analysis can help identify patterns and predict potential failures.

- **Big Data Processing:** Utilizing big data analytics to manage and analyze large volumes of data.

- **Trend Analysis:** Identifying patterns and trends in the data to predict potential failures.

5. Regular Maintenance and High-Quality

Materials: Implementing regular maintenance schedules and using high-quality materials can reduce the risk of failures.

- **Scheduled Inspections:** Regular maintenance schedules to identify and address potential issues before they lead to failures.

- **Quality Control:** Using high-quality materials and rigorous testing procedures to ensure the reliability and durability of PCBs.

6. Proper Storage:

Since the PCBs are sensitive to electrical and magnetic stresses even when not in use, their proper storage in anti-electrostatic bags can help reduce the failures of PCBs.

Conclusion

Failure prediction in multilayer PCBs of metro signaling systems is crucial for ensuring the reliability and safety of metro operations. While there are significant challenges and difficulties in predicting failures, advanced monitoring techniques, predictive maintenance models, data analytics, regular maintenance and proper storage can help overcome these challenges and improve the reliability of metro signaling systems.

By adopting these methods, it is possible to predict and control the PCB failures to some extent, thus helping the metro systems to enhance their operational efficiency and ensure passenger safety.

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Riding the Future: Delhi Metro's Cashless Evolution



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Asst. Superintendent

The paper titled "**Delhi Metro and Digital India: Driving the Transition to a Cashless Future**" has been published in the **International Journal of Research in Finance and Marketing (IJRFM)**. Authored by Ritesh Gupta, Meghendra Singh, and Yogesh Chandra Tiwari, the paper explores the pivotal role of Delhi Metro in driving the transition to a cashless future within urban transit systems.

The move to cashless transactions in Mass Rapid Transit Systems (MRTS) is a key element of the global shift towards digital economies. This paper highlights Delhi Metro's leadership in adopting innovative digital payment methods, in line with the objectives of the Digital India initiative. The Metro has integrated several advanced technologies, including smart cards, mobile payments, QR codes, and contactless systems. These innovations not only enhance commuter convenience but also help reduce operational costs and improve the overall travel experience.

The study examines the technological, policy, and operational factors that have contributed to Delhi Metro's success in this transition. It also delves into the broader impacts of these advancements on urban mobility, financial inclusion, and sustainability. Furthermore, the paper addresses the challenges of seamless digital integration and explores the potential for further expansion of cashless payment systems across the network.

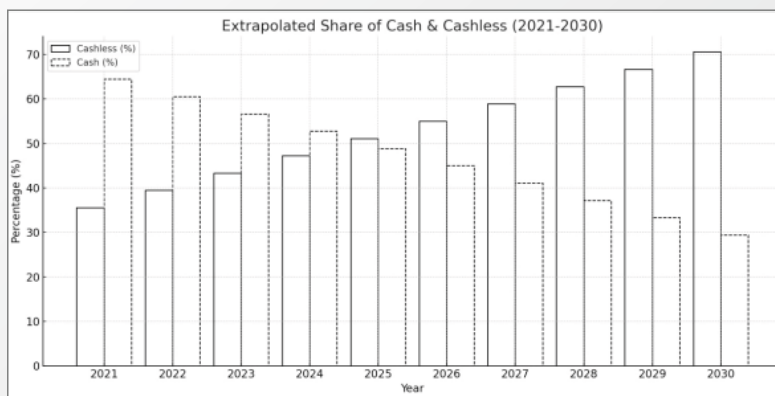
The shift from cash to cashless transactions reflects the broader global adoption of digital payment methods, driven by technological advancements, changing consumer preferences, and the growing demand for convenience, security, and efficiency in financial transactions. A table in the paper illustrates the year-on-year progress in the adoption of these payment methods.

The accompanying graph vividly demonstrates the growing trend of digital adoption, highlighting the rising preference for cashless payment methods. The decline in cash transactions, coupled with the steady increase in cashless transactions, underscores a significant shift in consumer behaviour and signals the broader transformation of financial ecosystems.

Delhi Metro's adoption of digital payment technologies reflects its commitment to the Digital India vision, promoting inclusivity, efficiency, and digital empowerment. Innovations such as smart cards, QR payments, UPI, and the National Common Mobility Card (NCMC) have set a benchmark for modern urban transit, enhancing convenience and supporting a cashless economy. Despite challenges like digital literacy gaps and cybersecurity risks, Delhi Metro's infrastructure upgrades and initiatives to encourage digital adoption showcase the transformative potential of cashless systems. Its success serves as a scalable model for other urban transit networks, emphasizing technology's role in fostering a digitally inclusive future.

To access the complete paper online, please follow these steps:

1. Visit <http://euroasiapub.org>
2. Go to the **Journals** section.
3. Select the **Current Issue** of the "*International Journal of Research in Finance and Marketing*".
4. Navigate to **Volume 14, Issue 12, December 2024**.





डी एम आर सी अकादमी

A step towards Indigenization of Train Driving Simulators: The Make in India Initiative



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In a country where rapid urbanization and technological advancements are shaping the future, the Delhi Metro Rail Corporation (DMRC) has taken a bold step towards self-reliance by launching the first prototype of an indigenous train-driving simulator. This initiative is not just a milestone in India's metro rail operations but also a significant contribution to the Make in India campaign, aiming to indigenize critical technologies and reduce dependence on foreign suppliers.

The Role of Simulators in Metro Operations

Driving simulators play a critical role in metro rail operations. They offer a range of benefits that enhance safety, efficiency of trainers and effectiveness of training. They offer a safe, controlled, and cost-effective environment to train drivers on a wide range of scenarios, including emergencies, technical failures and complex track layouts. Unlike the traditional training methods, simulators allow trainees to practice extensively without the risks or expenses associated with live train operations.

Since 2007, DMRC has relied on advanced train-driving simulators supplied by international companies such as M/s CORYS (France) and M/s Hensoldt (Germany). While these systems provided state-of-the-art training capabilities, they also created a long-term dependency on foreign Original Equipment Manufacturers (OEMs) for commissioning, maintenance, and eventual refurbishment of driving simulators.

Breaking the Dependence: The Indigenous Simulator

To address this reliance, DMRC has partnered with Bharat Electronics Limited (BEL), to develop an indigenous rolling stock driver training system (RSDTS) at DMRC Academy. This "Made-in-India" simulator is a breakthrough in metro technology, offering advanced features tailored to India's unique operational needs.

The indigenous simulator stands out for its flexibility. It features a universal core software system capable of adapting to various combinations of rolling stock, signaling systems, and line profiles. By simply modifying input data files and making minor adjustments to the driving desk hardware, the same simulator can be customized for different metro systems. This adaptability makes it a cost-effective and efficient solution for operator training.

Why Indigenization matters?

The benefits of adopting indigenous train-driving simulators are both practical and far-reaching:

- Enhanced local expertise:** By developing and deploying indigenous systems, India is building a pool of skilled engineers, software developers, and metro professionals.
- Cost savings:** Indigenous solutions eliminate import duties, licensing fees, and exchange rate risks, making them more affordable in the long run.
- Tailored to local needs:** These simulators are designed to replicate India's unique track layouts, signaling systems, and weather conditions with greater accuracy than foreign systems.



4. **Improved maintenance:** With local developers readily available on hand, maintenance, troubleshooting, and updates can be carried out quickly and efficiently thereby minimizing downtime.
5. **Boosting the economy:** The initiative supports local industries, generates employment, and promotes innovation in engineering and manufacturing.
6. **Operational independence:** Reduced reliance on foreign OEMs ensures long-term sustainability and aligns with the vision of Atmanirbhar Bharat (Self-Reliant India).



(Observer Work Station)



(Driving Desk)

(Indigenous Simulator being developed at DMRC Academy)

A glimpse into the Future

The indigenous simulator is more than just a technological achievement; it's a symbol of India's growing self-reliance. With this system, DMRC has set a benchmark for other metro operators in the country, showcasing how local expertise can drive innovation and efficiency.

This project also paves the way for India to become a global player in simulator technology. By leveraging its engineering talent and aligning with the government's Make in India initiative, the country can develop advanced systems for domestic use and export.

Conclusion

The journey toward indigenization is not without its challenges, but the rewards far outweigh the effort. DMRC's indigenous train-driving simulator exemplifies the perfect blend of innovation, self-reliance, and economic foresight. While foreign systems may have dominated the past, the future clearly belongs to solutions designed, developed, and built in India.

As DMRC continues to innovate, this initiative serves as an inspiring example for other sectors to follow. It's not just about reducing costs or breaking dependencies—it's about shaping a future where India leads with its expertise and vision.



Implementation of Axle Bearing Temperature Alerting and Monitoring System (ABTAMS) in Delhi Metro



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Monitoring the temperatures of axles in bearing area of train is essential for safe operation of metro trains. An elevated or sudden rise in temperature is an indication of problems of bearing that could lead to unsafe operating conditions.

A new innovative approach has been adopted for all trains of line 7 of Delhi Metro that combines the best of all solutions: precision and reliability of sensor systems, and practicality of wayside systems. With the adaptation of this system real time monitoring of all axle temperature of all trains of line 7 is possible automatically.

Previously the readings were taken manually using the temperature gun. But in UTO (Unattended Train Operation) depots, it is time taking process

as to enter in UTO enabled area i.e. on SBLs, staff has to go through the process of taking PTW (Permit to Work) and operation of SPK (Staff Protection Key).

The system is based on wireless temperature sensors interrogated by wayside readers. The sensors are battery-less and are energized by the electromagnetic field of the reader antenna.

This approach eliminates not only the need for costly electrical installations on trains, but also the problem of limited battery life of conventional sensor systems. Unlike infrared systems, it's unaffected by sunlight, dirt and environmental factors. Further, the add-on mechanical design means that no altering and fragilization of train's axle parts are necessary.

Components used for Axle Bearing Temperature Alerting and Monitoring System (ABTAMS):

Temperature Sensor:

Temperature measurement sensors are mounted on the surface of axle covers near the bearing area without interference of the existing TCMS (Train Control and Management System) configuration and architecture. Temperature Sensors are fitted on each axle of the train in both sides (Driving as well as Non-driving). These sensors are passive, that means, they do not contain any battery and are energized by the electromagnetic field of the antenna of way side reader. Once energized, the sensors perform a temperature measurement and send the

temperature value with a unique sensor identification number to the wayside reader. There are 24 axles in one train of line 7. So total 48 temperature sensors are fitted in 1 train (24 numbers in one side).

It is an independent and non-interfering with existing system of TCMS. No power and data is required from existing wiring of the train. The sensor are mounted by using the existing axle cover fasteners, hence it is a customized solution for retro fit.

Reader Antenna:

Reader Antenna is installed on selected location on track side. There are 3 locations of reader antenna in line 7 as well as in line 8. These locations in line 7 are:

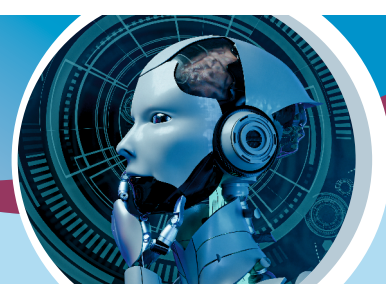
- ESI (E)
- BHIKAJI CAMA (E)
- IP extension (E)

Locations in line 8 are:

- JASOLA VIHAR (E)
- CHIRAG DELHI(UG)
- SADAR BAZAR (E)

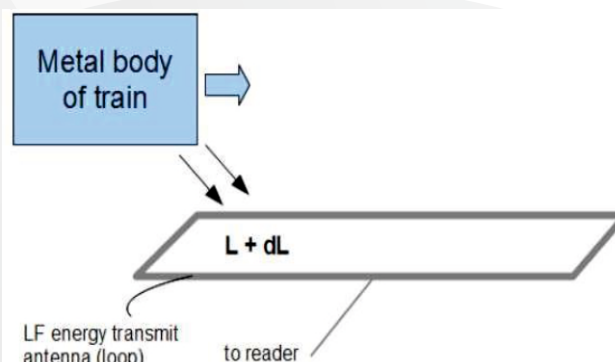
There are two set of reader antenna at each location for driving side and non-driving side sensor of each axle.



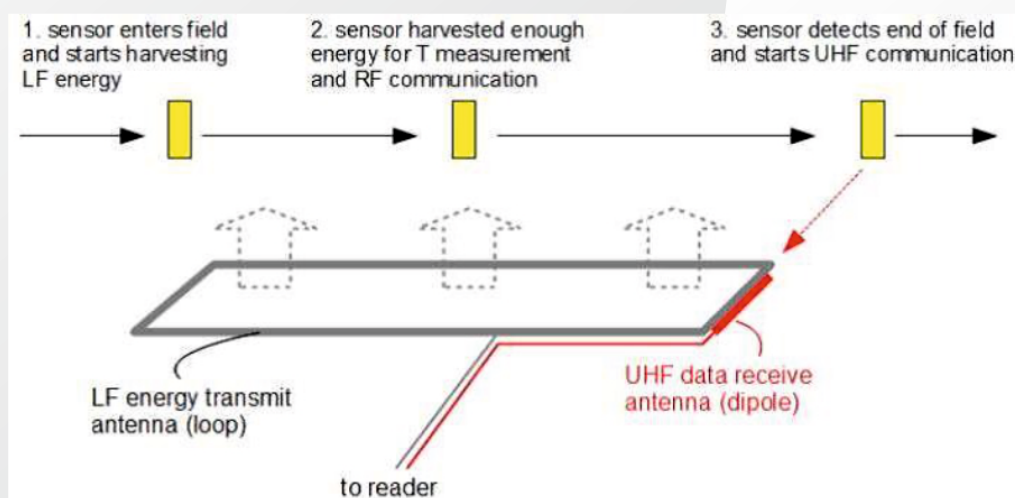


The antenna works on dual frequency scheme. It has low frequency link which is radiated by a magnetic loop antenna and energises the sensor located on the top of the loop antenna. The operating frequency is 133 KHz.

The antenna does not have a UHF(Ultra High Frequency) transmitter, only a passive UHF receiver. The operating frequency is in the band of 865-867MHz. Train detection is achieved by the same low frequency (LF) loop antenna that energizes the sensors. Normally, the LF antenna is in idle mode and its inductance is monitored by the reader. An approaching train causes an increase in inductance.



Detection of incoming train by monitoring the inductance of the low frequency loop antenna



Antenna Driver Unit (ADU): It contains two units ADU 1 & ADU 2

Antenna Driver Unit (ADU) 1: Detects the train arrival and reads the sensors under the command of the controller. ADU1 is installed in such a way that it sees the train first. Antenna Driver Unit (ADU) 2: reads the sensors on the other side of train once ADU1 has detected the train presence.

ADU works as an interface between reader(controller) and antenna.

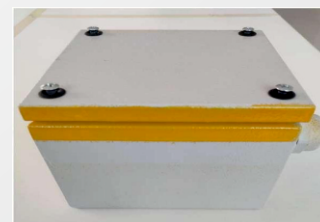
Reader Box / Controller:

The reader is installed at metro station TER (Telecom Equipment Room). There is first Reader for up line and second Reader for down line. The reader interrogates the sensors automatically up to a train Speed of 50kmph. It collects the data sent by sensor through ADU and transmits the raw sensor data to the data base server through DMRC Intranet.

Central Data Base Server:

It is located at depot. The data base server processes data gathered by all wayside readers and generates user information such as data collection, analysis and customised information and warning.

Conclusion: This Remote Axle bearing temperature system will help to diagnose the axle temperature while train is in revenue service and through server, Rolling Stock personnel can not only watch it for every train but also get warning signal if any axle temperature reaches a predefined limit. So it will help us to plan for its investigation in advance and finally it will reduce breakdown maintenance.





Challenges & Solutions of Urban mobility systems integrating Internet of Things (IoT)



Urban mobility systems face several challenges and integrating Internet of Things (IoT) technologies can provide effective solutions. Here are some challenges and potential IoT-based solutions in Micro mobility:

Adapting to Evolving Government Regulations:

Challenge: As population growth and market competition intensify, deploying micromobility fleets becomes increasingly complex. Compliance with varied city and state regulations, covering speed limits, parking standards, and vehicle caps, poses significant challenges. Moreover, many municipalities lack

clear guidelines for these vehicles, leading to uncertainties regarding licensing, insurance, and liability.

Solution: To address these hurdles, companies must monitor vehicle metrics such as speed, route adherence, and parking locations. This can be achieved by integrating IoT-enabled devices like GPS trackers and sensors into vehicles. These solutions enable wireless compliance with city regulations, facilitate locating nearby charging stations for electric scooters, and guide riders to proper parking spots.

Vehicle Tracking and Management:

Challenge: Ensuring real-time tracking such as speed, time taken to reach the destination, which route is being followed, where the vehicle is parked and efficient management of vehicles.

Solution: IoT-enabled GPS trackers and sensors can be installed on vehicles to provide accurate location data. Using these solutions, the vehicle can be wirelessly controlled to abide by city regulations, it helps in finding the nearest charging stations for electric scooters. When it comes to parking, IoT-based devices can notify the rider about the correct parking space and prompt them to park their vehicles in place. This information can be used for management, optimizing vehicle distribution, and monitoring vehicle health.

User Authentication and Security:

Challenge: Ensuring authenticated access to secure and Micro mobility vehicles. Providing secure transportation services is the most widely experienced challenge in Micro mobility. It becomes the responsibility of Micro mobility as a service provider to keep their riders and drivers safe. Furthermore, Micro mobility vehicles are vulnerable to accidents, collisions, and other safety hazards. Riders may also be at risk from other vehicles and pedestrians. Ensuring the safety of Micro mobility users is a key challenge for the transportation service providers.

Solution: Implementing IoT-based authentication systems, such as RFID cards, mobile apps, or biometric sensors, to ensure that only authorized users can access and operate the vehicles. The connected sensors ensure safer navigation for an e-bike and help a rider reach the desired destination quickly and effectively. Additionally, IoT security measures can protect against hacking and unauthorized access.

Battery Management:

Challenge: Managing the battery life of electric Micro mobility vehicles.

Solution: IoT sensors on vehicles can monitor battery levels and send alerts when they are low. Charging stations can be equipped with IoT technology to schedule charging during off-peak hours, optimize energy consumption and provide real time status updates. Lithium-titanate (LTO) battery chemistry was designed to move energy quickly and provide users with lightning-fast charging times. The batteries also offer greater safety against fires and are far more sustainable – up to 20 years. This reinvented tech can provide micro-mobility operators with improved revenues and reduced downtime while providing greater safety to riders. In addition, reducing the swap-and-replace of batteries helps operators significantly reduce the number of battery purchases.

Traffic and Route Optimization:

Challenge: Addressing traffic congestion and optimizing routes for micro mobility vehicles.

Solution: IoT devices can collect data on traffic patterns, road conditions, and usage patterns. This data can be analyzed to optimize routes, improve traffic flow, and enhance the overall efficiency of micro mobility services.



Data Privacy and Compliance:

Challenge: Ensuring compliance with data privacy regulations and protecting user information.

Solution: Implementing robust IoT security measures to safeguard user data and ensuring compliance with privacy regulations. This may include data encryption, secure communication protocols, and transparent data usage policies.

User Experience and Accessibility:

Challenge: Providing a seamless and accessible experience for users.

Solution: IoT can enhance the user experience by offering features such as real-time vehicle availability information, personalized recommendations, and integration with other transportation services through smart city platforms.

Data Sharing with Traffic Authorities:

Challenge: The majority of micro mobility operations take place through a mobile app, security issues and bugs in the software are the usual concerns, especially in electric bikes and scooters. These bugs cause several issues, for example, ending the ride midway, charging extra after the ride ends, not being able to navigate properly through the route.

Solution: To overcome these issues, the micro mobility service providers are now implementing over-the-air (OTA) firmware that remotely updates the code on a digital device. It helps in consistently updating the software and its behavior in order to improve the product and safeguard important data.

Rider Behavior:

Challenge: Here's a simple example to clear up, Mr. 'Q' rides a scooter to his workplace. As a responsible citizen, he is expected to drive consciously, within the speed limit and designated lane. However, Mr. 'Q' is not always in his best form and sometimes rides rashly. This rash riding becomes a problem not only for him but also for the micro mobility firms.

Solution: With IoT at their disposal, companies can keep track of vehicle behavior. In case of any discrepancies, they can send notifications on the app or the connected device to draw riders' attention. Put simply, if a scooter is cutting the lane, or wobbling, the internal IoT sensor detects it and prompts the rider to ride within the lane and lane change penalty has been deducted. This feature is helpful for new riders who tend to be a bit unstable on the roads for the first few times.

Vandalism/Theft Preventing and Reporting:

Challenge: A significant challenge in micro mobility is preventing vandalism and theft due to the public accessibility of vehicles. Riders need education on securing vehicles using locks in well-lit areas. Reporting incidents are also challenging, requiring clear guidance for riders on whom to contact and reporting procedures.

Solution: IoT sensors play a crucial role in preventing micro mobility theft by enabling features like IoT-enabled locks and anti-theft alarms. These sensors detect unusual activity or theft attempts, allowing for the disabling of vehicle movement. Additionally, they facilitate remote tracking, notifying authorities and riders of any potential damage when the vehicle is idle. Power tracking features can activate a kill switch in case of power loss, preventing scooter parts from being stolen. Utilizing IoT apps enhances rider education, providing interactive content and real time feedback on securing micro mobility vehicles effectively.

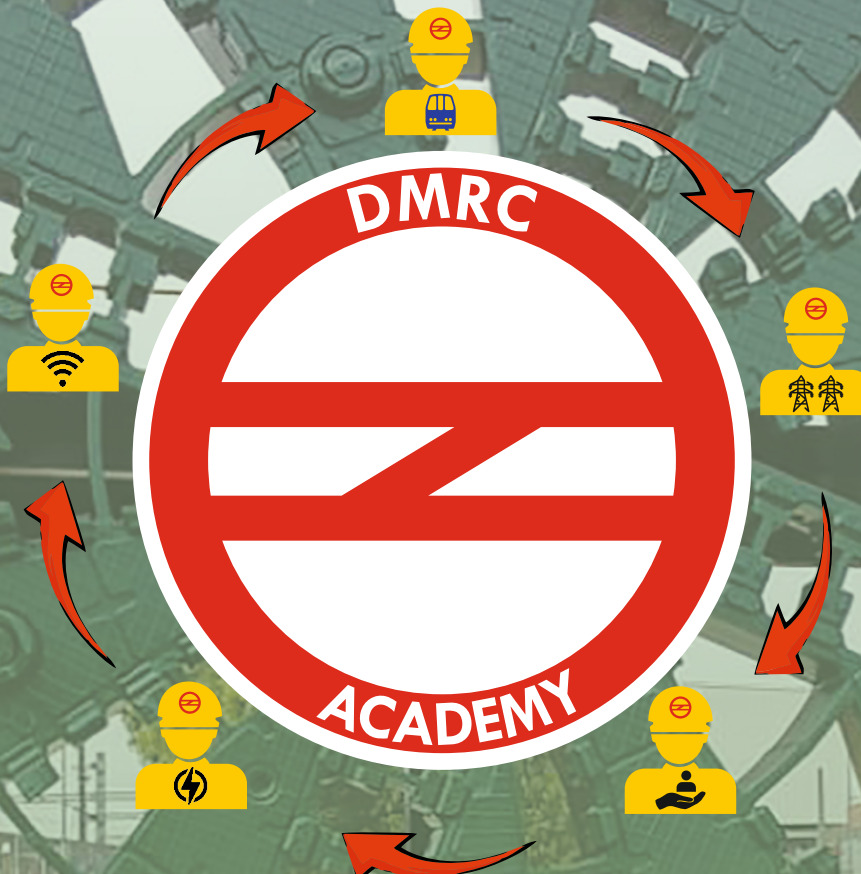
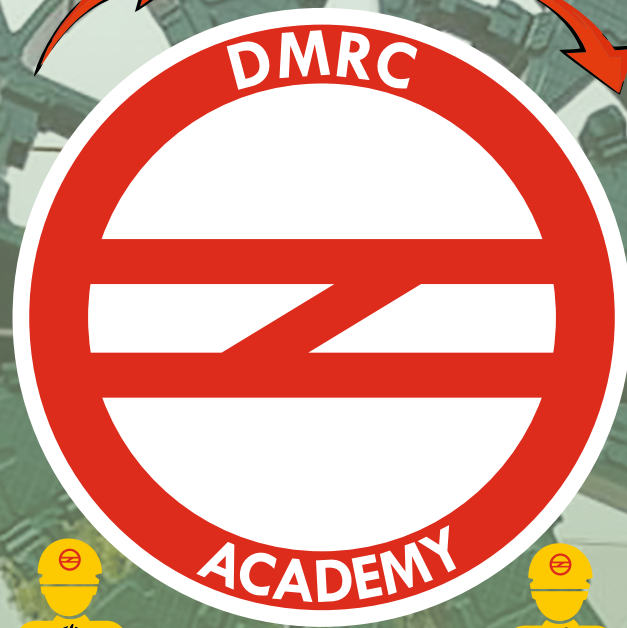
Allocating Extensive Land for Car Parking:

Challenge: Extensive parking space can lead to traffic gridlock, especially during peak hours, as vehicles circulate in search of parking spots. Allocating vast amounts of land for car parking contributes to urban congestion, as more space is dedicated to stationary vehicles instead of efficient mobility solutions.

Solution: Use IoT sensors to implement dynamic pricing for parking spaces. Prices can vary based on demand, encouraging more efficient use of available parking and discouraging unnecessary car usage during peak times. Implement IoT-based smart parking systems that provide real-time information about available parking spaces. This helps reduce the time spent searching for parking and improves overall traffic flow. Cars take up more space on roads and in parking areas compared to smaller micro-mobility vehicles like electric scooters. This size difference contributes to congestion, parking challenges and environmental impacts. Micro-mobility options, being smaller, offer a more space-efficient and sustainable solution, particularly for short-distance travel in urban areas.

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