T.C.
HARRAN ÜNİVERSİTESİ REKTÖRLÜĞÜ
Genel Sekreterlik

Sayı : E-26130895-824.01.01-211958 13.03.2023
Konu : Makale Çağrısı - International Journal of Advanced Virtual Reality

TÜM ÜNİVERSİTELERE

Üniversitemiz Mühendislik Fakültesi Yazılım Mühendisliği Bölümü öğretim üyesi Doç. Dr. Dursun AKASLAN tarafından 2022 yılında kurulan International Journal of Advanced Virtual Reality (e-ISSN: 2980-0897) dergisi Mart ve Eylül aylarında yılda iki defa yayınlanmakta olup, Arıtılmış Gerçeklik, Karma Gerçeklik ve Sanal Gerçeklik alanlarında makale kabul etmektedir. International Journal of Advanced Virtual Reality tarafından yayımlanan Mart sayısının tamamı ekte sunulmuş olan dergimiz ile ilgili ayrıntılı bilgiye http://journals.leukolion.com üzerinden de ulaşılmakta olup, Eylül sayısı için makale çağrımızın Üniversiteniz ilgili birimlerinde duyurulması hususunda;

Bilgilerinizi ve gereğini arz ederim.

Prof. Dr. Mehmet Sabri ÇELİK
Rektör

Ek:Mühendislik Fakültesi Dekanlığının Yazısı (54 sayfa)

Dağıtım:
Afyon Kocatepe Üniversitesi Rektörlüğüne
Battalgazi Mah. ANS Kampüsü Gazlıgöl Yolu
Üzeri 7. Km PK:3200
Merkez/AFYONKARAHİSAR
Ağrı İbrahim Çeçen Üniversitesi Rektörlüğüne
Erzurum Yolu 4. Km PK:04100 Merkez/AGRI
Alanya Alaaddin Keykubat Üniversitesi
Rektörlüğüne
Kestel Mahallesi Üniversite Caddesi No:80
Alanya Antalya/TÜRKİYE
Alanya Hamdullah Emin Paşa Üniversitesi
Rektörlüğüne
Cikcilli Mh. Saraybeleni Cd. No:7 PK:07400
Alanya/ANTALYA

Adres:Harran Üniversitesi Rektörlüğü Osmanbey Yerleşkesi 63300 Haliliye/Şanlıurfa
Telefon:0414 318 3012 Faks:0414 318 3190
Web:http://www.harran.edu.tr/
Kep Adresi:harranuniversitesi@hs01.kep.tr

Bilgi için: Zehra Mehtap BAY
Unvanı: Bilgisayar İşletmeni
Tel No: 0414 318 3000 (2033)

Amasya Üniversitesi Rektörlüğüne
Akbilek Mah. Muhsin Yazıcıoğlu Cad. No:
7 PK:05100 MERKEZ/AMASYA
Anadolu Üniversitesi Rektörlüğüne
Yunus Emre Kampüsü PK:26470
Tepebaşı/ESKIŞEHIR
Ankara Sosyal Bilimler Üniversitesi Rektörlüğüne
Hacı Bayram Mah. Hükümet Meydanı Cad. No:2
Ankara Sosyal Bilimler Üniversitesi Rektörlüğü
PK:06050 Ulus-Altındağ/ANKARA
Ankara Üniversitesi Rektörlüğüne
Dögol Cad. PK:06100 Tandogan-
Çankaya/ANKARA
Ankara Yıldırım Beyazıt Üniversitesi
Rektörlüğüne
Çankiri Cd. Çiçek Sk. No:3 Ulus-
Altindag/ANKARA
Atılım Üniversitesi Rektörlüğüne
Kızılcaşar Mah. İncek PK:06836
Gölbaşı/ANKARA
Avrasya Üniversitesi Rektörlüğüne
Adnan Kahveci Mah. Rize Cad. No:226 PK:61010
Pelitli/TRABZON
Bahçeşehir Üniversitesi Rektörlüğüne
Çırağan Cad. Osmanpaşa Mektebi Sok. No:4-6
Kat:4 Bahçeşehir Üniversitesi Beşiktaş Kampüsü
PK:34353 Beşiktaş-Beşiktaş/İSTANBUL
Balıkesir Üniversitesi Rektörlüğüne
Çagis Yerleskesi (Bigadiç Yolu Üzeri 17. km)
PK:10145 Altieylül/BALIKESIR
Bandırma Onyedi Eylül Üniversitesi Rektörlüğüne
Yeni Mh. Şehit Astsubay Mustafa Soner Varlık
Cd. No:77 Bandırma/BALIKESİR
Bartın Üniversitesi Rektörlüğüne
Agdaci Köyü Yolu 74100 Merkez/BARTIN
Başkent Üniversitesi Rektörlüğüne
Başkent Üniversitesi, Eğitim Fakültesi Bağlıca
Kampüsü Eskisehir Yolu 20. Km PK:06810
Etimesgut/ANKARA
Batman Üniversitesi Rektörlüğüne
Batı Raman Kampüsü Kuyu Başı Yolu 14.Km
PK:72100 Merkez/BATMAN
Bayburt Üniversitesi Rektörlüğüne
Dede Korkut Kampüsü Merkez/BAYBURT
Beykent Üniversitesi Rektörlüğüne
Ayazağa mah. Hadım Koru Yolu cad. No:19
Maslak/Sarıyer/İSTANBUL
Beykoz Üniversitesi Rektörlüğüne
Vatan Cd. No: 69 PK:34805 Kavacik-

Adres:Harran Üniversitesi Rektörlüğü Osmanbey Yerleşkesi 63300 Haliliye/Şanlıurfa
Telefon:0414 318 3012 Faks:0414 318 3190
Web:http://www.harran.edu.tr/
Kep Adresi:harranuniversitesi@hs01.kep.tr

Bilgi için: Zehra Mehtap BAY
Unvanı: Bilgisayar İşletmeni
Tel No: 0414 318 3000 (2033)

Beykoz/ISTANBUL
Bezm-İ Alem Vakıf Üniversitesi Rektörlüğüne
Adnan Menderes Blv. Vatan Cd. PK:34093
Fatih/ISTANBUL
Bilecik Şeyh Edebali Üniversitesi Rektörlüğüne
Gülümbe Mh. PK:11210 Merkez/BILECIK
Bingöl Üniversitesi Rektörlüğüne
Selahaddin-i Eyyubi Mh. Aydinlik Cd. No:1
Merkez/BINGÖL
Biruni Üniversitesi Rektörlüğüne
Kazliçesme Mh. 10. Yil Cd. Protokol Yolu No:45
Topkapi/ISTANBUL
Bitlis Eren Üniversitesi Rektörlüğüne
Rahva Yerleşkesi Beş Minare Mah. Ahmet Eren
Bulvarı 13000 Merkez/Bitlis
Boğaziçi Üniversitesi Rektörlüğüne
Rektörlük Ofisi 34342 Bebek-
Besiktas/ISTANBUL
Bolu Abant İzzet Baysal Üniversitesi
Rektörlüğüne
GÖLKÖY YERLEŞKESİ BOLU.
Yozgat Bozok Üniversitesi Rektörlüğüne
Bozok Üniversitesi Erdoğan Akdağ Kampüsü
Atatürk Yolu 7. Km 66900
Bursa Teknik Üniversitesi Rektörlüğüne
Mimar Sinan Mahallesi Mimar Sinan Bulvarı
Eflak Caddesi No:177 16310 Yıldırım/BURSA
Bursa Uludağ Üniversitesi Rektörlüğüne
Görükle Kampüsü PK:16059 Nilüfer/BURSA
Çağ Üniversitesi Rektörlüğüne
Adana-Mersin Karayolu Üzeri PK:33800 Yenice-
Tarsus/MERSIN
Çanakkale Onsekiz Mart Üniversitesi
Rektörlüğüne
Çanakkale Onsekiz Mart Üniversitesi Terzioglu
Yerleskesi Rektörlük Binası PK:17100
Merkez/ÇANAKKALE
Çankaya Üniversitesi Rektörlüğüne
Yukariyurtçu Mh. Mimar Sinan Cd. No:4
(Eskisehir Yolu 29. Km) PK:06790
Etimesgut/ANKARA
Çankırı Karatekin Üniversitesi Rektörlüğüne
Uluyazi Kampüsü Rektörlük Binasi
Merkez/ÇANKIRI
Fırat Üniversitesi Rektörlüğüne
Fırat Üniversitesi Rektörlüğü Elazığ
Galatasaray Üniversitesi Rektörlüğüne
Çiragan Cd. No:36 PK:34349 Ortaköy-
Besiktas/ISTANBUL

Adres:Harran Üniversitesi Rektörlüğü Osmanbey Yerleşkesi 63300 Haliliye/Şanlıurfa
Telefon:0414 318 3012 Faks:0414 318 3190
Web:http://www.harran.edu.tr/
Kep Adresi:harranuniversitesi@hs01.kep.tr

Bilgi için: Zehra Mehtap BAY
Unvanı: Bilgisayar İşletmeni
Tel No: 0414 318 3000 (2033)

Gazi Üniversitesi Rektörlüğüne
Emniyet Mh. Bogaziçi Sk. PK:06500 Besevler-
Yenimahalle/ANKARA
Gaziantep Üniversitesi Rektörlüğüne
Üniversite Blv. Kilis Yolu Üzeri PK:27310
Sehitkamil/GAZIANTEP
Gebze Teknik Üniversitesi Rektörlüğüne
Cumhuriyet Mah. 2254 Sok. No:2 (P.K. 141)
Gebze 41400-KOCAELİ
Giresun Üniversitesi Rektörlüğüne
Gaziler Mahallesi Prof.Dr. Ahmet Taner Kışlalı
Caddesi No :48 İç kapı No:1 Merkez GİRESUN
Gümüşhane Üniversitesi Rektörlüğüne
Baglarbasi Mh. PK:29100
Merkez/GÜMÜSHANE
Hacettepe Üniversitesi Rektörlüğüne
Hacettepe Üniversitesi Rektörlüğü
Hakkari Üniversitesi Rektörlüğüne
Merzan Mah. Küçük Sanayi Sitesi Arkası 433
Sok. No:51 Merkez/HAKKARI
Haliç Üniversitesi Rektörlüğüne
Örnektepe, İmrahor Cd. No: 81, 34445, 34445
Beyoğlu/İstanbul
Hasan Kalyoncu Üniversitesi Rektörlüğüne
Havaalani Yolu Üzeri 8. Km
Sahinbey/GAZIANTEP
Hatay Mustafa Kemal Üniversitesi Rektörlüğüne
Tayfur Sökmen Kampüsü PK:31060
Hitit Üniversitesi Rektörlüğüne
Kuzey Kampüsü Çevre Yolu Blv. PK:19030
Merkez/ÇORUM
Iğdır Üniversitesi Rektörlüğüne
Iğdır Üniversitesi Rektörlüğü
Şehit Bülent Yurtseven Kampüsü 76000
Iğdır - Türkiye
Işık Üniversitesi Rektörlüğüne
Mesrutiyet Mh. Üniversite Sk. No:2
Sile/ISTANBUL
İbn Haldun Üniversitesi Rektörlüğüne
Başak Mah. Ordu Cad. No:3 P.K. 34480
İhsan Doğramacı Bilkent Üniversitesi
Rektörlüğüne
Üniversiteler Mh. 1609 Sk. No:10 06800 Bilkent-
Çankaya/ANKARA
İnönü Üniversitesi Rektörlüğüne
Merkez Kampüsü Battalgazi/MALATYA
İskenderun Teknik Üniversitesi Rektörlüğüne
İskenderun Teknik Üniversitesi (İSTE)
Rektörlüğü Merkez Kampüs, 31200, İskenderun,

Adres:Harran Üniversitesi Rektörlüğü Osmanbey Yerleşkesi 63300 Haliliye/Şanlıurfa
Telefon:0414 318 3012 Faks:0414 318 3190
Web:http://www.harran.edu.tr/
Kep Adresi:harranuniversitesi@hs01.kep.tr

Bilgi için: Zehra Mehtap BAY
Unvanı: Bilgisayar İşletmeni
Tel No: 0414 318 3000 (2033)

Hatay, Türkiye
İstanbul 29 Mayıs Üniversitesi Rektörlüğüne
Elmalıkent Mah. Elmalıkent Cad. No:4 34764
Ümraniye / İSTANBUL
İstanbul Arel Üniversitesi Rektörlüğüne
Türkoba Mahallesi Erguvan Sokak No: 26/K
Tepekent- BÜYÜKÇEKMECE/İSTANBUL
İstanbul Aydın Üniversitesi Rektörlüğüne
Besyol Mh. Inönü Cd. No:38 Sefaköy-
Küçükçekmece/ISTANBUL
İstanbul Topkapı Üniversitesi Rektörlüğüne
Ayvansaray Caddesi, No:45, 34087, Balat -
İstanbul
İstanbul Esenyurt Üniversitesi Rektörlüğüne
Dogan Arasli Blv. No:79 Esenyurt/ISTANBUL
İstanbul Gedik Üniversitesi Rektörlüğüne
Cumhuriyet Mh. Ilkbahar Sk. No:1 PK:34876
Yakacik-Kartal/ISTANBUL
İstanbul Kent Üniversitesi Rektörlüğüne
Cihangir Mahallesi Sıraselviler Caddesi No:71
PK:34433
İstanbul Kültür Üniversitesi Rektörlüğüne
E-5 arayolu Üzeri PK:34156
Bakirköy/ISTANBUL
İstanbul Medeniyet Üniversitesi Rektörlüğüne
İstanbul Medeniyet Üniversitesi Rektörlüğü
Kuzey Yerleşkesi Ünalan Mahallesi Ünalan Sokak
D-100 Karayolu Yanyol 34700 Üsküdar/İstanbul
İstanbul Medipol Üniversitesi Rektörlüğüne
Kavacık Mah. Ekinciler Cad. No.19 Kavacık
Kavşağı - 34810
İstanbul Rumeli Üniversitesi Rektörlüğüne
Mehmet Balcı Yerleşkesi: Yeni Mah. Mehmet
Silivrili Cad. No: 38 İstanbul / TÜRKİYE
İstanbul Sabahattin Zaim Üniversitesi
Rektörlüğüne
Halkali Cd. No:2 PK:34303 Halkali-
Küçükçekmece/ISTANBUL
İstanbul Şehir Üniversitesi Rektörlüğüne
Orhantepe Mahallesi, Turgut Özal Bulvarı, No:
21, PK: 64865
İstanbul Teknik Üniversitesi Rektörlüğüne
Ayazaga Kampüsü PK:34469 Maslak-
Sariyer/ISTANBUL
İstanbul Ticaret Üniversitesi Rektörlüğüne
Sütlüce Mahallesi İmrahor Caddesi No: 90 34445
Beyoğlu/İSTANBUL
İstanbul Yeni Yüzyıl Üniversitesi Rektörlüğüne
Yeni Doğan Mahallesi Yılanlı Ayazma Caddesi,

No: 26 P.K. 34010 Cevizlibağ
İstinye Üniversitesi Rektörlüğüne
Ümraniye/ISTANBUL
İzmir Bakırçay Üniversitesi Rektörlüğüne
İzmir Bakırçay Üniversitesi Rektörlüğü Seyrek Kampüsü, Gazi Mustafa Kemal Mah. Kaynaklar Cad. Seyrek/Menemen/İZMİR
İzmir Demokrasi Üniversitesi Rektörlüğüne
Üçkuyular Mahallesi, Gürsel Aksel Bulvarı, No:14 35140
İzmir Ekonomi Üniversitesi Rektörlüğüne
Sakarya Cad. No:156 Balçova/IZMIR
İzmir Katip Çelebi Üniversitesi Rektörlüğüne
Çigli Ana Yerleskesi PK:35620 Çigli/IZMIR
Kadir Has Üniversitesi Rektörlüğüne
Kadir Has Cd. PK:34083 Fatih/ISTANBUL
Kafkas Üniversitesi Rektörlüğüne
Kafkas Üniversitesi Rektörlüğü Şehitler Mah. Turan Çelik Cd. Eski Kombina Yolu Üzeri Merkez/KARS
Kahramanmaraş Sütçü İmam Üniversitesi Rektörlüğüne
Batıçevre Yolu Bulvarı Kayseri Yolu Üzeri Avsar Yerleskesi PK:46100
Onikisubat/KAHRAMANMARAS
Karabük Üniversitesi Rektörlüğüne
Baliklakayasi Mevkii PK:78050
Merkez/KARABÜK
Karadeniz Teknik Üniversitesi Rektörlüğüne
KTÜ Kampüsü PK:61080 Ortahisar/TRABZON
Karamanoğlu Mehmetbey Üniversitesi Rektörlüğüne
Üniversite Mh.Ibrahim Öktem Cd. Yunus Emre Yerleskesi Merkez/KARAMAN
Kastamonu Üniversitesi Rektörlüğüne
Kastamonu Üniversitesi Rektörlüğü, Kuzeykent Kampüsü, Merkez/KASTAMONU
Kırıkkale Üniversitesi Rektörlüğüne
Merkez Yerleske PK:71450
Yahsihan/KIRIKKALE
Kilis 7 Aralık Üniversitesi Rektörlüğüne
Mehmet Sanli Mh. Dogan Güres Pasa Blv. No:134
Merkez/KILIS
Kocaeli Üniversitesi Rektörlüğüne
Umuttepe Yerleskesi PK:41380 Izmit/KOCAELI
Koç Üniversitesi Rektörlüğüne
Rumelifeneri Yolu PK:34450 Sariyer/ISTANBUL
Konya Gıda ve Tarım Üniversitesi Rektörlüğüne
Melikşah Mh. Beysehir Cd. No:9 Meram/KONYA

Adres:Harran Üniversitesi Rektörlüğü Osmanbey Yerleşkesi 63300 Haliliye/Şanlıurfa
Telefon:0414 318 3012 Faks:0414 318 3190
Web:http://www.harran.edu.tr/
Kep Adresi:harranuniversitesi@hs01.kep.tr

Bilgi için: Zehra Mehtap BAY
Unvanı: Bilgisayar İşletmeni
Tel No: 0414 318 3000 (2033)

Kto-Karatay Üniversitesi Rektörlüğüne
Akabe Mh. Alaaddin Kap Cd. No:130 PK:42020
Karatay/KONYA
Kütahya Sağlık Bilimleri Üniversitesi
Rektörlüğüne
Kütahya Sağlık Bilimleri Üniversitesi Evliya
Çelebi Yerleşkesi Tavşanlı Yolu 10. km
KÜTAHYA
Maltepe Üniversitesi Rektörlüğüne
Marmara Eğitim Köyü 34857
Mardin Artuklu Üniversitesi Rektörlüğüne
Rektörlük Yerleşkesi (AKM)Artuklu/MARDİN
Marmara Üniversitesi Rektörlüğüne
Göztepe Yerleskesi PK:34722
Kadiköy/ISTANBUL
Mef Üniversitesi Rektörlüğüne
Huzur Mh. Maslak Ayazaga Cd. No:4
Sariyer/ISTANBUL
Burdur Mehmet Akif Ersoy Üniversitesi
Rektörlüğüne
Istiklal Yerleskesi PK:15030 Merkez/BURDUR
Mersin Üniversitesi Rektörlüğüne
MERSİN ÜNİVERSİTESİ ÇİFTLİKKÖY
KAMPÜSÜ 33343 YENİŞEHİR/MERSİN
Mimar Sinan Güzel Sanatlar Üniversitesi
Rektörlüğüne
Meclis-i Mebusan Cd. No:24
Beyoglu/ISTANBUL
Muğla Sıtkı Koçman Üniversitesi Rektörlüğüne
Kötekli Mh. PK:48000 Mentese/MUGLA
Muş Alparslan Üniversitesi Rektörlüğüne
MUŞ ALPARSLAN ÜNİVERSİTESİ
KÜLLİYESİ 49250/MUŞ
Tekirdağ Namık Kemal Üniversitesi Rektörlüğüne
Namık Kemal Üniversitesi Rektörlüğü
Değirmenaltı
Necmettin Erbakan Üniversitesi Rektörlüğüne
Yaka Mah. Yeni Meram Cad. Kasım Halife Sok.
No:11/1
42090 Meram / KONYA
Nevşehir Hacı Bektaş Veli Üniversitesi
Rektörlüğüne
NEVŞEHİR HACI BEKTAŞ VELİ
ÜNİVERSİTESİ REKTÖRLÜĞÜ
Niğde Ömer Halisdemir Üniversitesi
Rektörlüğüne
Niğde Ömer Halisdemir Üniversitesi Rektörlüğü
Merkez Yerleskesi Bor Yolu Üzeri PK:51240
Merkez/NIGDE

Adres:Harran Üniversitesi Rektörlüğü Osmanbey Yerleşkesi 63300 Haliliye/Şanlıurfa
Telefon:0414 318 3012 Faks:0414 318 3190
Web:http://www.harran.edu.tr/
Kep Adresi:harranuniversitesi@hs01.kep.tr

Bilgi için: Zehra Mehtap BAY
Unvanı: Bilgisayar İşletmeni
Tel No: 0414 318 3000 (2033)

İstanbul Nişantaşı Üniversitesi Rektörlüğüne
MASLAK 1453 NEOTECH CAMPUS Söğütözü
Sokak Maslak 1453 No:20 34398 Sarıyer/İstanbul
Nuh Naci Yazgan Üniversitesi Rektörlüğüne
Kuzey Çevreyolu Erkilet Dere Mh.
Kocasinan/KAYSERI
İstanbul Okan Üniversitesi Rektörlüğüne
Tuzla Kampüsü PK:34959 Tuzla/ISTANBUL
Ondokuz Mayıs Üniversitesi Rektörlüğüne
Kurupelit Kampüsü PK:55139 Atakum/SAMSUN
Ordu Üniversitesi Rektörlüğüne
CUMHURİYET YERLEŞKESİ ORDU
ÜNİVERSİTESİ REKTÖRLÜĞÜ
ALTINORDU / ORDU
Orta Doğu Teknik Üniversitesi Rektörlüğüne
Üniversiteler Mh. Dumlupınar Blv. No:1
PK:06800
Çankaya/ ANKARA
Osmaniye Korkut Ata Üniversitesi Rektörlüğüne
Fakıuşağı Mah. PK:80000
Merkez/OSMANİYE
Özyeğin Üniversitesi Rektörlüğüne
Çekmeköy Kampüsü Nisantepe Mh. Orman Sk.
NO:34-36 PK:34794 Çekmeköy/ISTANBUL
Pamukkale Üniversitesi Rektörlüğüne
Kınıklı Kampüsü / Denizli
Piri Reis Üniversitesi Rektörlüğüne
Postane Mh. Eflatun Sk. No:8, PK:34940
Tuzla/ISTANBUL
Recep Tayyip Erdoğan Üniversitesi Rektörlüğüne
Recep Tayyip Erdogan Üniversitesi Zihni Derin
Yerleşkesi - Fener Mahallesi 53100 Merkez/RİZE
Sabancı Üniversitesi Rektörlüğüne
Orta Mh. Üniversite Cd. No:27 PK:34956
Tuzla/ISTANBUL
Sakarya Üniversitesi Rektörlüğüne
Sakarya Üniversitesi Esentepe Kampüsü
P.K:54187 Serdivan/SAKARYA
Sanko Üniversitesi Rektörlüğüne
Gazi Muhtar Pasa Blv. No:36 PK:27090
Sehitkamil/GAZIANTEP
Selçuk Üniversitesi Rektörlüğüne
Alaeddin Keykubat Yerleşkesi, Akademi Mah.
Yeni İstanbul Cad. No:369 Posta Kodu:42130
Selçuklu-Konya
Siirt Üniversitesi Rektörlüğüne
Kezer Kampüsü SİİRT
Sinop Üniversitesi Rektörlüğüne
Korucuk Köyü Trafo Mh. No:36 PK:57000

Adres:Harran Üniversitesi Rektörlüğü Osmanbey Yerleşkesi 63300 Haliliye/Şanlıurfa
Telefon:0414 318 3012 Faks:0414 318 3190
Web:http://www.harran.edu.tr/
Kep Adresi:harranuniversitesi@hs01.kep.tr

Bilgi için: Zehra Mehtap BAY
Unvanı: Bilgisayar İşletmeni
Tel No: 0414 318 3000 (2033)

Merkez/SINOP
Süleyman Demirel Üniversitesi Rektörlüğüne
Süleyman Demirel Cd. PK:32260 Çünür-
Merkez/ISPARTA
Şırnak Üniversitesi Rektörlüğüne
Yeni Mah. Kuza Mevkii Sanayi Sitesi Karşısı
Mehmet Emin Acar Yerleşkesi Şırnak/Merkez
Ted Üniversitesi Rektörlüğüne
Ziya Gökalp Cd. No:48 Kolej-Çankaya/ANKARA
Tobb Ekonomi ve Teknoloji Üniversitesi
Rektörlüğüne
Sögütözü Cd. No:43 PK:06560
Çankaya/ANKARA
Tokat Gaziosmanpaşa Üniversitesi Rektörlüğüne
Gaziosmanpaşa Üniversitesi Rektörlüğü
Taşlıçiftlik Kampusü 60250
Toros Üniversitesi Rektörlüğüne
Bahçelievler Kampüsü 1857 Sk. No:12 PK:33140
Yenisehir/MERSIN
Trakya Üniversitesi Rektörlüğüne
Balkan Yerleskesi Merkez/EDIRNE
Tobb Ekonomi ve Teknoloji Üniversitesi
Rektörlüğüne
Sögütözü Cd. No:43 PK:06560
Çankaya/ANKARA
Malatya Turgut Özal Üniversitesi Rektörlüğüne
Alacakapı Mahallesi Kırkgöz Caddesi No:70 P.K.
44210 Battalgazi / MALATYA
Türk Hava Kurumu Üniversitesi Rektörlüğüne
Bahçekapi Mh. Okul Sk. No:11
Etimesgut/ANKARA
Türk-Alman Üniversitesi Rektörlüğüne
Sahinkaya Cd. 86 34820 Beykoz/ISTANBUL
Ufuk Üniversitesi Rektörlüğüne
Ufuk Üniversitesi Kızılcaşar Mah.İncek Bulvarı
06836 İncek /Gölbaşı/ANKARA
Uşak Üniversitesi Rektörlüğüne
UŞAK ÜNİVERSİTESİ REKTÖRLÜĞÜ ÖZEL
KALEM MÜDÜRLÜĞÜ BİR EYLÜL KAMPÜS
YERLEŞKESİ MERKEZ / UŞAK
Üsküdar Üniversitesi Rektörlüğüne
Altunizade Mh. Haluk Türksoy Sk. No:14
PK:34662 Üsküdar/ISTANBUL
Van Yüzüncü Yıl Üniversitesi Rektörlüğüne
Zeve Kampüsü 65080 Tuşba / VAN
Yalova Üniversitesi Rektörlüğüne
Merkez Yerleskesi Çinarcik Yolu Üzeri PK:77200
Merkez/YALOVA
Yaşar Üniversitesi Rektörlüğüne

Adres:Harran Üniversitesi Rektörlüğü Osmanbey Yerleşkesi 63300 Haliliye/Şanlıurfa
Telefon:0414 318 3012 Faks:0414 318 3190
Web:http://www.harran.edu.tr/
Kep Adresi:harranuniversitesi@hs01.kep.tr

Bilgi için: Zehra Mehtap BAY
Unvanı: Bilgisayar İşletmeni
Tel No: 0414 318 3000 (2033)

Selçuk Yasar Kampüsü Üniversite Cd. No:37-39
Ağaçlıyol PK: 35100 Bornova/IZMIR
Yeditepe Üniversitesi Rektörlüğüne
26 Agustos Yerlesimi Kayisdagi Cd. Kayisdagi-
Atasehir/ISTANBUL
Yıldız Teknik Üniversitesi Rektörlüğüne
Davutpaşa Mah. Davutpaşa Caddesi 34220
Esenler- İstanbul
Yüksek İhtisas Üniversitesi Rektörlüğüne
Baglum Blv. No:2 Keçiören/ANKARA
Zonguldak Bülent Ecevit Üniversitesi
Rektörlüğüne
Incivez Mh. PK:67100 Merkez/ZONGULDAK
Antalya Bilim Üniversitesi Rektörlüğüne
Çıplaklı Mahallesi Akdeniz Bulvarı No:290 A
Döşemealtı / ANTALYA
Abdullah Gül Üniversitesi Rektörlüğüne
Sümer Kampüsü Barbaros Mh. Erkilet Blv.
Kocasinan/KAYSERI
Acıbadem Mehmet Ali Aydınlar Üniversitesi
Rektörlüğüne
İçerenköy Mah. Kayışdağı Cad. No:32 Kerem
Aydınlar Kampüsü PK:34752
Ataşehir/İSTANBUL
Adana Alparslan Türkeş Bilim ve Teknoloji
Üniversitesi Rektörlüğüne
Balcalı Mahallesi, Çatalan Caddesi No:201/1
01250 Sarıçam/ADANA
Adıyaman Üniversitesi Rektörlüğüne
Altinsehir Mh. Atatürk Blv. No:1
Merkez/ADIYAMAN
Aydın Adnan Menderes Üniversitesi
Rektörlüğüne
Merkez Kampüs Aytepe Mevkii PK:09100
Efeler/AYDIN
Kırşehir Ahi Evran Üniversitesi Rektörlüğüne
Bagbasi Mh. Sahir Kurutluoglu Cd. No:100
PK:40100 Merkez/KIRSEHIR
Akdeniz Üniversitesi Rektörlüğüne
DumlupInar Blv. PK:07070
KonyaaltI/ANTALYA
Aksaray Üniversitesi Rektörlüğüne
Adana Yolu Üzeri E-90 Karayolu 7. Km Merkez
Kampüs PK:68100 Merkez/AKSARAY
Artvin Çoruh Üniversitesi Rektörlüğüne
Seyitler Yerleşkesi Artvin
Antalya Akev Üniversitesi Rektörlüğüne
Kadriye Mah. Celal Bayar Cad. No:5-6
Serik/ANTALYA

Adres:Harran Üniversitesi Rektörlüğü Osmanbey Yerleşkesi 63300 Haliliye/Şanlıurfa
Telefon:0414 318 3012 Faks:0414 318 3190
Web:http://www.harran.edu.tr/
Kep Adresi:harranuniversitesi@hs01.kep.tr

Bilgi için: Zehra Mehtap BAY
Unvanı: Bilgisayar İşletmeni
Tel No: 0414 318 3000 (2033)

Ardahan Üniversitesi Rektörlüğüne
Çamliçatak Mevkii Yenisey Kampüsü PK:75000
Merkez/ARDAHAN
Atatürk Üniversitesi Rektörlüğüne
Atatürk Mh. PK:25240 Yakutiye/ERZURUM
Sivas Cumhuriyet Üniversitesi Rektörlüğüne
Yenişehir Mahallesi Kayseri Caddesi Sivas
Cumhuriyet Üniversitesi Rektörlüğü
Merkez/SİVAS
İstanbul Gelişim Üniversitesi Rektörlüğüne
Cihangir Mh. Sht. Jand. Komado Er Hakan Öner
Sk. No:1 Avcilar/ISTANBUL
Manisa Celal Bayar Üniversitesi Rektörlüğüne
Şehit Prof.Dr.İlhan Varank Yerleşkesi Kampüsü
PK:45140 Yunusemre/MANISA
Munzur Üniversitesi Rektörlüğüne
Aktuluk Mh. Üniversite Yerleskesi
Merkez/TUNCELI
Sabancı Üniversitesi Rektörlüğüne
Orta Mh. Üniversite Cd. No:27 PK:34956
Tuzla/ISTANBUL
İzmir Tınaztepe Üniversitesi Rektörlüğüne
Doğuş Cad. 3/19 Sk. No:6 Begos, Tınaztepe/İzmir

Adres:Harran Üniversitesi Rektörlüğü Osmanbey Yerleşkesi 63300 Haliliye/Şanlıurfa
Telefon:0414 318 3012 Faks:0414 318 3190
Web:http://www.harran.edu.tr/
Kep Adresi:harranuniversitesi@hs01.kep.tr

Bilgi için: Zehra Mehtap BAY
Unvanı: Bilgisayar İşletmeni
Tel No: 0414 318 3000 (2033)

Evrak Tarih ve Sayısı: 10.03.2023-211549

T.C.
HARRAN ÜNİVERSİTESİ REKTÖRLÜĞÜ
Mühendislik Fakültesi Dekanlığı

ACELE

Sayı : E-62438271-020-211549
Konu : Makale Çağrısı - International Journal of Advanced Virtual Reality

10.03.2023

REKTÖRLÜK MAKAMINA
(Genel Sekreterlik)

İlgi : 09.03.2023 tarihli ve 211315 sayılı yazı,

Fakültemiz, Yazılım Mühendisliği Bölümü öğretim üyemiz Doç. Dr. Dursun Akaslan tarafından 2022 yılında kurulan **International Journal of Advanced Virtual Reality** (e-ISSN: 2980-0897) dergisinin Eylül ayı sayısı için makale çağrısının tüm Üniversitelerimize bildirilmesine ilişkin Yazılım Mühendisliği Bölüm Başkanlığının ilgi yazısı ekte sunulmuştur.

Bilgilerinizi ve gereğini arz ederim.

Prof. Dr. Hüsamettin BULUT
Dekan V.

Ek:İlgi Yazı

Adres:Mühendislik Fakültesi Mardin Yolu 22 Km Osmanbey Kampüsü Şanlıurfa
Telefon:0414 318 3476 Faks:0414 318 3799
e-Posta:muhendislik@harran.edu.tr Web:http://web.harran.edu.tr/muhendis/
Kep Adresi:harranuniversitesi@hs01.kep.tr

Bilgi için: Mehmet Yaşar DURU
Unvanı: Teknisyen
Tel No: 1098

Evrak Tarih ve Sayısı: 09.03.2023-211315

T.C.
HARRAN ÜNİVERSİTESİ REKTÖRLÜĞÜ
Mühendislik Fakültesi Dekanlığı
Yazılım Mühendisliği Bölüm Başkanlığı

ACELE

Sayı : E-62438271-020-211315
Konu : Makale Çağrısı - International Journal of Advanced Virtual Reality

09.03.2023

MÜHENDİSLİK FAKÜLTESİ DEKANLIĞINA

Harran Üniversitesi Mühendislik Fakültesi Yazılım Mühendisliği Bölümü öğretim üyemiz Doç. Dr. Dursun Akaslan tarafından 2022 yılında kurulan I**nternational Journal of Advanced Virtual Reality** (e-ISSN: 2980-0897) dergisi Mart ve Eylül aylarında olmak üzere yılda iki defa yayınlanmakta olup Arıtılmış Gerçeklik, Karma Gerçeklik ve Sanal Gerçeklik alanlarında makale kabul etmektedir.

Uluslararası hakemli bir dergi olarak dünyanın dört bir yanındaki üniversitelerden, araştırma enstitülerinden, endüstrilerden ve kuruluşlardan önde gelen endüstriyel araştırmacıların, bilim adamlarının, mühendislerin, uygulayıcıların ve öğrencilerin en son araştırma fikirlerini, yöntemlerini, bulgularını paylaşabilecekleri ve deneyimlerini paylaşabilecekleri bir zemin sağlamayı amaçlamaktadır.

International Journal of Advanced Virtual Reality dergisi ücretsiz ve açık erişimli bir dergi olup yayımlamakta olduğu makaleleri "Creative Commons Attribution 4.0 International" altında lisanslamakta olup makale işleme ücreti gibi herhangi bir ad altında herhangi bir ücret talep etmemekte ve yayımlanan her makaleye DOI ataması ücretsiz olarak yapılmaktadır.

Dergiye gönderilen makaleler çift-taraflı kör hakemlik sistemi kullanılarak en az iki kişi olmak üzere uluslararası hakemler tarafından değerlendirilmekte olup her makale için birinci turta hakemlerimize 14 gün ve diğer turlar için 7 gün süre verilmektedir.

International Journal of Advanced Virtual Reality tarafından yayımlanan Mart sayısının tamamı ekte sunulmuş olan dergimiz ile ilgili ayrıntılı bilgi **http://journals.leukolion.com** üzerinden de verilmekte olup Eylül sayısı için makale çağrımızın tüm üniversitelerimize bildirilmesi hususunda;

Gereğini arz ederim.

Doç. Dr. Dursun AKASLAN
Bölüm Başkanı

Ek:Mart Sayısı

Bu belge, güvenli elektronik imza ile imzalanmıştır.

Belge Doğrulama Kodu :*BSCKVLN77U* Pin Kodu :40282

Belge Takip Adresi : https://ebys.harran.edu.tr/envision/Validate_Doc.aspx?eD=BSCKVLN77U&eS=211315

Adres:Harran Üniveristesi Mühendislik Fakültesi Yazılım Mühendisliği Bölümü Osmanbey Kampüsü
63000 Şanlıurfa
Telefon:0414 318 3476 Faks:0414 318 3799
e-Posta:muhendislik@harran.edu.tr Web:http://web.harran.edu.tr/muhendis/
Kep Adresi:harranuniversitesi@hs01.kep.tr

Bilgi için: Dursun AKASLAN
Unvanı: Bölüm Başkanı
Tel No: 1378

Adres:Harran Üniveristesi Mühendislik Fakültesi Yazılım Mühendisliği Bölümü Osmanbey Kampüsü 63000 Şanlıurfa
Telefon:0414 318 3476 Faks:0414 318 3799
e-Posta:muhendislik@harran.edu.tr Web:http://web.harran.edu.tr/muhendis/
Kep Adresi:harranuniversitesi@hs01.kep.tr

Bilgi için: Dursun AKASLAN
Unvanı: Bölüm Başkanı
Tel No: 1378

Volume	Issue	Month	Year
01	01	March	2023

International Journal of Advanced Virtual Realit

Sponsored by

Leukolion Informatics

e-ISSN	Founded	Period	Publisher
2980-0897	2022	Biannually	Dursun Akaslan

Contents

Publisher

Doç. Dr. Dursun Akaslan
Harran Üniversitesi, Mühendislik Fakültesi, Yazılım Mühendisliği Bölümü
Osmanbey Yerleşkesi, Haliliye, Şanlıurfa, Türkiye
info@leukolion.com
http://www.leukolion.com
ORCID: 0000-0003-3432-8154

International Journal of Advanced Virtual Reality is an international refereed journal that publishes articles in the field of Augmented Reality, Mixed Reality and Virtual Reality.

International Journal of Advanced Virtual Reality aims to provide a ground where leading industrial researchers, scientists, engineers, practitioners and students from universities, research institutes, industries and organizations all around the world can exchange their latest research ideas, methods, findings and share their experiences.

International Journal of Advanced Virtual Reality publishes two issues in March and September between the first and last days of each mentioned month.

International Journal of Advanced Virtual Reality is free, open access and does not charge any fees under any name such as Article Processing Fees.

International Journal of Advanced Virtual Reality uses a double-sided blind review system. The referee list is published on the web page of the journal at the beginning of each issue.

International Journal of Advanced Virtual Reality or its published articles are indexed, abstracted, hosted or scanned by the following databases, search engines or hostings:

Google Scholar	OpenAIRE	Zenodo

Reviewers

Name	Organization	Country
Ishteyaaq Ahmad	Uttaranchal University Dehradun	India
Shalini Attri	BPS Women University	India
Hamid Mohammad Azimi	Central University of Tehran	Iran
A. S. N. Chakravarthy	JNTUK-University College of Engineering Vizianagaram	India
Binod Deka	Krishna Kanta Handiqui State Open University	India
Deepika Kohli	College of Technology and Engineering, MPUAT	India
Kezia Herman Mkwizu	The Open University of Tanzania	Tanzania
Jeetendra Pande	Uttarakhand Open University	India
S. K. Pulist	Indira Gandhi National Open University	India
Mani Das Runu	University of Hyderabad	India
Mehmet Hadi Suzer	Harran University	Türkiye
Shantanu Trivedi	University of Petroleum and Energy Studies	India

Authors

Name	Organization	Country
Dursun Akaslan	Harran University	Türkiye
Mehmet Emin Dolaş	Harran University	Türkiye
J. V. Madhusudan	University of Hyderabad	India
Kezia Herman Mkwizu	The Open University of Tanzania,	Tanzania
Shantanu Trivedi	University of Petroleum and Energy Studies	India
Mani Das Runu	University of Hyderabad	India
Mehmet Hadi Suzer	Harran University	Türkiye
Saurav Negi	Modern College of Business and Science	Oman
Mustafa Ulukavak	Harran University	Türkiye

Articles

The Metaverse in Supply Chain Management: Application and Benefits

(Literature Review Article)
36-43

Shantanu Trivedi
University of Petroleum and Energy Studies
India

Saurav Negi
Modern College of Business and Science
Oman

International Journal of Advanced Virtual Reality

Volume: 1, Issue: 1, Page: 1-7, Year: 2023
http://www.journals.leukolion.com

Mixed Reality and Resilience in Tourism

Kezia Herman Mkwizu[1]

[1] *The Open University of Tanzania, Tanzania, kmkwizu@hotmail.com, ORCID: 0000-0003-4436-9603*

Article History:
Received: 08 Feb 2022
Revised: 17 Feb 2022
Accepted: 26 Feb 2022
Online: 15 Feb 2023

Keywords:
Mixed Reality
Resilience
Tourism
Tanzania

Abstract
The orientation towards a resilient future for the tourism sector is paramount particularly due to the effects of the Coronavirus disease 2019 (COVID-19) global pandemic which include travel restrictions, social distancing and lockdowns. Existing technologies such as mixed reality allows individuals to see and experience the vicinity around them by blending the physical and virtual worlds but there is limited literature on mixed reality and resilience in tourism. Hence, to extend the scope of the study, this paper's main objective is to explore mixed reality and resilience in tourism and specifically to explore the relationship between the use of mixed reality and resilient future in tourism within the context of Tanzania. The adopted methodology is the literature review method using integrated literature review approach to gather relevant information to address the objective of this paper. Content analysis supplemented the literature review method. The key findings revealed that the use of mixed reality is minimal in relation to resilient future in tourism thus adding literature in the phenomenon of resilience in tourism. Hence, the conclusion is that the usage of mixed reality can enhance a resilient future towards revamping Tanzania's tourism sector. The practical implication is that the tourism practitioners should encourage the use of mixed reality in promotion efforts to ensure a resilient tourism sector.

Contents

How to Cite

Mkwizu, K. H. (2023). Mixed Reality and Resilience in Tourism. *International Journal of Advanced Virtual Reality*, 1(1), 1-7.

1. Introduction

Tourism has been severely affected by the Coronavirus disease 2019 (COVID-19) pandemic with reduced travel and loss of revenue as indicated in various studies and reports such as Mkwizu (2023); Mkwizu and Kimeto (2022); Ntounis et al. (2021); The World Bank (2021). Other scholars (Setthachotsombut and Suaiam, 2020; Lindsay-Smith et al., 2021; Jones and Comfort, 2020; Ntounis et al., 2021; Zhang et al., 2023) have connected resilience with tourism to study how countries are coping with the effects of the pandemic resulting from travel bans, stay home and lock-downs. The lock-down measures also caused shutdown in film and TV productions (Rahman and Arif, 2021).

The effects of COVID-19 pandemic in tourism is a global problem for all countries. Furthermore, in the UK, Ntounis et al. (2021) concentrated on tourism and hospitality resilience to crises and found that there were vulnerabilities for tourism-dependent businesses because of various reasons such as longer lock-down durations and demand seasonality. Sharma et al. (2021) urged inclusive resilience in the tourism industry to include sustainable tourism, climate action and involvement of local communities. In Africa, there are reports and a few articles that have mentioned resilience in tourism.

For example, the African Development Bank (2021) took the initiative to conduct a forum specifically on resilience for the African content. On the other hand, resilience has been defined as the process and outcome of successfully adapting to difficult or challenging life experiences (American Psychological Association, 2020). In connecting the concept of resilience to tourism, other scholars such as Siang et al. (2021) noted resilience in tourism through the use of augmented reality mainly for virtual museum tours, and also highlighted on mixed reality. According to Statista (2021) mixed reality is projected to have a market size of 3.6 billion US dollars worldwide in 2025 compared to 47 million US dollars in 2017.

Mixed reality is important for the survival of the tourism stakeholders due its ability to enhance tourists' experiences in attractions especially during this phase of history where there are still travel restrictions emanating from the COVID-19 variants. Similarly, Fadzli et al. (2020) did state that mixed reality is a technology which supplement real-life with computer-generated data thus enabling users' interactions through natural senses that include augmented reality and virtual reality technologies. Furthermore, Mkwizu (2021b,a) hinted that the use of augmented reality can assist to enhance tourists' experiences including for destinations in Africa with unique tourist attractions like geoparks and national parks.

As mixed reality embraces the virtual world, Mkwizu (2021c) advocated for re-defining the concept of domestic tourism which can be important for the tourism stakeholders to survive by ensuring that tourism is both physical and virtual. However, given the importance of mixed reality and the need for countries to find ways to revamp their tourism sectors in a resilient manner, the purpose of this paper was to explore mixed reality and resilience in tourism guided by the Access, Better, Connect, Dis-intermediate and Educate (ABCDE) approach. Specifically, the research objective is on the relationship between the use of mixed reality and resilient future in tourism within the context of Tanzania. The significance of this paper is that the findings can be useful in guiding destination managers and tourism stakeholders in their post-covid-19 pandemic measures in building a resilient tourism industry.

2. Literature Review

2.1 Resilience in Tourism

Resilience has had several definitions in the past literature. For instance, resilience as a concept has been defined by Windle (2011) as the process involving effective negotiations, adaptations or managing significant sources of stress or trauma. The study by Fullerton et al. (2021) mentioned resilience from the process perspective of resources protecting against negative impact of stress towards positive outcomes.

The term resilience has also been extended in tourism particularly in this period of 2020 and 2021 which had both negative and positive impacts of COVID-19 pandemic. According to the tourism study by Karunarathne et al. (2021), resilience for a destination can focus on social and structural interactions. However, Hudson (2010) defined resilience as the ability of the socio-economic system to cope with disruptions, absorb exogenous and endogenous shocks and adjust organization, form change through continuous creativity and learning.

Equally, Orchiston et al. (2016) defined resilience as the ability of a system to maintain its identity and adapt its essential structure and function in the face of disturbance. Fabry and Zegni (2019) added that linking resilience and tourism is significant due to disturbances. Therefore, in this paper, resilience is referred to as the ability of a tourism destination to cope with disruptions and adjust its tourism activities, products and services in order to enhance tourists' experiences using technologies such as mixed reality.

2.2 Mixed Reality

Mixed Reality (MR) is simply referred to as the possibility of the user to interact with contents (Debandi et al., 2018). The interaction is possible through MR applications that enhance the users experience during cultural tours when the synthetic contents are anchored in positions of real space (Debandi et al., 2018). The concept of MR is also considered as one of the branches of virtual reality (Zakhariv et al., 2020).

Other scholars (Fadzli et al., 2020) have defined MR as a technology that supplement real-life with computer-generated data to enable users to interact through natural senses that include augmented reality and virtual reality technologies. Qui et al. (2020) added that MR is defined as the field of human and computer interactions involving the superposition of virtual reality graphs that makes it possible for the user to interact with the virtual world tangibly. This paper adopts the definition of MR by Fadzli et al. (2020).

2.3 The ABCDE approach

In Permatasari et al. (2020), the Access, Better, Connect, Dis-intermediate and Educate (ABCDE) approach as mentioned by Cantoni (2018) are the five main areas that can be used as Information Communication Technologies (ICTs) roles in promoting sustainable tourism and preservation of cultural heritage. According to Cantoni (2018), access simply means access to information and raise awareness while better is using digital communication such as mobile to enrich the tourists' experiences. Connect is the act of connecting local stakeholders to heritage (Cantoni, 2018) whereas dis-intermediate is about information distribution, communication support and promotional activities Davida and Cantoni (2015).

The educate approach refers to training and education activities to relevant stakeholders through means like digital archives or MOOCs (Cantoni, 2018). Past studies like Miralbell et al. (2014) mentioned that e-learning can increase the interest and motivation of tourism employers and employees in the tourism sector. Further emphasis was made by Villarejo et al. (2014) with findings indicating that the use of augmented reality in cultural heritage studies is useful from a pedagogical and technological perspectives. Additionally, Sharma (2020) contributed literature on pedagogy and self-directed learning using the virtual world. Moreover, other scholars have also contributed knowledge on virtual world by designing and implementing virtual reality applications as well as virtual reality glasses in language learning (Akaslan, 2020; Akaslan et al., 2020). Hence, previous studies such as Iglesias (2014); Kalbaska (2014); Miralbell et al. (2014); Villarejo et al. (2014) complement the educate element of ABCDE approach in educating and training tourism stakeholders.

ICTs have technologies and Fadzli et al. (2020) defined MR as a technology that supplement real-life with computer-generated data to enable users to interact through natural senses that include augmented reality and virtual reality technologies. The ABCDE approach has been stated in tourism studies including the research by Permatasari et al. (2020). Moreover, Permatasari et al. (2020) found that even though mobile apps are used in Indonesia include information on cultural heritage, the inscription and other relevant information on UNESCO World Heritage Sites (WHS) are less mentioned. Therefore, this paper adopts the ABCDE approach to guide in exploring mixed reality and resilience in tourism.

2.4 Mixed reality and resilience in tourism

In general, studies on resilience in tourism exist on a global level and these include Buultjens et al. (2017); Karunarathne et al. (2021); Noorashid and Chin (2021); Sharma et al. (2021); Lai and Cai (2023). For example, in Sri Lanka, Karunarathne et al. (2021) found that defensive measures such as visa extension without any excess payments were applied during the pandemic as a resilient mechanism. Another example is in India, Suneeth et al. (2021) mentioned that resilient tourism policy and practices are mitigation measures in the tourism education system. While Karunarathne et al. (2021); Suneeth et al. (2021) covered tourism resilience in terms of tourism operations and education, other scholars focused on mixed reality. For instance, Ntounis et al. (2021) applied mixed-method approach of quantitative and qualitative to study urban resilience in English towns of the UK with findings indicating that tourism-dependent businesses were vulnerable in the COVID-19 pandemic owing to longer lock-down durations and also uncertainty in the time frames for reopening.

With the projection of high market size for MR indicated by Statista (2021); Debandi et al. (2018) examined MR by focusing on cultural tourism using MR applications. Debandi et al. (2018) found that users of MR during cultural tours can select objects such as buildings and also allow the user to interact with augmented contents displayed in the video or text audio. In the Africa context, the African Development Bank (2021) had a forum on resilience for Africa and the concern was on COVID-19 and beyond particularly to work together by sharing experiences and lessons learned in order to build lasting resilience in the continent. Subsequently, for example in Kenya there were virtual safaris during the COVID-19 to virtual travelers (Africa Renewal, 2020) even Tanzania had virtual tours.

Conversely, in Tanzania the emphasis has been on responsible tourism during the pandemic as indicated in the study by Trade for Development News (2020). Furthermore, Tanzania was not on lock-down however, the effects of the pandemic was felt in fresh graduates that could enter the labor market in the tourism sector (Trade for Development News, 2020). The report by The World Bank (2021) stated that Tanzania's tourism to recovery includes creating a reliable business environment, the establishment of information management systems, accessibility to finance, promoting safety protocols and investment to support nature-based landscape and seascape management. In efforts towards resilience, Tanzania teamed up with other East African states and successfully hosted the first East Africa Regional Tourism Expo (EARTE) aiming to promote resilient tourism for inclusive socio-economic development (East African Community (EAC), 2021).

Additionally, The World Bank (2021) mentioned that the focus of resilience is on destination planning and management, product diversification, inclusion of local value chains, improved business and investment climate and new business models based on partnership and shared value creation. Past studies have concentrated on resilience in terms of climate and economy and this is evident in the paper by Greene (2015); Zhang et al. (2023). However, there are scant studies that connect mixed reality and resilience in tourism in the context of Tanzania. The effects of COVID-19 pandemic on the tourism sector is a huge problem and demand more research on how countries can forge a resilience path. Therefore, this paper extends the literature on resilience in tourism by exploring mixed reality and resilience in tourism in Tanzania.

3. Materials and Methods

This study applied a literature review method and specifically the integrated literature review approach for purposes of gathering relevant information on mixed reality and resilience in tourism.

The literature review approach involves using books, journals, reports and conference papers with relevant information on mixed reality and resilience in tourism. Subsequently, content analysis was adopted to further the analysis of the specific research objective on the relationship between the use of mixed reality and resilient future in tourism within the context of Tanzania. Previous scholars (Cheng et al., 2016; Mkwizu, 2020; Mkwizu and Kimeto, 2022) have also applied the use of integrated literature review approach with content analysis. Additionally, content analysis has been applied in tourism research (Camprubi and Coromina, 2016). Subsequently, Chen et al. (2020) investigated Chinese news coverage on COVID-19 and tourism using content analysis.

The popularity of content analysis in research extend beyond tourism to other fields of study such as organization (Duriau et al., 2007) and nutrition education (Kondracki et al., 2002). Cheng et al. (2016) used a trio methodology approach which included content analysis and integrated review and found that there was under-representation of non-Western tourists in the Western geographical context. Mixing method approaches is a methodology phenomenon used in tourism and other fields such as finance. For instance, Dewasiri et al. (2018) highlighted on mixed-method approaches in research related to finance. Although the study by Dewasiri et al. (2018) focused on finance research, other fields such as tourism can and have applied mixed-method research approach.

4. Findings and Discussion

From the existing literature, the findings revealed that the use of mixed reality is minimum in relation to resilient future in tourism for Tanzania. Majority of the literature focused on resilience measures in terms of "responsible tourism", "destination planning and management", "product diversification", "inclusion of local value chains", "improved business and investment climate", "new business models based on partnership", "shared value creation" and "having EXPOs". There is less on the issue of mixed reality usage in tourism as a measure for resilience in tourism in Tanzania as summarized in Table 1.

The various reports such as The World Bank (2021); African Development Bank (2021); East African Community (EAC) (2021) have highlighted on resilience measures like responsible tourism, destination planning and management, product diversification, inclusion of local value chains and having EXPOs. The forum conducted by African Development Bank (2021) serves to build resilience for the African continent including Tanzania. This implies that there are various options that have been suggested as measures of resilience in tourism for Tanzania.

Table 1. Use of mixed reality and resilient future in tourism

Literature Review	Author(s)	Year
Responsible tourism during the pandemic	Trade for Development News	2020
Destination planning and management Product diversification Inclusion of local value chains Improved business and investment climate New business models based on partnership Shared value creation	World Bank	2021
Having EXPOs	East African Community	2021

However, the findings of this paper reveal that although mixed reality is projected by Statista (2021) to have huge market size worldwide, there is still little mention of mixed reality usage and resilient future in tourism in the context of Tanzania. This can further imply that the use of mixed reality is minimum in relation to resilient future in tourism. Conversely, studies by Siang et al. (2021) mentioned of mixed reality in tourism but this was confined to museums in cultural and heritage sites. Tanzania is endowed with unique tourism attractions and therefore, mixed reality can be used in museums but extend to other attractions such as national parks. Cantoni (2018) added that ICTs role in promoting sustainable tourism and cultural heritage is hinged in Access, Better, Connect, Dis-intermediate and Educate (ABCDE) approach. As countries are looking for ways to enhance tourists' experiences, the ABCDE approach can be handy particularly in the post COVID-19 pandemic as a measure to revive the tourism sector.

ICTs such as mixed reality technologies have the capacity to enhance tourists' experiences as indicated by Cantoni (2018). Hence, the practical implication from this paper's findings is that given the positive projections of mixed reality market size in 2025 and the ability of mixed reality technologies to enhance tourists' experiences, the managers and tourism stakeholders in Tanzania should begin to embrace and invest in mixed reality usage for resilience in tourism. Furthermore, as mixed reality comprises augmented reality and virtual reality, studies such as (Iglesias, 2014; Kalbaska, 2014; Miralbell et al., 2014; Villarejo et al., 2014) emphasized on the need to educate and train employers and employees in the tourism sector. This implies that countries such as Tanzania when investing in the use of mixed reality for a resilient tourism should embark on educating and training the tourism stakeholders on mixed reality.

5. Conclusion

The aim of this paper was to explore mixed reality and resilience in tourism. In addition, the specific objective was to explore the relationship between the use of mixed reality and resilient future in tourism in the context of Tanzania. The key findings revealed that the literature on mixed reality and resilience in tourism in the context of Tanzania is limited.

Furthermore, the use of mixed reality is minimal in relation to resilient future in tourism. Most of the literature concentrated on resilience issues related to "responsible tourism", "destination planning and management", "product diversification", "inclusion of local value chains", "improved business and investment climate", "new business models based on partnership", "shared value creation" and "having EXPOs".

In exploring mixed reality and resilience in tourism in the context of Tanzania, this study contributes literature in the phenomenon of resilience in tourism. Furthermore, the application of mixed reality can enhance a resilient future towards revamping Tanzania's tourism sector. The use of mixed reality can assist to enhance the access, better, connect, dis-intermediate and educate as an ABCDE approach in building a resilient tourism that enhances tourists' experiences.

The implication for practitioners is that it is essential to encourage the use of mixed reality in promotion efforts to ensure a resilient tourism sector. Moreover, this also implies that investment in the use of mixed reality for a resilient future in tourism should go hand in hand with educating and training the tourism stakeholders on mixed reality and its respective technologies. This study was limited to literature review approach and content analysis as methodological approaches in exploring mixed reality and resilience in tourism in the context of Tanzania.

Hence, future studies can explore mixed reality and resilience in tourism using mixed methods of quantitative and qualitative to further understand resilience in tourism in the post COVID-19 pandemic.

Acknowledgments

I wish to sincerely thank my family for their unconditional love and support.

References

Africa Renewal (2020). Tourism in africa: Virtual safaris kick in as countries slowly open to tourists. https://www.un.org/africarenewal/web-features/coronavirus/tourism-africa-virtual-safaris-kick-countries-prepare-reopen-tourists. Accessed: October, 29, 2021.

African Development Bank (2021). Africa resilience forum (afr. https://www.afdb.org/en/events/africa-resilience-forum-arf2021. Accessed: October, 29, 2021.

Akaslan, D. (2020). Designing and implementing a virtual reality application for language learning. In *Proceedings of the 2nd International Conference on Virtual Reality*, page 44, Sanliurfa, Turkey. Harran University.

Akaslan, D., Balak, M. V., and Ernst, F. B. (2020). Designing and implementing virtual reality glasses. In *Proceedings of the 2nd International Conference on Virtual Reality*, page 36, Sanliurfa, Turkey. Harran University.

American Psychological Association (2020). Resilience. https://dictionary.apa.org/resilience. Accessed: February, 25, 2022.

Buultjens, J., Ratnayake, I., and Gnanapala, A. (2017). Sri lankan tourism development and implications for resilience. In Butler, R., editor, *Tourism and resilience*, page 83–95. CABI, Wallingford.

Camprubi, R. and Coromina, L. (2016). Content analysis in tourism research. *Tourism Management Perspectives*, 18:134–140.

Cantoni, L. (2018). Heritage and sustainable tourism. the role and challenge of information and communication technologies. In Gravari-Barbas, M. and Cantoni, L., editors, *Silvia De Ascaniis*, page 68–74. Tourism Management at UNESCO World Heritage Sites.

Chen, H., Huang, X., and Li, Z. (2020). A content analysis of chinese news coverage on covid-19 and tourism. *Current Issues in Tourism*, pages 1–8.

Cheng, M., Edwards, D., Darcy, S., and Redfern, K. (2016). A tri-method approach to a review of adventure tourism literature: Bibliometric analysis, content analysis, and a quantitative systematic literature review. *Journal of Hospitality and Tourism Review*, 42(60):997–1020.

Davida, S. and Cantoni, L. (2015). Co-design of etourism application. In *The case of Ilha de Mozambique*. Enter eTourism Conference 2015.

Debandi, F., Lacoviello, R., Messina, A., Montagnuolo, M., Manuri, F., Sanna, A., and Zappia, D. (2018). Enhancing cultural tourism by a mixed reality application for outdoor navigation and information browsing using immersive devices. *IOP Conference Series: Materials Science and Engineering*, 364.

Dewasiri, N. J., K., W. B. Y., and Azeez, A. A. (2018). Mixed methods in finance research: The rationale and research designs. *International Journal of Qualitative Methods*, 17:1–13.

Duriau, V. J., Reger, R. K., and Pfarrer, M. D. (2007). A content analysis of the content analysis literature in organization studies. *Organizational Research Methods*, 10:5–34.

East African Community (EAC) (2021). 1st eac regional tourism expo. https://www.eac.int/news-and-media/calendar-of-events/event/791-1st-eac-regional-tourism-expo. Accessed: February, 13, 2023.

Fabry, N. and Zegni, S. (2019). Resilience tourist destinations and governance: An analytical framework. https://hal.science/hal-02070497/document. Accessed: February, 13, 2023.

Fadzli, F. E., Ismail, A. W., Talib, R., Alias, R. A., and Ashari, Z. M. (2020). Mr-deco: Mixed reality application for interior planning and designing. *IOP Conference Series: Materials Science and Engineering*, page 979.

Fullerton, D. J., Zhang, L. M., and Kleitman, S. (2021). *An integrative process model of resilience in an academic context: Resilience resources, coping strategies, and positive adaptation*. PLOS ONE.

Greene, S. (2015). *Resilience building in Tanzania: Learning from experiences of institutional strengthening: Review of learning and early contributions to climate resilient development*. International Institute for Environment and Development (IIED).

Hudson, R. (2010). Resilient regions in an uncertain world: wishful thinking or practical reality? *Cambridge Journal of Regions, Economy and Society*, 3(1):11–25.

Iglesias, M. (2014). Digital technologies and foreign language learning in tourism studies. *eLC Research Paper Series*, 8:15–26.

Jones, P. and Comfort, D. (2020). The role of resilience in research and planning in the tourism industry. *Athens Journal of Tourism*, 7(1):1–16.

Kalbaska, N. (2014). National tourism organizations' online training offer. switzerland travel academy case study. *eLC Research Paper Series*, 8:35–44.

Karunarathne, A. C. I. D., Ranasinghe, J. P. R. C., Sammani, U. G. O., and Perera, K. J. T. (2021). Impact of the covid-19 pandemic operations and resilience: Stakeholders' perspective in sri lanka. *Worldwide Hospitality and Tourism Themes*, 13(3):369–382.

Kondracki, N. L., Wellman, N. S., Fada, R. D., and Amundson, D. R. (2002). Content analysis: Review of methods and their applications in nutrition education. *Soc. Nutr. Educ*, 34:224–230.

Lai, Y. and Cai, W. (2023). Enhancing post-covid-19 work resilience in hospitality: A micro-level crisis management framework. *Tourism and Hospitality Research*, 23(1):88–100.

Lindsay-Smith, G., Pyke, J., Nguyen, V., Shaikh, S., Gamage, A., and de Lcay, T. (2021). Building the resilience of tourism destinations to disasters: The 2020 victorian bushfires ad covid-19 pandemic. Technical report, Victoria University, Melbourne, Australia.

Miralbell, O., Cantoni, L., and Kalbaska, N. (2014). The role of e-learning applications within the tourism sector. *eLC Research Paper Series*, 8:04–05.

Mkwizu, K. H. (2020). Digital marketing and tourism: opportunities for africa. *International Hospitality Review*, 34(1):05–12.

Mkwizu, K. H. (2021a). Augmented reality and destinations in africa: An abcde approach. In *The 3rd International Conference on Virtual Reality (VR2021)*, Sanliurfa, Turkey. November.

Mkwizu, K. H. (2021b). Augmented reality and tourism. In *The 3rd International Conference on Virtual Reality (VR2021)*, Sanliurfa, Turkey.

Mkwizu, K. H. (2021c). Re-defining domestic tourism in the 'new normal'. a literature review. In *The 3rd Africa-Asia Dialogue Network (AADN) International Conference on Advances in Business Management and Electronic Commerce Research (AADNIC-ABMECR)*, Ganzhou, Jiangxi, China.

Mkwizu, K. H. (2023). Africa and the belt and road initiative: Opportunities for tourism. In *The 7th Global Research Network Belt and Road Initiative Conference 2023*, Nairobi, Kenya.

Mkwizu, K. H. and Kimeto, J. C. (2022). Challenges and strategies for managing customer services education and tourism in the post-covid-19 pandemic: A comparative study of tanzania and kenya. *EducationETMA*, 1(3):13–26.

Noorashid, N. and Chin, W. L. (2021). Coping with the covid-19: The resilience and transformation of community-based tourism in brunei darussalam. *Sustainability*, 13:8618.

Ntounis, N., Parker, C., Skinner, H., Steadman, C., and Warnaby, G. (2021). Tourism and hospitality industry during the covid-19 pandemic: Evidence from england. *Current Issues in Tourism*, pages 1–14.

Orchiston, C., Prayag, G., and Brown, C. (2016). Organizational resilience in the tourism sector. research notes and reports. *Annals of Tourism Research*, 56:128–163.

Permatasari, P. A., Qohar, A. A., and Rachman, A. F. (2020). From web 1.0 to web 4.0: The digital heritage platforms for unesco's heritage properties in indonesia. *Archaeology Review*, 11(23):75–93.

Qui, T. C. T., Nguyen, T. H. D., Cheok, A. D., Teo, S. L., Xu, K., Zhou, Z., and Le Nam Thang, Y. L. (2020). Magicland: A 3d human capture mixed reality system for museum experiences. *Re-thinking technology in museums: Towards a new understanding of people's experience in museums*, 71.

Rahman, K. T. and Arif, M. Z. U. (2021). Impacts of binge-watching on netflix during the covid-19 pandemic. *South Asian Journal of Marketing*, 2(1):97–112.

Setthachotsombut, N. and Suaiam, G. (2020). The resilience development for the entrepreneurs tourism sector (rdets) from 2019 coronavirus crisis in thailand. https://www.ajhtl.com/uploads/7/1/6/3/7163688/article_52_vol_9_2__2020_thailand.pdf. Accessed: August, 29, 2021.

Sharma, D. D., Thomas, A., and Paul, J. (2021). Reviving tourism industry post covid-19: A resilience-based framework. *Tourism Management Perspective*, 37:100786. Accessed: 29 Oct 2021.

Sharma, R. (2020). Pedagogy and self-directed learning through virtual world. In *Proceedings of the 2nd International Conference on Virtual Reality*, page 15, Sanliurfa, Türkiye.

Siang, T. G., Aziz, K. A., and Ahmad, Z. (2021). Augmented reality: The game changer of travel and tourism industry in 2025. *Augmented Reality in Tourism, Museums and Heritage*, pages 195–210.

Statista (2021). Mixed reality (mr) market size worldwide in 2017, 2018 and 2025. https://www.statista.com/statistics/897595/world-mixed-reality-market-value/. Accessed: October, 29, 2021.

Suneeth, B. G., Kashyap, S., Reddy, G. M., and Kaushal, V. (2021). Resilience adaptations in tourism education for the post-covid-19 era – a study of india. In Gowreesunkar, V. G., Maingi, S. W., Roy, H., and Micera, R., editors, *Tourism Destination Management in a Post-Pandemic Context (Tourism Security-Safety and Post Conflict Destinations)*, pages 291–302. Emerald Publishing Limited, Bingley.

The World Bank (2021). Tanzania economic update: How to transform tourism into a more sustainable, resilient and inclusive sector. https://www.worldbank.org/en/country/tanzania/publication/tanzania-economic-update-how-to-transform-tourism-into-a-more-sustainable-resilient-and-inclusive-sector. Accessed: 28 August 2021.

Trade for Development News (2020). Responsible tourism in tanzania, recommendations for covid-19 recovery. https://trade4devnews.enhancedif.org/en/op-ed/responsible-tourism-tanzania-recommendations-covid-19-recovery. Accessed: 28 Aug 2021.

Villarejo, L., González, F., Miralbell, O., and Gomis, J. M. (2014). Introducing augmented reality in cultural heritage studies. *eLC Research Paper Series*, 8:06–14.

Windle, G. (2011). What is resilience? a review and concept analysis. *Reviews in Clinical Gerontology*, 21(2):152–169.

Zakhariv, P. V., Kataeva, A. S., Kochkin, A. S., Eremin, A. M., and Markidonov, A. V. (2020). Some aspects of using mixed reality technologies in the training of physics teachers. *Journal of Physics: Conference Series*, page 1691.

Zhang, P., Yu, H., Xu, L., Guo, W., and Shen, M. (2023). Synergistic relationship or not? understanding the resilience and efficiency of the tourism economy: Evidence from hainan province, china. *Environment Development and Sustainability*.

International Journal of Advanced Virtual Reality

Volume: 1, Issue: 1, Page: 8-19, Year: 2023
http://www.journals.leukolion.com

Augmented Reality Technology to Display Infrastructure Data in the Field Work

Mehmet Emin Dolaş[1] and Mustafa Ulukavak [2]

[1] *Harran University, Şanlıurfa, Türkiye, mehmetemindolas@gmail.com, ORCID:0000-0001-8619-6320*
[2] *Harran University, Şanlıurfa, Türkiye, mulukavak@harran.edu.tr, ORCID:0000-0003-2092-3075*

Article History:
Received: 10 Feb 2022
Revised: 26 Feb 2022
Accepted: 20 May 2022
Online: 15 Feb 2023

Keywords:
Infrastructure
Data
Augmented Reality
Field Studies
Efficiency

Abstract
Urbanization, which took place in parallel with technological development, has increased rapidly throughout the world. In order to increase the welfare level of the societies living in cities, infrastructure studies have been given importance in the design of cities. It ensures that infrastructure services such as electricity, drinking water, sewerage, natural gas, telecommunications and Internet services are provided for the benefit of people. In order to provide infrastructure services in a sound manner, it is important to keep track of the infrastructure inventory and carry out regular maintenance and repairs, in addition to urban planning. In terms of providing infrastructure services, ensuring that existing infrastructure data is displayed during field studies will increase the efficiency of work. In our study, the visualization of the water and wastewater infrastructure was done in an augmented reality environment. The pilot study conducted in Şanlıurfa, Karaköprü District, Maşuk Region, aimed to increase the efficiency of infrastructure services.

Contents

How to Cite

Dolaş, M. E. and Ulukavak, M. (2023). Augmented Reality Technology to Display Infrastructure Data in the Field Work. *International Journal of Advanced Virtual Reality*, 1(1), 8-19.

1. Introduction

People have contributed to the advancement of technology by passing on the knowledge they have learned and applied to future generations, from the past to the present. With the increase in the development of technology, we are witnessing that our lives are changing at a very fast pace. People can easily access and analyze the data they want in the age of technology. Today, in parallel with the proliferation of mobile phones, wearable technologies, and Internet of Things technologies, an incredible cloud of data has been created. It has become important to be able to use data at the right time and in the right place when we do not have a data problem. Augmented reality technology aims to make our lives easier by presenting the data you need in real time and in the physical world (Azuma et al., 2011). We constantly interact with the world and objects in our social lives. Our interaction with the real world and objects in our lives is enhanced by Augmented Reality technology. AR is a technology that makes it possible for computer-generated sounds and images to be used in the real world (Arth et al., 2015).

This technology gives us an advantage. It shows us images that we cannot see in the physical world under normal conditions. In many fields such as marketing, construction, architecture, museums, medicine, and education, augmented reality technology has been applied. Marketing techniques have been developed by the increase of customer interaction with augmented reality applications in the field of marketing. In the construction industry, the use of augmented reality technology for construction inspection will be a cost and time saving measure (Behzadan and Kamat, 2009). In education, the use of augmented reality has paved the way for a more permanent and fluid educational application (Azuma, 1997).

There have been developments in mobile augmented reality applications as a result of developments in mobile communications technology (Kengne, 2014). The benefits of mobile augmented reality technologies have been enhanced by the development of the network infrastructure in mobile communication devices, the improvement of location sensitivity, and the improvement of the image quality of mobile cameras (Ortman and Swedlund, 2012). It is well known that when augmented reality technology first emerged, mobile communication technology was not as widespread as it is today.

The creation of sustainable and livable cities has become increasingly important as urbanization increases. The quality of life of future generations should be considered when designing cities (Ekin and Çabuk A., 2011). It is important to remember that people's quality of life is directly affected by the design of infrastructure and superstructure projects. Technical infrastructure services, such as drinking water, natural gas, Internet, telecommunications and electricity, are provided to meet people's essential needs (Bayraktar, 2019).

It is well known that these infrastructure services are indispensable to human life. Efforts are being made by relevant institutions and organizations to provide infrastructure services without interruption. It is important to prevent accidents that may occur during excavation work by conducting excavation work in a controlled manner. In our country, infrastructure coordination centers have been established with the "Regulation on Metropolitan Municipalities Coordination Centers" published in the Resmi Gazete on 15.06.2006, in order to discipline and coordinate infrastructure works.

The aim of the Infrastructure Coordination Center is to prevent material and moral damages that may occur during excavation works by issuing licenses for excavation works. Aykome units provide coordination between all companies and related organizations operating in the city. The most important point in providing infrastructure services is to ensure service continuity.

Nowadays, infrastructure services have become indispensable. Accidents occur during excavations. This is especially true because the inventory of underground infrastructure in the excavated area is not clearly known during excavation (Schall et al., 2014). Accidents are a cause of loss of time and money. The existence of an infrastructure inventory by the institutions, organizations or individuals in charge of the excavation can be a preventive measure against possible accidents.

The aim of this study is to present the infrastructure data in a coordinated way with augmented reality technology and to use it in field studies. With the use of augmented reality technology in field studies, it will be possible to have information about the underground works in the field easily.

2. Literature Review

Sherman and Craig (2019) emphasized the effective use of virtual reality as a communication tool. They talked about the necessary components for designing virtual reality applications, why virtual reality technology is needed, and the areas that can be used in the future. As a result of cheaper software development costs in parallel with technological developments, virtual reality technology has been used as a communication tool in many fields.

Keskin Mustafa and Yılmaz (2014) stated that it is important to design and implement the infrastructure information system, which is included in the city information system, by authorized institutions and organizations in order to provide infrastructure services in a healthy way. Researchers studied drinking water and sewerage services from infrastructure services in terms of infrastructure information system. They explained the importance of the infrastructure information system so that local governments can bequeath a healthy infrastructure service to future generations, and so that infrastructure services can be carried out in a planned manner without loss of cost.

In the research on augmented reality, Tekin (2019) has observed that location-based augmented reality applications are relatively less among mobile augmented reality applications. He has worked on displaying infrastructure data in a location-based augmented reality application. In the study, which used water and wastewater pipes in Yıldız Technical University Davutpaşa Campus, geographic data was arranged using Autocad and Netcad and transferred to Mapbox map service (MAPBOX, 2021). Android based application designed with Unity 3D. In the designed application, it was found that the position sensitivity in the display of linear data was not at the desired level. The application designed using open source software is open to development.

By examining the studies on augmented reality, it is believed that augmented reality is still open to development and will be mentioned very often in the future. Bayraktar (2019) stated that the need for technical infrastructure has increased with the increase in urban population, and more importance should be given to technical infrastructure over time. Occupational accidents that occur in technical infrastructure works can cause loss of life, as well as loss of cost and time.

The researcher, who mentioned the accessibility and accuracy of the data in the studies to be conducted, aimed to establish an infrastructure information system in the infrastructure coordination center with the infrastructure data. The researcher emphasized the diversity of companies providing technical infrastructure services and the differences in the data of these companies, as well as the problems in the accuracy of the data, and emphasized that the infrastructure information system should be created with the data of all companies and institutions with high accuracy data. In the study, the technology of geographic information systems was examined and the standards of geographic information systems were mentioned, and the importance of the infrastructure information system for Trabzon Metropolitan Municipality Aykome Directorate was stated.

Uluğ (2020) stated that museums need to renew themselves over time and explained that innovations in museums have emerged in the light of new technological developments. The researcher stated that the promotion and protection of works is the most important issue in museology, and explained the advantages that augmented reality applications can provide at this point. By examining the mobile augmented reality application of Sakıp SABANCI Museum, the researcher made suggestions on what should be considered when designing augmented reality applications in the museum industry.

3. Materials and Methods

In the study, a region located in Seyrantepe neighborhood of Karaköprü district of Şanlıurfa was selected as the study area. An android-based mobile augmented reality application was prepared by using the data of drinking water and sewerage networks in our study area (Fig. 1).

3.1 Platforms Used

We used the Unity platform for our AR application. Unity provides simulation and video game development for computers, consoles and mobile devices. Our application is developed using C# programming language through Unity Platform. Mapbox Unity SDK, developed by Mapbox, helps to use the data stored in Mapbox on the Unity platform via web service.

The World Alignment Kit included in the Mapbox Unity SDK enables augmented reality applications on the Unity Platform. The World Alignment Kit enables the visualization of personalized geospatial data in Mapbox Studio on the Unity Platform via web services and the display of physical geospatial data at world scale. ARCore software provides geolocation and access to spatial information. Since the ARCore software supports Android 7.0 (Level 24) and higher, the minimum Android version is 7.0 (Level 24). The application prepared accordingly can be installed on all devices with Android operating system compatible with ARCore. In our study, the Redmi Note 8 (2017) device manufactured by Xiaomi was used as a test device.

3.2 Preparation of Data

The data of drinking water and wastewater networks in our study area were in .ncz file format. It was used by converting the data to geojson format to be used as a web service with the help of geographic information system platforms. The prepared data was transferred to Mapbox Studio to be published through the Mapbox web service. The data is published as a service through the tile_set_editor via Mapbox Studio.

3.3 Designing the Mobile Application

Unity Software version 2018.3.1 was used in the design process of the mobile AR application. A new project was created in Unity Software and this project was organized as an Android-based mobile application (Fig. 2).

- Scene Panel: Provides a 3D vision of the playground.
- Hierarchy Panel: It is the panel where all objects in the scene are listed.
- Inspector Panel: It is the panel that contains detailed information about the selected objects.
- Project Panel: All resource files that you can use in your game are located here.

To use the geospatial data in the Unity environment, the geospatial data is arranged through Mapbox Studio and published as a tile_set and style so that it can be used in Unity through the web service. Geographic data can also be edited using Mapbox Studio (Fig. 3).

The Unity SDK was designed by Mapbox to make it easy to bring geographic data to the Unity platform and build location-based mobile applications. When the Mapbox Unity SDK is opened in Unity, many sample applications appear. A World Scale AR sample has been prepared by Mapbox for world-scale AR applications. The Mapbox Unity SDK version 2.1.0 was used to build the application for this study.

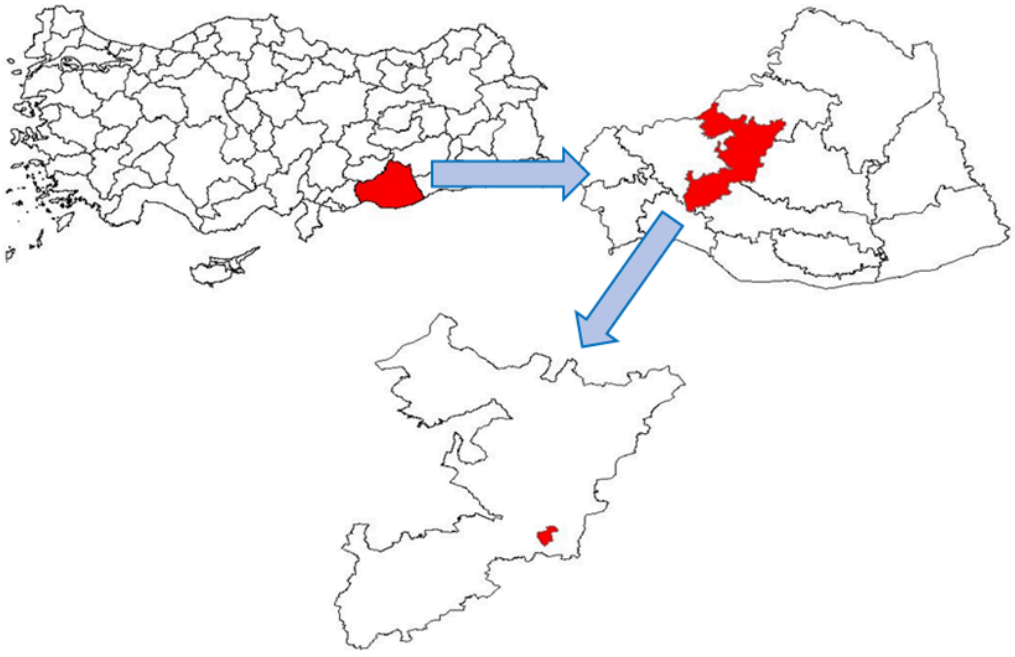

Figure 1. Study Area

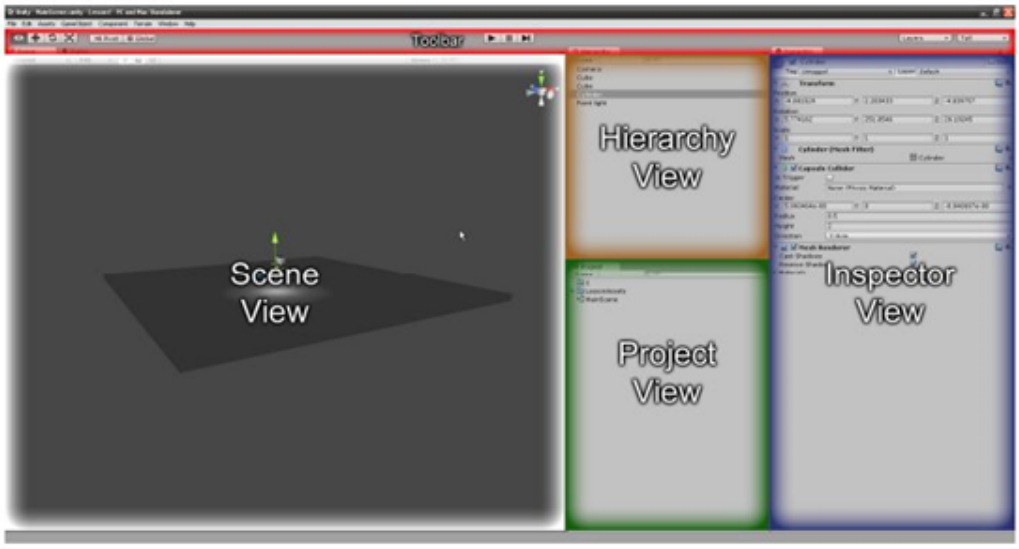

Figure 2. Unity Workbench (MapBox, 2021)

The application design began by importing the Mapbox Unity SDK 2.1.0, created by Mapbox, into the Unity platform. The Mapbox Unity SDK transferred to the Unity environment contributes to the design of location-based games and augmented reality applications (Fig. 4).

In the application created using the Mapbox Unity SDK, there are five game_objects taken from the Mapbox SDK. Using these game_objects, Mapbox created a personalized application that visualizes geographic data and turns it into an AR application. In the Mapbox World_Alignment_Kit;

- **AR_Root:** The Unity interface prefab for building cross-platform AR applications.
- **Map_Camera:** A top-down view of the map, used to display GPS tracks, AR position, and current map orientation. View in play mode with the map checkbox.
- **AR_Aligned_Map:** The map aligned to AR Root using your device's location services. Renders orange debug buildings by default.

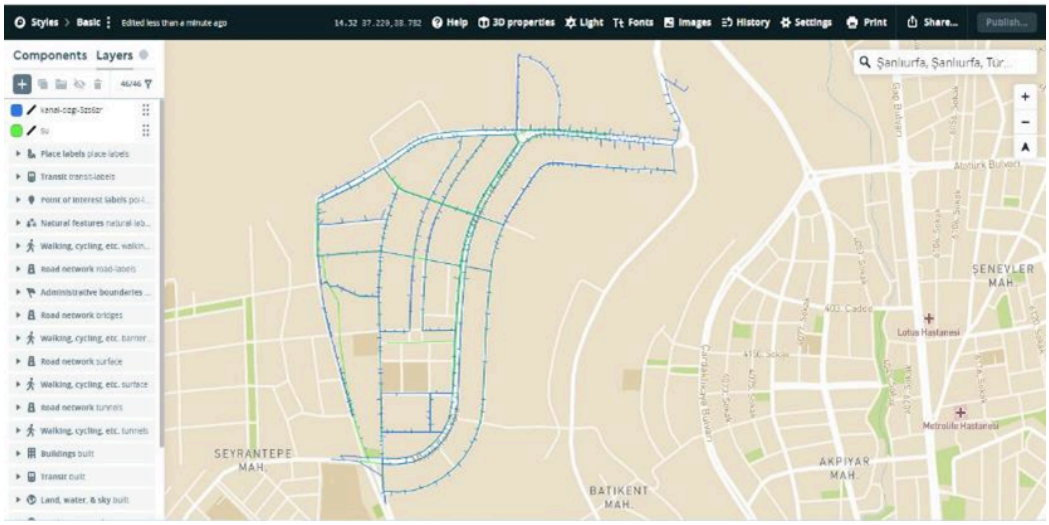

Figure 3. Screenshot of Mapbox Studio

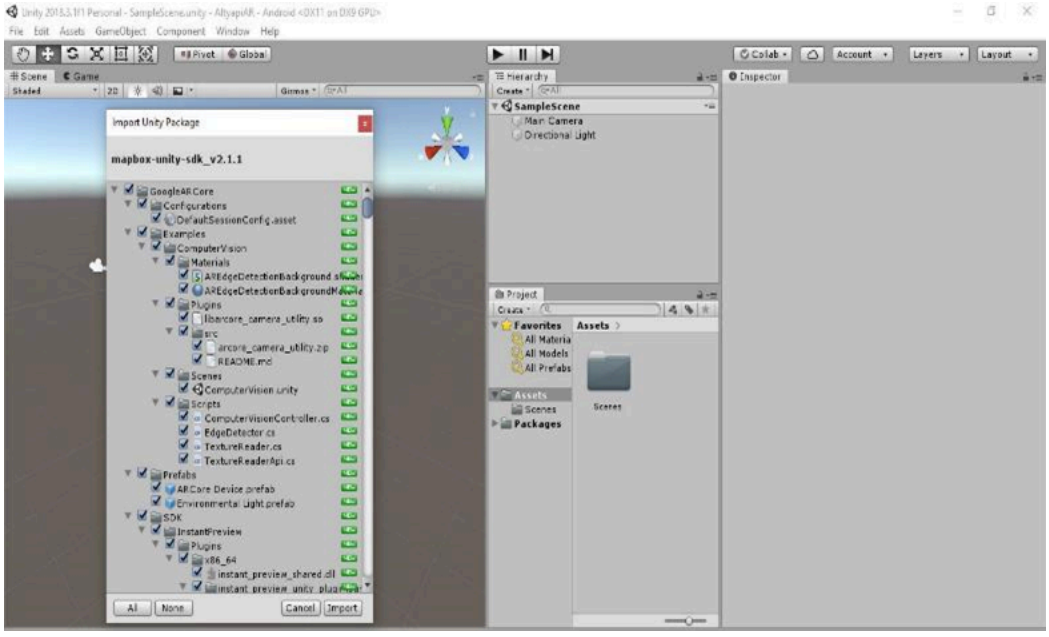

Figure 4. Screenshot of Mapbox Unity SDK

- **Debug_Canvas:** A detailed debug log of location services and AR activity, viewable by pressing the 'LOG' icon in play mode and on devices. This is included as a unified UI element to make location debugging easier.

- **Location Provider:** Provides GPS data to the map and spoofs data for testing in the editor. (UNITY, 2005).

These services provided by Mapbox are free up to a certain usage level, after which a fee is charged. In the application we have built, we have taken care to use free software.

Because the Mapbox Unity SDK is imported into the Unity environment, access token information is requested. Mapbox users will be able to create tokens in their Mapbox accounts for the application they are building, and access statistical information about those tokens (Fig. 5).

When designing applications using Unity software, it is possible to visualize with desired icons by uploading images in .png format to the buttons on the main screen. When designing our application, care was taken to create an understandable design by using images suitable for the buttons on the main screen (Fig. 6).

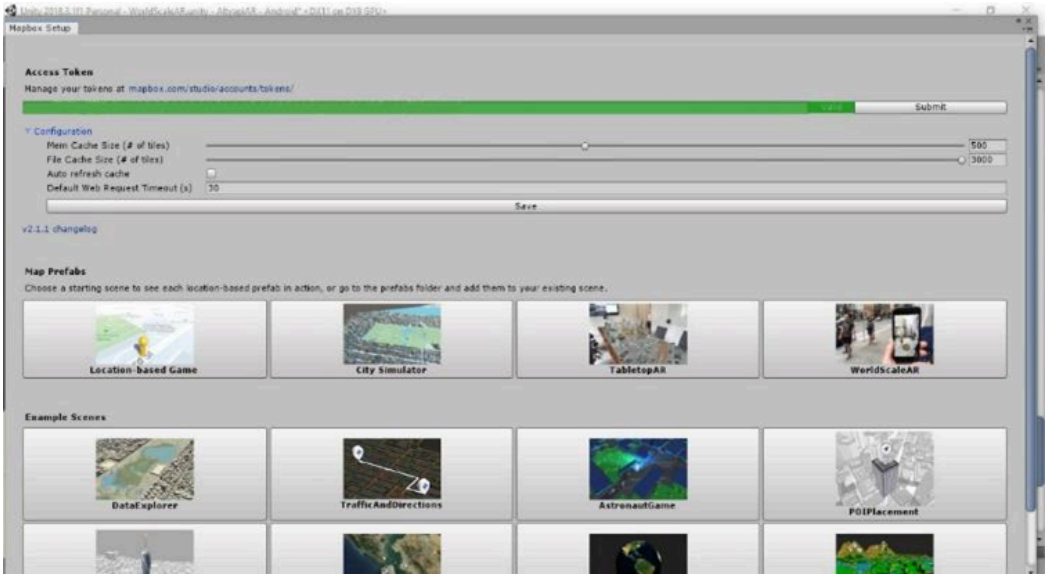

Figure 5. Mapbox Unity SDK

Figure 6. Main Screen Design of AR Application

By using 7 buttons in the home screen design, we enabled operations on the application with the help of these buttons. Buttons we created;

1. The button we have shown as the Settings icon allows manual adjustments of the direction of the data displayed in the augmented reality environment where the position sensitivities are insufficient. When this button is pressed, the direction buttons 7 are opened and manual adjustments are made using the direction buttons.
2. With the help of the button we have shown with the GPS icon, when the user of the application is on the move, it provides the data to be updated again according to the GPS position, in case the updating of the data is insufficient due to the position sensitivity. With the help of this button, the data visible on the ground will be updated and displayed again.
3. Button 3, marked with the LOG icon, is where the GPS records are stored. It allows us to see GPS sensitivities and actual GPS values.
4. Compass helps to determine the direction of the user using the application.
5. The Map button displays a map on the screen with streets and important buildings, as well as our geographical data. This map was created in Mapbox Studio using Mapbox Basemaps.
6. The button we call AR enables the use of the Augmented Reality platform, where the phone's camera is turned on and geographic data is placed on the phone's screen according to your location.
7. These buttons with directional arrows allow you to make the manual adjustments mentioned in button 1.

It is possible to customize the appearance of geographic data in the application on the Unity platform, which we have enabled to be displayed in Unity through the Mapbox web service. The AR_Aligned_Map object is used for all adjustments related to geographic data. The visualization of 3 different data related to the visualization of geographic data in Unity has been arranged.

The part we call Image provides the visualization of the map with our geographical data, roads and important buildings. The Terrain part is used to model the land surface. Map layers are used to arrange the data that will be displayed in augmented reality. The AR_Aligned_Map object, for which we created map and augmented reality arrangements, uses tileset and studio data from Mapbox Studio. An ID is created for each piece of data we create in Mapbox Studio. It is possible to make adjustments by entering the ID information in the Unity environment (Fig. 7).

In the AR_Aligned_Map object, we have two geographic data layers that we have set up in map layers; drinking water data and waste water data. After our geographic data layers are opened in unity with their id information, the visualization of this data is adjusted from the Data Layers section. With Mapbox Geographic Services, the data opened in unity can also be visualized on the unity platform (Fig. 8).

In the application we designed, the synchronization of geographic data is done automatically. In the tests we have made with the geographic data that we have created the visualization; directional problems have occurred in the linear geographic data. We have added a manual adjustment feature for editing the directional problems. We made functional definitions for the buttons by making changes in the codes on the AR_Controller in order to manually edit the data with the help of buttons (Fig. 9).

On mobile phones, it takes time for GPS accuracy to recover after the user moves. In the application we developed, a function was added to update the map using a GPS button. In the first tests we conducted, it was observed that the data on the map could not be accurately positioned after the application was moved for a while. Functionality was added to the GPS button by making an adjustment in AR_Aligned_Map_Object (Fig. 10).

We designed the AR application, which we created by making the necessary arrangements through the Unity platform, to work in harmony with Android operating system 7.0 and above mobile devices. In our application, which also includes Google ARCORE support, the infrastructure data is visualized in an augmented reality environment.

The Xiaomi Redmi Note 8 device was used for testing the mobile AR application. The technical specifications of the device are shown in Table 1.

Table 1. Technical specifications of the used device

MONITOR	
Display Technology:	IPS LCD
Screen Size:	6.3 inch
Aspect Ratio:	19,5:9
Screen Resolution:	1080 x 2340 pixels
Pixel Density:	409 ppi
Colour Depth:	16 million colours, 24-bit
Screen to Body Ratio:	82%
Screen Refresh Rate:	60 Hz
HARDWARE / SOFTWARE FEATURES	
Operation System (OS):	Android 9.0 Pie
User Interface (UI):	MIUI V10
Chipset:	Qualcomm Snapdragon 665
Number of CPU Cores:	8
CPU:	4x 2.0 GHz Kryo 260, 4x 1.8 GHz Kryo 260
CPU Manufacturing Technology:	11 nm
CPU Design:	64-bit
GPU:	Qualcomm Adreno 610
CONNECTION FEATURES	
Wi-Fi:	802.11a (IEEE 802.11a-1999)
USB Connection Type:	USB Type-C
Bluetooth Version:	4.2
Navigation:	GPS, A-GPS, GLONASS, BDS (BeiDou)
Other Connection Types:	Infrared port
	VoLTE

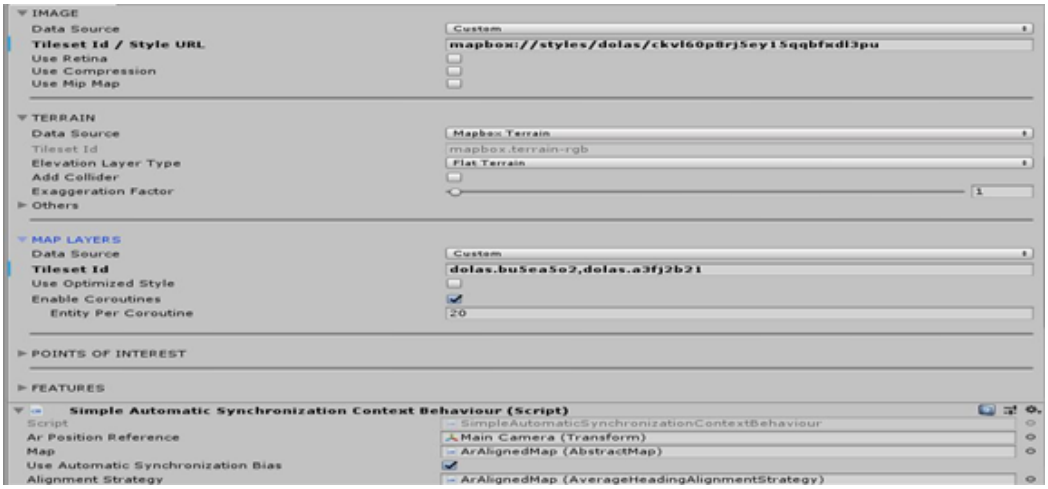

Figure 7. AR Aligned Map Object

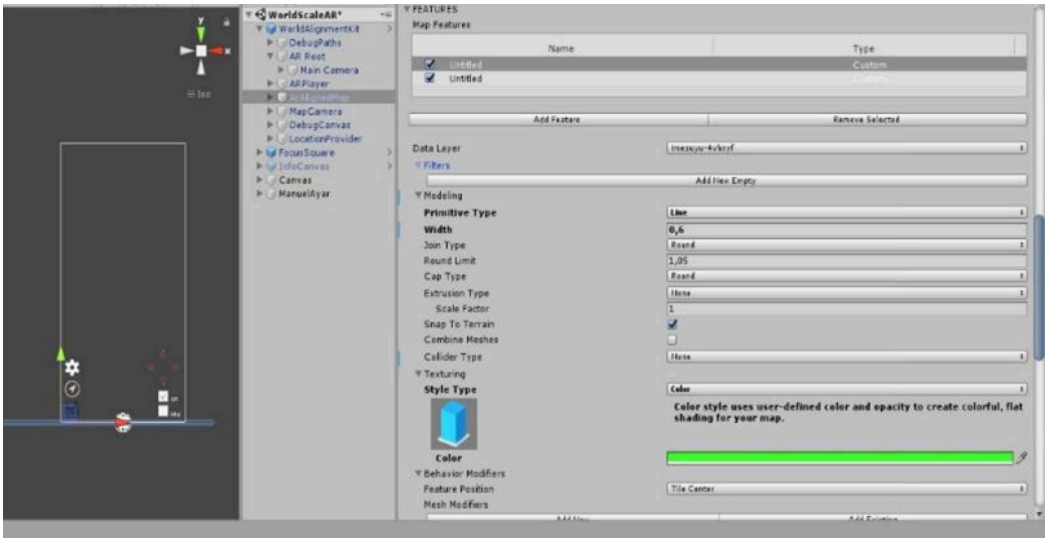

Figure 8. Screenshot of Map Features

4. Findings and Discussion

In the AR application we designed, linear geographic data belonging to infrastructure networks is used. We have seen that the direction of linear data cannot be accurately positioned in mobile AR applications. It has been observed that positioning in AR applications using point data is more sensitive than linear data.

In mobile applications designed for more precise positioning of linear data, manual adjustment buttons can be added to the data to provide movement capability. In mobile AR applications that are designed with manual adjustment buttons, known fixed points in the workspace are needed for precise positioning of lines in the real world. Using known landmarks, it is possible to position the lines according to the landmarks.

To determine the positional accuracy of the prepared application, coordinate readings were taken using the ground control points determined from the geographic data and the images of the AR application in the field. Coordinate readings on the ground were performed using both a Continuously Operating Reference Stations-Turkey (CORS-TR) supported Global Navigation Satellite System (GNSS) receiver and a mobile application.

The line seen in the mobile AR application and the coordinates collected over land were compared. Since the line directions on land were matched to the infrastructure data by manual corrections in the mobile AR application, the location information obtained from the mobile AR application was not trusted and was not used as a validation criterion. In the study, the UTM coordinate system in WGS84 datum was used as the coordinate system.

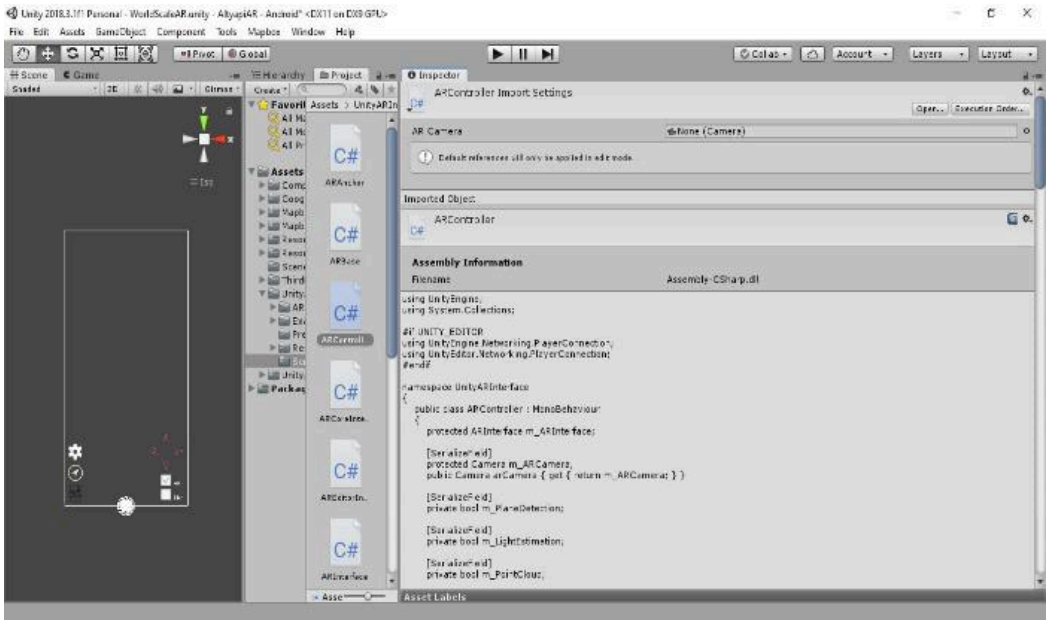

Figure 9. AR Controller

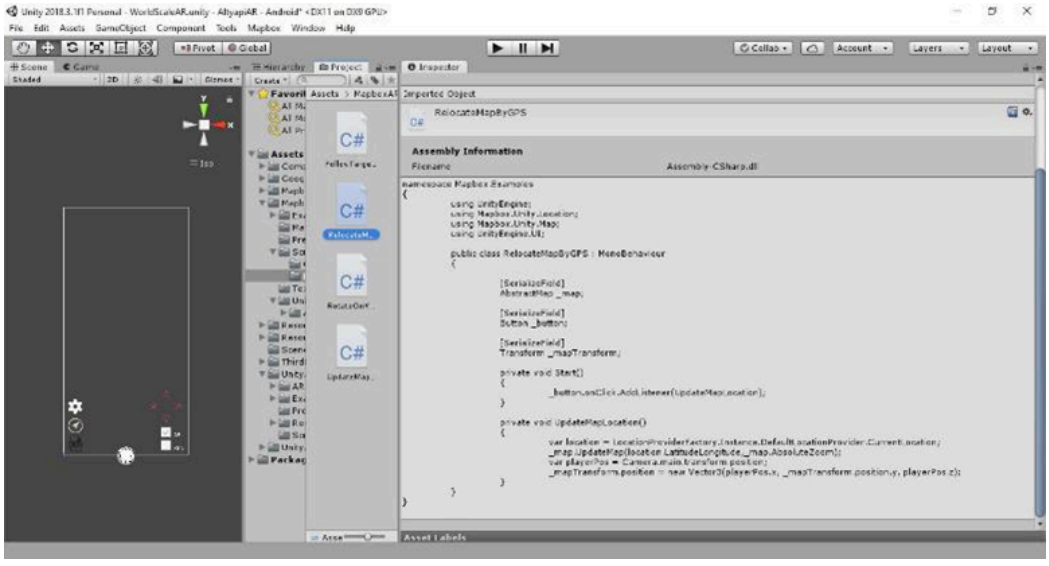

Figure 10. Settings of GPS Button

The location accuracy of the mobile AR application was tested by collecting coordinate information from the geographic data and the field from the ground control points by markers in the field of view of the mobile device. The Root Mean Square Error (RMSE) was obtained by using the double measurement method in the error theory.

Direction problems in field data, coordinate information was collected after manual settings were made in AR application. Therefore, the coordinates of field data could be collected more accurately with the help of CORS-TR supported GNSS receiver (Table 2).

Table 2 shows the UTM coordinates collected from the pilot region. By subtracting the land and CORS-TR coordinates; de presents for the easting and dn for the northing difference calculations in centimetres (Equations 1 and 2).

$$de = (y_{LK} \quad y_{AR}) * 100 \tag{1}$$

$$dn = (x_{LK} \quad x_{AR}) * 100 \tag{2}$$

Here, x_{LK}, y_{LK} and x_{AR}, y_{AR} are the coordinates from the land and CORS-TR supported augmented reality application, respectively (Table 3).

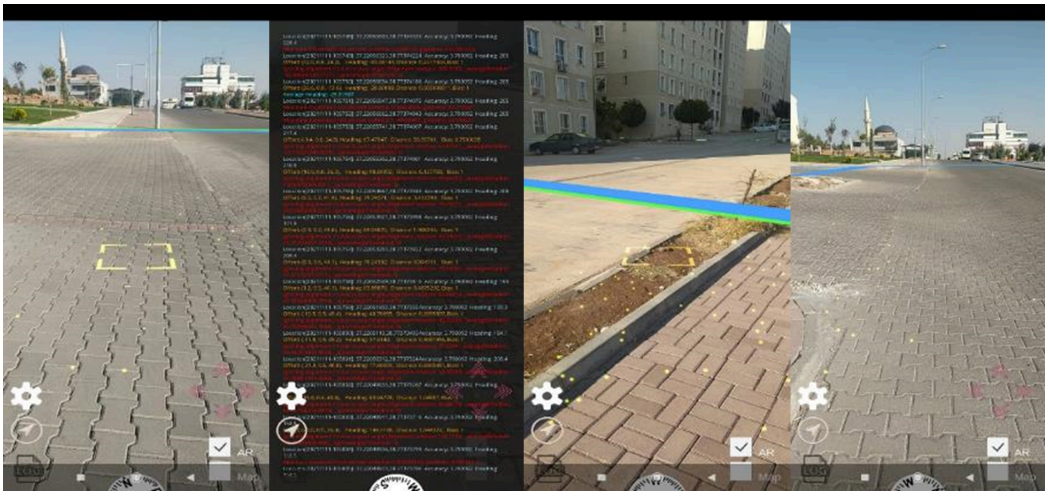

Figure 11. Screenshots of Mobile AR Application

Table 2. Land coordinates collected for control purposes

Point	Land Coordinates		CORS Coordinates	
	East (m)	North (m)	East (m)	North (m)
1	479811,89	4119162,92	479811,88	4119162,62
2	479817,90	4119163,24	479817,91	4119163,03
3	479825,41	4119163,14	479825,60	4119162,98
4	479833,04	4119163,42	479833,05	4119163,53
5	479844,21	4119163,38	479844,39	4119163,56
6	479861,33	4119163,72	479861,52	4119164,16
7	479890,48	4119164,16	479890,86	4119164,87
8	479926,85	4119164,72	479926,91	4119164,99
9	479958,71	4119165,20	479958,83	4119164,96
10	479994,48	4119165,77	479994,49	4119165,58
11	480021,53	4119166,18	480021,61	4119165,90
12	480057,50	4119166,73	480057,69	4119166,23
13	480090,05	4119167,28	480090,01	4119167,22
14	480093.48	4119167.14	480093.18	4119166.76
15	480097.57	4119167.30	480097.28	4119167.32
16	480100.04	4119171.66	480100.10	4119171.14
17	480100.41	4119177.03	480100.27	4119176.85
18	480100.97	4119189.94	480100.84	4119189.75
19	480101.39	4119197.07	480101.29	4119196.83
20	480102.72	4119209.65	480102.55	4119209.85
21	480105.96	4119231.95	480105.76	4119231.79

Table 3. Coordinate differences between land and CORS-TR

Point	Coordinate Differences	
	de (cm)	dn (cm)
1	1	30
2	1	21
3	19	16
4	1	11
5	18	18
6	19	44
7	38	71
8	6	27
9	12	24
10	1	19
11	8	28
12	19	50
13	4	6
14	30	38
15	29	2
16	6	52
17	14	18
18	13	19
19	10	24
20	17	20
21	20	16

Using the calculated dn and de values; northing, easting and resultant mean error calculations were calculated with the mean error formula by using the Eq. (3).

$$RMSE = \pm \frac{\overline{[d_i d_i]}}{2 * n} \quad (3)$$

Here, d_i is the differences between the northing and easting land coordinates of each pair of measures and the coordinates taken by the AR application with CORS-TR; n represents the number of control points collected. The mean error value for the easting is $\pm 11.9cm$, for the northing is $\pm 21.8cm$, and the resultant mean error value is $\pm 24.9cm$.

AR technology will continue to evolve with improvements in software and hardware. Location-based AR applications are affected by position sensitivities so that spatial data can be accurately placed on the real world. In AR applications created with geographic data, applications created with point data can give more successful results. It can be seen that the directions of the lines cannot be used accurately when using linear data in AR applications, where spatial sensitivities are observed to be better in point data. AR applications designed with linear data need to be manually adjusted with ground control points on the land.

In order to carry out infrastructure works in a healthy way, it is necessary to consider the opinions and suggestions of all stakeholders involved in infrastructure management. Infrastructure management, which includes both public institutions and infrastructure companies, should be carried out on a common denominator. Geographical data related to infrastructure should be collected by involving all stakeholders, and this data should be used by all stakeholders. All infrastructure networks can be protected in multi-stakeholder studies.

Since the location sensitivity of the smartphones used cannot reach the desired precise location sensitivity without the use of additional equipment, external location information should be verified with geodetic GNSS instruments in these applications.

5. Conclusion

Augmented reality (AR) technology services offered by companies that produce geographic information system (GIS) software are becoming more widespread. By using GIS software, people and institutions that host their geographic data on a geographic server can see their data in an AR application. The design of spatial AR applications becomes easier with the development of AR application design in free and open source software.

In order to extend the designed mobile application, it is necessary to eliminate the directional problems in linear data. It is possible to eliminate this problem, which is often encountered in the design process of AR applications, by using additional hardware. By adding manual adjustment buttons to AR applications designed for use on mobile devices, direction corrections can be made using these buttons. Known landmarks in the field are required for manual fine-tuning. Ensuring that known fixed points in the field are displayed with point symbols in AR applications will facilitate manual adjustments. Although it is easy to use such a method in an area covering a few streets, many more fixed points will be needed for a study covering many streets. It is known that the directional problems can be solved with the hardware developments in AR applications.

As a result of the comparison between the coordinate values obtained from the geographic data and the field data, an average error of $\pm 24.9cm$ was obtained. The use of the AR application that we have prepared near the study area in excavations to be carried out in field studies with the calculated average error will provide great advantages in terms of carrying out the process.

Acknowledgments

We would like to thank Şanlıurfa Metropolitan Municipality Information Processing Department and Şanlıurfa Metropolitan Municipality General Directorate of Water and Sewerage Administration for their support in the provision of geographical data regarding the drinking water and sewerage networks in the Seyrantepe Neighborhood of Şanlıurfa Province Karaköprü District. Moreover, we would like to inform our reader that some findings of our study were presented in the 3rd International Conference on Virtual Reality, November, 15-16, 2021 Şanlıurfa, Türkiye.

References

Arth, C., Grasset, R., Gruber, L., Langlotz, T., Mulloni, A., and Wagner, D. (2015). The history of mobile augmented reality. Technical report, Graz University of Technology.

Azuma, R., Billinghurst, M., and Klinker, G. (2011). Special section on mobile augmented reality. *Computers and Graphics*, 35:vii–viii.

Azuma, R. T. (1997). A survey of augmented reality. *Presence: Teleoper. Virtual Environ.*, 6(4):355–385.

Bayraktar, Z. (2019). Altyapı koordinasyon merkezleri için konumsal veri standartlarına uygun bilgi sistemi tasarımı: Trabzon örneği. Master's thesis, Karadeniz Teknik Üniversitesi, Trabzon, Türkiye.

Behzadan, A. H. and Kamat, V. R. (2009). Interactive augmented reality visualization for improved damage prevention and maintenance of underground infrastructure. *Building a Sustainable Future - Proceedings of the 2009 Construction Research Congress*, pages 1214–1222.

Ekin, E. and Çabuk A. (2011). Ogc olanakları ile cbs tabanlı hizmet yönetimi: Akıllı altyapı. In *6th International Advanced Technologies Symposium (IATS'11)*, pages 16–18.

Kengne, P. A. (2014). Mobile augmented reality supporting marketing: Using mobile's augmented reality-based marketing applications to promote products or services to end customers. Bachelor's thesis, Lahti University of Applied Sciences, Lahti, Finland.

Keskin Mustafa, E. and Yılmaz, A. G. (2014). Altyapı Şebekelerinin yönetiminde kent bilgi sisteminin Önemi. IMO Library.

MAPBOX (2021). World-scale ar maps, geocoding, and navigation apis and sdks | mapbox. https://docs.mapbox.com/unity/maps/examples/world-scale-ar/. Accessed: 2021-11-11.

Ortman, E. and Swedlund, K. (2012). Guidelines for user interactions in mobile augmented reality. Master's thesis, Umea University, Sweden.

Schall, G., Junghanns, S., and Schmalstieg, D. (2014). *VIDENTE-3D Visualization of Underground Infrastructure using Handheld Augmented Reality*, pages 207–219.

Sherman, W. R. and Craig, A. B. (2019). Chapter 1 - introduction to virtual reality. In Sherman, W. R. and Craig, A. B., editors, *Understanding Virtual Reality (Second Edition)*, The Morgan Kaufmann Series in Computer Graphics, pages 4–58. Morgan Kaufmann, Boston, second edition edition.

Tekin, A. C. (2019). Developing a location based augmented reality application for infrastructure maps. Master's thesis, Yıldız Teknik Üniversitesi, İstanbul, Türkiye.

Uluğ, A. B. (2020). Müze sergilerinde artırılmış gerçeklik uygulamaları. Master's thesis, Yıldız Teknik Üniversitesi, İstanbul, Türkiye.

UNITY (2005). Browser to unity communication. unity 3d. https://forum.unity.com/threads/browser-to-unity-communication.10342/. Accessed: 2021-22-09.

International Journal of Advanced Virtual Reality

Volume: 1, Issue: 1, Page: 20-25, Year: 2023
http://www.journals.leukolion.com

Augmented Reality as a Performance Enhancement Technology in Primary Education: A Systematic Review

Mani Das Runu[1] and J. V. Madhusudan[2]

[1] *University of Hyderabad, India, runumanidas123@gmail.com, ORCID: 0000-0003-0583-7603*
[2] *University of Hyderabad, India, madhusudanjv@uohyd.ac.in, ORCID: 0000-0002-6582-0152*

Article History:
Received: 16 Feb 2022
Revised: 21 Feb 2022
Accepted: 20 May 2022
Online: 21 Feb 2023

Keywords:
Augmented Reality
Augmented Reality Application
Primary Education
Systematic Review

Abstract
Augmented reality combines virtual objects into the real environment to enhance the performance of the real environment. In the educational field, augmented reality has been used to improve learner performance and make education advantageous. Especially in primary education, applications related to augmented reality have been developed to make education interesting and meaningful. However, only a few studies have analyzed and discussed the effectiveness of augmented reality on students' performance in primary education. In this context, the author seeks to find out the factors related to AR that enhances students' performance in primary school. Based on the previous studies, this study provides a systematic review of current knowledge and information. Mainly 14 research papers referred to the topic have been chosen to analyze the data which were published from 2018 to 2021. The result shows augmented reality applications have positive effects on learners' performance. The observation and results signify that augmented reality applications enhance the learners' motivation, interest, and academic performance of the learner.

Contents

How to Cite

Runu, M. D. and Madhusudan, J. V. (2023). Augmented Reality as a Performance Enhancement Technology in Primary Education: A Systematic Review. *International Journal of Advanced Virtual Reality*, 1(1), 20-25.

1. Introduction

In an educational setting, primary education is the first stage of formal education. It is the stage of learning basic concepts and acquiring basic information of formal education. Primary education mostly focused on playful learning for the development of the cognitive abilities of the learner in a joyful way. Therefore, teaching methods in primary education need to be modified and explore different aspects to enhance the learner's performance in primary education.

Integration of technology in the teaching-learning process is exploring new ways of enhancing students' performance. The use of ICT tools, virtual reality, mixed reality, digital games, etc. is the recent technological integration in the primary education system. Within these, augmented reality is also one of the enhanced technologies that have been developing an increasing interest in today's primary educational field.

In primary education, augmented reality effectively organizes the learner's learning habits by imposing AR applications and tools. The term augment has been derived from the Latin word **"augmentare"** which is indicated to enhance the real world with virtual aspects. Augmented reality (AR) produces a reality that is enhanced and augmented by bridging the virtual and real worlds (Wu et al., 2013). Real-world objects can be blended with virtual objects or superimposed information utilizing an augmented reality application. Subsequently, virtual items appear to cohabit with the real world in the same place (Bacca-Acosta et al., 2015).

AR apps run on mobile devices like smartphones and tablets and use built-in cameras, GPS sensors, and Internet connection to embed dynamic, context-aware, and interactive digital information in real-world (Chiang et al., 2014; Zhang et al., 2014). In primary education, Augmented Reality is used to make learning joyful and active. Considering the reviews, most studies focused on game-based learning applications in primary education. Therefore, the present study focuses on the positive effects of augmented reality applications in primary education, which enhances the learner's performance. This study also deals with the factors that depend on suitable teaching methods, learning environment of AR application that enhance learning in primary education. The research questions of our study are shaped and labelled as follows:

RQ1: What are the positive effects of augmented reality applications that enhance the performance of the learner in primary education published in between 2018-2021 research studies?

RQ2: What are the most suitable teaching methods and learning environments used to apply AR in the classroom in primary school to enhance learner performance published in between 2018-2021 research studies?

RQ3: What are the subjects that mostly used AR applications in primary school published in between 2018-2021 research studies?

RQ4: How factors of AR-enhanced performance of learners in primary school?

2. Literature Review

Research conducted by Dimitriadou et al. (2020) discussed the application of AR at the primary level to explain mathematical activities improve interactivity and students' interest. An investigation done by Safar et al. (2017) pointed out the use of augmented reality in primary school to increase English learning. Augmented reality uses 2D, 3D models, a live visual concept to connect the real world with a virtual object (Sáez-López et al., 2019). Fotaris et al. (2017) on a systematic review of augmented reality game-based learning in primary education has described the games that have been used to teach in primary education children. In total 17 studies from 2012 to 2017 have been covered in the study. The study has given importance to discussing verities of game-based applications that have been used in primary education. AbdulJabbar and Felicia (2015) in their systematic review of game play engagement and learning through games tried to find the impact of game features on cognitive and emotional levels. Another study by Bacca-Acosta et al. (2014) analyzed 32 studies between 2003 to 2013, concerned the scientific review of augmented reality trends in education discussed the challenges, attributes, and utilization of augmented reality in the educational process.

3. Materials and Methods

This research employs the "Systematic Review" method. A sort of literature review is a systematic review. The basic goal of a systematic review is to find all relevant subjects to a single topic. The systematic review method is used to analyze and evaluate a huge number of resources related to one particular field (Fotaris et al., 2017). Kitchenman proposed the idea of Systematic Review (Kitchenham and Charters, 2007) to utilize the previous literature systematically. Kitchenman's Systematic Review process includes three steps: Planning the Review, Administering the Review Process and Reporting the Review.

3.1 Planning the Review:

The first step is called Planning the Review and consists of the journal selection,criteria for inclusion and exclusion, categories of analysis.

3.1.1 Selection of Journal

In the initial stage, the appropriate journals are selected. The selection of journals process depends on the suitable method and scientifically relevant data. Initially, Google Scholar, ERIC, JSTOR, Springs abstracts, Research Gate articles have been chosen for journal selection of educational technology category. Journals such as the Asian Journal of university education, Journal of Computer Assisted Learning, Education and Information Technologies, Education Science, Research in Learning Technologies, etc. are selected for the present research topic.

3.1.2 Inclusion and Exclusion

Various researches have been conducted regarding augmented reality based on educational benefits. Especially use of AR in primary education has been considered as specific criteria and included in the study. Application of AR to enhance students' performance, a new application used to deliver information through AR, students active learning with AR have been included in the study.

Research that discusses the application of augmented reality in another educational setting such as secondary education, higher education has been excluded. Articles that are based on a comparison of AR, VR, and Mixed Reality, review-based articles, book chapters are excluded from the category.

3.1.3 Categories of analysis

Data are analyzed and categorized according to each research question are analyzed in group categories and subcategories. Augmented reality applications, subjects that are used for teaching augmented reality, teaching methods used for augmented reality are the category that has been discussed in the results and discussion part.

3.2 Administering the review process

The second step is called Administering the Review Process and consists of selection of study, extraction of data, synthesis of data, and coding of data

3.2.1 Selection of the study

The present study selected articles based on the application of augmented to teach different disciplines in primary school. Mainly, the method of the studies is based on experimental and quasi-experimental methods. In total 14 studies were selected between 2018-2021 for the present study.

3.2.2 Data extraction and data coding:

Data extraction and data coding have been completed after reading and understanding all the 14 review papers thoroughly. Data extraction and the coding process have been done by extracting main points and key terms from the studies and then coded as positive effects- enhance subject performance, enhance educational and cognitive values, active and joyful learning, etc. Factors coded as a teaching method, learning environment, suitable subject, teaching professional, etc. are the terms that have been selected from the reviews of augmented reality.

3.3 Reporting the Review

The third step is called Reporting the Review and consists of discussion and interpretation of the data. Table 1 shows the total studies with subjects, methods, findings of augmented reality applications in primary education. 4

Overall studies provide information regarding the effects of augmented reality applications, teaching methods used, and subjects that studies carried out.

4. Findings and Discussion

RQ1: What are the positive effects of augmented reality applications that enhance the performance of the learner in primary education published in between 2018-2021 research studies?

As per Table 1, most of the studies reported that augmented reality has positive effects on the performance of the learner. Augmented reality applications have potentially enhanced students' motivation, interest, subject performance, attitude, cognitive values, etc.

RQ2: What are the teaching methods and learning environments used to apply AR in the classroom in primary school to enhance learner performance published in between 2018-2021 research studies?

In the studies, as illustrated in Fig. 1, most of the experimental studies preferred indoor learning environments and used augmented reality game-based learning, ICT with the teacher-centered method, play and learn the method. On the other hand, few studies had conducted an experiment in outdoor learning environments that used the project method, outdoor games-sports.

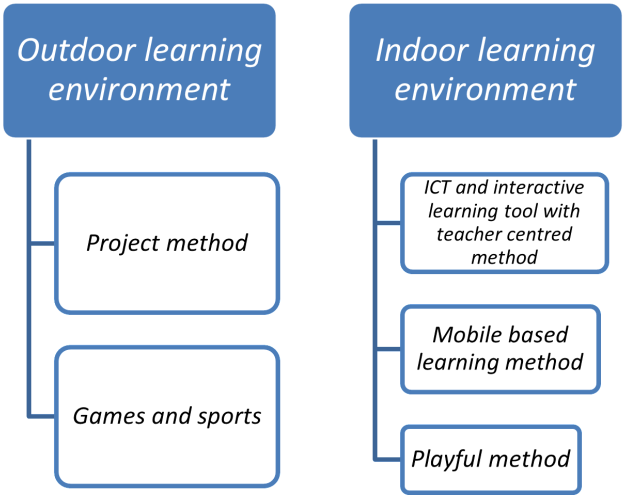

Figure 1. Teaching methods and learning environment for AR technology

RQ3: What are the subjects that mostly used AR applications in primary school published in between 2018-2021 research studies?

In a total of 14 studies, as illustrated in Fig. 2, half of the studies conducted research on science subjects i.e., 50%, whereas 35% shows that language subjects used AR to improve the language skills of primary school learners. Along with these, social science and physical education consist of 14% respectively.

RQ4: How factors of AR enhance the performance of learners in primary school?

Table 1. An Overall outline of Scientific Research in Primary Education

Research Studies	Types of Application	The subject of the study	Research Method	Results and Observation
Lu et al. (2018)	AR embedded physical puzzle game	Evaluation of AR embedded physical puzzle game on students' learning achievement and motivation on elementary natural science	Quasi-experimental design	Enhances specific knowledge in natural science
Pombo and Marques (2019)	EduPARK	The potential educational value of mobile augmented reality games: the case of EduPARK app	Mixed-method approach	Enhance educational values, interest and promote learning
Lubis and Nur Wangid (2019)	A-R Assisted Pictorial Story Book	AR-assisted pictorial storybook:media to enhance discipline character of primary school students	Quantitative Approach	Enhanced disciplinary character of the learner
Sáez-López et al. (2019)	WallaMe- An Ambiquitious Game	Application of the ubiquitous game with augmented reality in primary education	Quasi-experimental Design	Improvement in the academic performance and competence in information search and analysis of the subject, developed motivation and enjoyment, level of fun, information search skill and collaboration.
Lozada et al. (2019)	KARLMS	Augmented Reality-MS kinect in the learning of basic mathematics: KARMLS case	Quantitative approach	KARMLS has an important effect on the students. The positive effect of using computer-supported AR-based technology
Wu (2019)	Pokemon Go	The applications and effects of learning English through augmented reality: a case study of pokemon Go	Experimental method	Significant in learning performance and promote learning attitude, satisfaction and, achievement
Kumpulainen et al. (2020)	MyAR Julle	Children's augmented storying in with, and for nature	Narrative study	Improved cognitive learning, joyful and active learning
Baran et al. (2020)	Mobile Augmented Visual Reality	Application of Mobile Augmented Visual Reality (MAVR) for vocabulary learning in the ESL classroom	Repeated Measure Experimental Design	Students' vocabulary managed to be improved and AVR helps to develop motivation and interest among learner
López-Faican and Jaen (2020)	EmoFindAR Application	EmoFindAR: evaluation of a mobile multiplayer augmented reality game for primary school chidren	Experimental design	Satisfy learner with constructive empathy such as happiness, fun, and inquisitiveness which improves learner's performance
Wen (2020)	AR-Supported Chinies Character Learning Game	Augmented reality enhanced cognitive engagement: designing classroom based collaborative learning activities for young language learners	Mixed method	In the AR supported learning improve cognitive and rational engagement of the students
Jalaluddin et al. (2021)	Mobile Augmented Visual Reality	Application of Mobile Augmented Visual Reality (MAVR) for vocabulary learning in the ESL classroom	Experimental method	Students vocabulary managed to be improved and AVR helps to develop motivation and interest among learner
Midak et al. (2020)	AR-Technology in Lico.STEM Mobile App	Augmented reality technology within studying natural subjects in primary schools	Experimental method	Results show that students developed interest, curiosity, cognitive motivation, etc.
Midak et al. (2021)	AR technology in Lico.STEM Mobile App	AR technology to study the astronomic subject in primary school	Experimental method	Improve critical thinking, motivation, understanding the concept, power of memorization.
Safar et al. (2017)	AR smart flashcard application	Basic geometry shapes, creative thinking and motivation	Quasi-experimental method	Enhance geometry learning, enhance academic performance, creative thinking, positive relationship between augmented manipulative and creative skills, motivation has been found in the study.

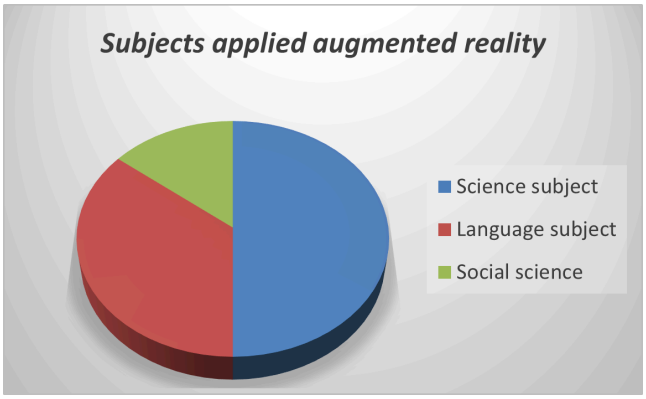

Figure 2. Subjects used to apply augmented reality

Teachers' teaching style, technology awareness, training in technology, learning environment, a suitable subject for AR application are the factors that improve the performance of the learner. The above Table 1 discussed the importance of the availability of teaching staff, ICT tools, trained professionals, internet connectivity, mobile phones/computer to support AR learning in the classroom. Overall, learners' performance depends on the factors of AR application to enhance students' performance in an educational setting.

Overall, the study discloses that a) augmented reality applications have positive effects on learners performance since findings show that learner develops motivation, subject interest, cognitive value, learning interest with the use of augmented reality application in primary education b) Science, STEM are the subjects that AR applications have been used mostly, c) Mobile learning with teacher center method, project method, laboratory, group discussion are the teaching methods that AR used to enhance the performance of the learner d) Teaching method, learning environment, subjects, professional expert are the principal factors of AR enhancement learning.

5. Conclusion

In conclusion, the present review is designed to bring light to different factors of augmented reality application in primary education which enhances the learning performance of the learner. The result of the study may incorporate new knowledge and ideas about the enhancement of primary education by applying augmented reality applications. The study shows the positive effects of augmented reality applications in primary education to enhance the performance of the learner. The positive effects of augmented reality applications help learners to develop a positive attitude, motivation, interest to learn interestingly. Factors of AR applications need to be considered while applying AR technology in the educational system. Teaching methods, professional experts, subjects, internet connectivity, technological tools, mobile, and computer should be available in the educational settings to apply AR technology. However, remote areas, poor internet connectivity in the school, lack of trained teachers are the aspects of the hindrance of using AR in an educational setting. This review has focused only on the factors and positive effects of AR applications in primary education which enhances the performance of the learner. Although, game-based learning with AR, the negative impact of AR application in psycho-social learning needs to be considered as an important aspect while applying AR-based technology in primary education.

Acknowledgments

We would like to inform our reader that some findings of our study are presented in the 3rd International Conference on Virtual Reality, November, 15-16, 2021, Şanlıurfa, Türkiye.

References

AbdulJabbar, A. I. and Felicia, P. (2015). Gameplay engagement and learning in game-based learning: A systematic review. *Review of Educational Research*, 85(4):740–779.

Bacca-Acosta, J., Baldiris, S., Fabregat, R., Graf, S., and Kinshuk, D. (2014). Augmented reality trends in education: A systematic review of research and applications. *Educational Technology and Society*, 17:133–149.

Bacca-Acosta, J., Baldiris, S., Fabregat, R., Kinshuk, D., and Graf, S. (2015). Mobile augmented reality in vocational education and training. *Procedia Computer Science*, 75:49–58.

Baran, B., Yecan, E., Kaptan, B., and Paşayiğit, O. (2020). Using augmented reality to teach fifth grade students about electrical circuits. *Education and Information Technologies*, 25.

Chiang, T., Yang, S., and Hwang, G.-J. (2014). An augmented reality-based mobile learning system to improve students' learning achievements and motivations in natural science inquiry activities. *Educational Technology and Society*, 17:352–365.

Dimitriadou, E., Stavroulia, K.-E., and Lanitis, A. (2020). Comparative evaluation of virtual and augmented reality for teaching mathematics in primary education. *Education and Information Technologies*, 25.

Fotaris, P., Pellas, N., Kazanidis, I., and Smith, P. (2017). A systematic review of augmented reality game-based

applications in primary education. In *11th European Conference on Games Based Learning (ECGBL)*, pages 181–191.

Jalaluddin, I., Darmi, R., and Ismail, L. (2021). Application of mobile augmented visual reality (mavr) for vocabulary learning in the esl classroom. *Asian Journal of University Education*, 17(3):162–173.

Kitchenham, B. A. and Charters, S. (2007). Guidelines for performing systematic literature reviews in software engineering. Technical Report EBSE 2007-001, Keele University and Durham University Joint Report.

Kumpulainen, K., Byman, J., Renlund, J., and Wong, C.-C. (2020). Children's augmented storying in, with and for nature. *Education Sciences*, 10:149.

Lozada, R., La-Serna-Palomino, N., and Molina, F. (2019). Augmented reality and ms-kinect in the learning of basic mathematics: Karmls case. *International Education Studies*, 12:54.

Lu, S.-J., Liu, Y.-C., Chen, P.-J., and Hsieh, M.-R. (2018). Evaluation of ar embedded physical puzzle game on students' learning achievement and motivation on elementary natural science. *Interactive Learning Environments*, 28(4):451–463.

Lubis, A. and Nur Wangid, M. (2019). Augmented reality-assisted pictorial storybook: Media to enhance discipline character of primary school students. *Mimbar Sekolah Dasar*, 6:11.

López-Faican, L. and Jaen, J. (2020). Emofindar: Evaluation of a mobile multiplayer augmented reality game for primary school children. *Computers & Education*, 149:103814.

Midak, L., Kravets, I., Kuzyshyn, O., Berladyniuk, K., Buzhdyhan, K., Baziuk, L., and Uchitel, A. D. (2021). Augmented reality in process of studying astronomic concepts in primary school. pages 239–250.

Midak, L., Pahomov, J., Lutsyshyn, V., Uchitel, A., and Rih, K. (2020). Augmented reality technology within studying natural subjects in primary school. In *CEUR Workshop Proceedings*.

Pombo, L. and Marques, M. M. (2019). Learning with the augmented reality edupark game-like app: Its usability and educational value for primary education. In Arai, K., Bhatia, R., and Kapoor, S., editors, *Intelligent Computing*, pages 113–125, Cham. Springer International Publishing.

Safar, A., Al-Jafer, A., and Al-Yousefi, Z. (2017). The effectiveness of using augmented reality apps in teaching the english alphabet to kindergarten children: A case study in the state of kuwait. *EURASIA Journal of Mathematics, Science and Technology Education*, 13(02):417–440.

Sáez-López, J.-M., Sevillano-García-García, M., and Pascual Sevillano, M. A. (2019). Application of the ubiquitous game with augmented reality in primary education. *Comunicar*, 27.

Wen, Y. (2020). Augmented reality enhanced cognitive engagement: designing classroom-based collaborative learning activities for young language learners. *Educational Technology Research and Development*, 69(02):843–860.

Wu, H.-K., Lee, S. W.-Y., Chang, H.-Y., and Liang, J.-C. (2013). Current status, opportunities and challenges of augmented reality in education. *Computers & Education*, 62:41–49.

Wu, M.-H. (2019). The applications and effects of learning english through augmented reality: a case study of pokémon go. *Computer Assisted Language Learning*, 34:1–35.

Zhang, J., Sung, Y.-T., Hou, H.-T., and Chang, K. (2014). The development and evaluation of an augmented reality-based armillary sphere for astronomical observation instruction. *Computers & Education*, 73:178–188.

International Journal of Advanced Virtual Reality

Volume: 1, Issue: 1, Page: 26-35, Year: 2023
http://www.journals.leukolion.com

Absenteeism and Self-Efficacy on 3D Schematic Drawing and PCB Design Course

Dursun Akaslan[1] and Mehmet Hadi Suzer[2]

[1] *Harran University, Şanlıurfa, Türkiye, dursunakaslan@harran.edu.tr, ORCID: 0000-0003-3432-8154*
[2] *Harran University, Şanlıurfa, Türkiye, mhsuzer@harran.edu.tr, ORCID: 0000-0002-0083-8757*

Article History:
Received: 09 Jan 2023
Revised: 15 Jan 2023
Accepted: 21 Feb 2023
Online: 21 Feb 2023

Keywords:
Absenteeism
Self-Efficacy
PCB Design
3D

Abstract
Absenteeism as a global issue is defined as the situation in which students stay away from school with no valid rationales. Additionally, the concept of self-efficacy is considered as the personal judgments of individuals about what they can do in possible situations. Much attention is paid to the effects of absenteeism on the school success, whereas little one is placed on the effects of absenteeism on self-efficacy. This study aims to find the effects of absenteeism on the self-efficacy of students before and after a specific 3D Schematic Drawing and PCB Design course. The course, lasted 4 weeks, was held online-and face-to-face in Harran University. To assess students' self-efficacy, the General Self-Efficacy scale developed by Sherer et al. (1982), is used in our study. The demographic distribution of the students such as gender, birth of year, learning mode and organization is surveyed at the beginning and at the end of the course. Our findings indicate that the overall scores of the self-efficacy of students increase when they regularly attend the course. Moreover, our study revealed that the expected level of self-efficacy of the students in our study are sufficient based on our assessment scale. The attendance rate of students has a positive impact on the self-efficacy of students in distance education, whereas it plays a negative role in face-to-face one.

Contents

How to Cite

Akaslan, D. and Suzer, M. H. (2023). Absenteeism and Self-Efficacy on 3D Schematic Drawing and PCB Design Course. *International Journal of Advanced Virtual Reality*, 1(1), 26-35.

1. Introduction

Absenteeism is defined as a situation in which students stay away from school with no valid rationales. Absenteeism is mainly studied to find out an answer to two main questions: what causes absenteeism and the causal effects of absenteeism (Goodman and Atkin, 1984). Absence from classes among students are accepted as a global issue (Mohamed et al., 2018).

Akaslan (2017) reveals that there is a negative relationship between student absenteeism and school achievement, which is clearly observed in the final and make-up exams.The effect of absenteeism is also examined from the perspective of employees (Muchinsky, 1977). For instance, the effects of absenteeism on nurses are examined by Masenyani et al. (2018) and they found that absenteeism creates a burden for nurses and causes an unhealthy working environment.

Much attention has been drawn to the effects of absenteeism on academic achievement. However, little attention has been placed on the effects of absenteeism on students' self-efficacy. The self-efficacy is described from various perspectives.

The concept of self-efficacy has been considered as one of the most influential factors in student success in scientific studies conducted around the world for over forty years and in Türkiye for the last decade (Yıldırım and Ilhan, 2010; Sakız, 2013). It is mainly defined as the personal judgments of people about what they can do in possible situations (Bandura, 1982) (as cited in Birişçi et al. (2018)). Yıldırım and Ilhan (2010) consider the self-efficacy as the belief of people in their ability to start, to continue and to end an action in a way which would have an impact on their environment. An individual self-efficacy is perceived as a strong determinant about the effort, persistence, strategizing, subsequent training and job performance of people (Heslin and Klehe, 2006). The self-efficacy is gained gradually with the development of cognitive, social, linguistic and/or physical abilities acquired through experience (Bandura, 1982; Gist, 1987) (as cited in, Kızanlıklı and Silik (2019)).

Cervone (2000) emphasizes that people's perceptions of their capabilities for performance are a cognitive system underlying behavioral change. Bandura (1997) (as cited in Luszczynska and Schwarzer (2015)) postulates that four informational sources might give a rise to self-efficacy: personal accomplishment, various experience, verbal persuasion and emotional arousal. The effect of self-efficacy on various tasks has been examined by several researchers. For example, Igbaria and Iivari (1995) examined the effect of self-efficacy on computer usage by analyzing the belief of people in their capabilities of using a computer in the accomplishment of specific tasks and found that computer experience has a strong positive effect on self-efficacy. The purpose of this study is to compare the self-efficacy of students before and after applying the 3D Schematic Drawing and Printed Circuit Board Design course using a PCB CAD software namely DipTrace (Diptrace, 2023b). To achieve our purpose, the following questions have been addressed:

- Is there any change between the students' self-efficacy before and after the delivery of the course?
- Do learning methods, face to face and distance, affect self-efficacy of participants?
- Is there any difference in students' self-efficacy based on their gender?
- Does attendance affect the students' self-efficacy?

2. Literature Review

Self-efficacy is described by Bandura as a person's belief in their capabilities to perform a particular task with a success (Heslin and Klehe, 2006). However, highly experienced people in success might have more positive self-efficacy than lowly experienced one in success in a greater variety of situations for carrying out a particular task. Sherer et al. (1982) emphasize that individuals with various and numerous experiences of success might be expected to have positive self-efficacy expectancies in a greater variety of situations than individuals with experiences of limited success and of failure. A particular task might be anything such as computer use. Individuals' beliefs about the successful use of computers to solve tasks and manage situations might refer to computer self-efficacy Compeau and Higgins (1995). Much attention has been drawn to the computer self-efficacy. However, little attention has been paid to software usage such as 3D Schematic Drawing and Printed Circuit Board Design in our case.

Printed Circuit Boards (PCB) are described by the Ministry of Education as the plates on which the electronic circuit elements are placed and the electrical connections between the elements are provided by copper means (MEB, 2018). Printed Circuit Boards (PCBs) are used in almost all electronics application from mobile phones to air-crafts (Silvestre et al., 2019). The PCBs are mainly used to perform a particular task by soldering or connecting components by wires together (Sreedhar et al., 2021). The development of the circuit elements placed on the PCB, especially transistors, increases the complexity of the printed circuit board design and also prolongs the placement time of the elements (Altıntaş et al., 2018).

Moreover, most advanced systems utilize multilayer PCBs up to eight or more layers (Zumbahlen, 2008). Even an eight-layer board can be folded in a thousands of different ways (Burkhert, 2022). Additionally, electromagnetic compatibility (EMC) affects the functional capability of electrical and electronic equipment within a defined margin of safety and at design levels without suffering from electromagnetic interference (Montrose, 2000). A more controlled precision design is easily affected by numerous factors such as number of holes, different tool changes to drill those holes, size of the board, thickness of copper material, type of insulating material, and trace tolerances (Kwashnak, 2020). Therefore, PCB CAD software such as Altium, DipTrace, Eagle, KiCad and OrCAD play a critical role to minimize such problems.

As an example, the KiCad is suitable for creating designs of all complexities up to 32 copper layers (Charras et al., 2023). PCB CADs are also used to 3D-preview the model of the PCB with all components installed on, rotating the board on three axes, zooming in and out, changing colors of the components (e.g., board, copper areas, solder mask, silkscreen, and background) and exporting to STEP and VRML formats (Diptrace, 2023a). The term "3D" is defined as the dimensionality of the raw data that constitutes the basis of the visualization process Wood et al. (2005). 3D technology has gained an increasing momentum recently as a game changer in the challenge to meet performance, cost, and size demands Sadaka et al. (2010).

3D modeling is first used in the military flight simulators, and the aerospace and automobile industries of the 1950s with the computer-aided design (CAD) systems Vernon and Peckham (2002). Nowadays, 3D modeling is frequently used in supporting PCB design (Pérez et al., 2022; Raj et al., 2019).

3. Materials and Methods

3.1 Self-efficacy Scale

Efficacy items should accurately reflect the construct by concerning with perceived capability in terms of "can do" rather than "will do" (Bandura, 2006). The self-efficacy scale used in our study is developed by Sherer et al. (1982) and named as the General Self-Efficacy Scale. The validity and reliability of the scale in Turkish is implemented by Yıldırım and Ilhan (2010). The scale contains 17 items and measures self-efficacy without reference to any specific behavioral domain as illustrated in Table 1 in English and Table 2 in Turkish. The letter N and P in the tables denotes negative and positive items, respectively. The self-efficacy scale contains negative and positive items such as planning, distraction and perseverance.

Planning is described as an arrangement for what people intend to do or how they intend to do something. The ability to plan, organize and prioritize work is considered as one of the most important ten skills sought after by employers (Adams, 2014). The findings of a study carried out by Gauvain and Rogoff (1989) demonstrates that older children are more skilled at planning in advance of action than younger ones. Moreover, Chuvgunova and Kostromina (2016) found that lower planning strategies than cognitive and meta-cognitive learning strategies might conclude that planning skills of learning are not sufficient. Therefore, it is important to understand to what extent people are certain that they can make plans work.

The ability to think carefully about something we are doing and nothing else is called motivation and considered highly important to focus at work. However, **distractions** such as social media, phone calls, and busy settings affect the focus of individuals. Purvis et al. (2016) emphasize that social media absorbs valuable time because it quickly distracts people by taking them into a number of unfruitful channels. Dontre (2021) also points that there is ample evidence to indicate that social media use in classrooms is largely disruptive and generally increases academic distraction. Much attention have been already drawn to the social media distractions. However, Williams et al. (2004) note that numerous attributions play a critical role for learners' success (e.g. effort, strategy, and interest) and learners' failures (e.g. distractions by others, difficulty of work and poor teaching). For that reason, understanding whether people can get to work or not does matter as part of self-efficacy.

The ability to keep doing something difficulty is defined as **perseverance**. Perseverance is gained over time and based on experiences through failures and success (Ingham, 2018). Ashraf et al. (2018) notes that when a determined student encounters difficulties or repeated unsuccessful results while following a certain path, they will adjust and update their expectation and preferences. Moreover, individuals who have the passion and perseverance to extensively work and study through challenges and adversite to achieve a set of goals are likely to achieve higher achievement compared to others who lack similar aspects (Hernández et al., 2020). Hence, it is import to understand whether students will keep trying until they can if they cannot do a job the first time.

Table 1. General Self-Efficacy Scale in English

No	Item	Rev.
1	When I make plans, I am certain I can make them work.	P
2	One of my problems is that I cannot get down to work when I should.	N
3	If I cannot do a job the first time, I keep trying until I can.	P
4	When I set important goals for myself, I rarely achieve them.	N
5	I give up on things before completing them.	N
6	I avoid facing difficulties.	N
7	If something looks too complicated, I will not even bother to try it.	N
8	When I have something unpleasant to do, I stick to it until I finish it.	P
9	When I decide to do something, I go right to work on it.	P
10	When trying to learning something new, I soon give up if I am not initially successful.	N
11	When unexpected problems occur, I do not handle them well.	N
12	I avoid trying to learn new things when they look too difficult for me.	N
13	Failure just makes me try harder.	P
14	I feel insecure about my ability to do things.	N
15	I am a self-reliant person.	P
16	I give up easily.	N
17	I do not seem capable of dealing with most problems that come up in life.	N

3.2 Assesment Scale

The items in the questionnaire are evaluated with a five-point Likert-scale with the leftmost and rightmost anchors being "Strongly Disagree" and "Strongly Agree" respectively as illustrated in Fig. 1. Moreover, a new option "No Idea" is also included in the Likert-scale. It is important to note here that the assessment scale for the negative items will be recoded in direction of high self-efficacy to find out the overall scores of the items. The recommendation of Aydin and Tasci (2005) is also considered in our study, that the mean score of 3.40 is identified as expected level of self-efficacy for each item.

Table 2. General Self-Efficacy Scale in Turkish

No	Item	Rev.
1	Planlar yaparken, onları hayata geçirebileceğimden eminimdir.	P
2	Sorunlarımdan birisi, bir işe zamanında başlayamamamdır.	N
3	Eğer bir işi ilk denemede yapamazsam başarana kadar uğraşırım.	P
4	Belirlediğim önemli hedeflere ulaşmada, pek başarılı olamam.	N
5	Her şeyi yarım bırakırım.	N
6	Zorluklarla yüz yüze gelmekten kaçınırım.	N
7	Eğer bir iş çok karmaşık görünüyorsa onu denemeye bile girişmem.	N
8	Hoşuma gitmeyen bir şey yapmak zorunda kaldığımda onu bitirinceye kadar kendimi zorlarım	P
9	Bir şey yapmaya karar verdiğimde hemen işe girişirim.	P
10	Yeni bir şey denerken başlangıçta başarılı olamazsam çabucak vazgeçerim.	N
11	Beklenmedik sorunlarla karşılaştığımda kolayca onların üstesinden gelemem.	N
12	Bana zor görünen yeni şeyleri öğrenmeye çalışmaktan kaçınırım.	N
13	Başarısızlık benim azmimi arttırır.	P
14	Yeteneklerime her zaman çok güvenmem.	N
15	Kendime güvenen biriyim.	P
16	Kolayca pes ederim.	N
17	Hayatta karşıma çıkacak sorunların çoğuyla baş edebileceğimi sanmıyorum.	N

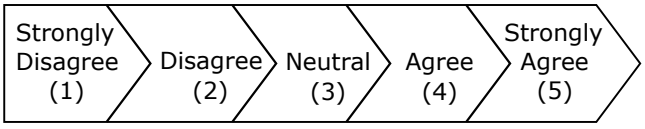

Figure 1. Assessment Scale

3.3 Sampling of Participants

The course is designed in four parts namely Schematic Design, Printed Circuit Design, Library and 3-D Modeling on September 19^{th}, 2021. The designed course is announced on November 10^{th}, 2021, through social media and the website of Harran University by using a poster. 79 individuals applied for the course by November 24^{th}, 2021. After the delivery of the course, students were able to implement a sample design as shown in Fig. 2. However, 22 of them did not attend any of the lectures. Table 3 illustrates the number of attended participants based on their affiliations.

As seen from the Table 3, majority of the participants are from Harran University (f: 42, %: 73.7). The course lasted 4 weeks and held both online and face-to-face from November 29, 2021, to December 24, 2021, in Harran University. 57 students filled the self-efficacy scale at the beginning of the course, whereas it was 29 at the end. The gender, birth of year, learning mode and organization of the students are surveyed at the beginning (female: 28.07% and male: 71.93%) and at the end (female: 31.03% and male: 68.97%).

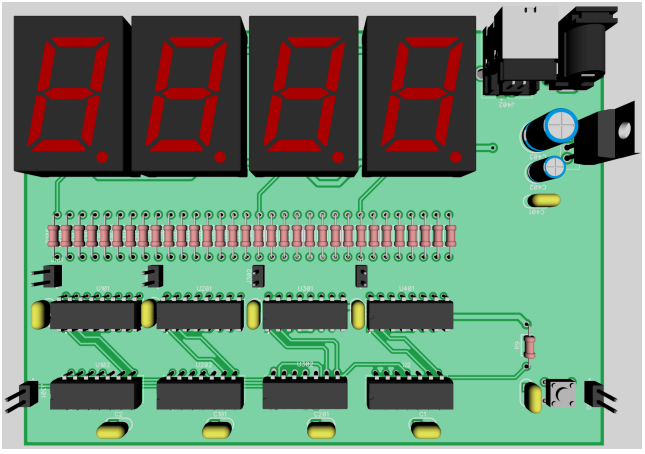

Figure 2. Four Digit Decimal Counter Design using Diptrace

Table 3. Number and percentage of participants

Institutions	F	%
Adıyaman Sanayi Geliştirme Merkezi	1	1.8
Atatürk University	1	1.8
Bingöl University	1	1.8
Bursa Teknik University	1	1.8
Gümüşhane University	1	1.8
Harran University	42	73.7
Iğdır University	1	1.8
İstanbul Medipol University	1	1.8
İstanbul University	1	1.8
Marmara University	1	1.8
Milli Eğitim Bakanlığı	1	1.8
Şehit Muhammed Cihangir Çubukçu Anadolu Lise	1	1.8
Siirt University	1	1.8
Tarım ve Kırsal Kalkınmayı Destekleme Kurum	1	1.8
Yıldız Teknik University	1	1.8
Yükseliş Fen ve Teknoloji Lisesi	1	1.8
Total	57	100.0

3.4 Data Analysis

Microsoft Excel is used to edit and organize raw data in several steps. First, the questions and answers are listed respectively and coded using numbers starting from zero (e.g., female: 0, male: 1). Second, the answers of the participants are updated with the code given in the first step. Third, the coded data is then analyzed to extract the results.

3.5 Ethics Committee Approval

Ethics Committee Approval is obtained for the research with the consent of the Harran University Social and Human Sciences Ethics Committee at the session dated February 11, 2020 and with the decision numbered 2020/11. Upon obtaining the Ethics Committee Approval, the self-efficacy of students are measured before and after the delivery of the course.

4. Findings and Discussion

This section is divided into two parts: The first part reports the descriptive statistics among items in the study whereas the second part compares the mean scores of variables namely gender and learning mode of the participants to find out whether there is any significant difference with respect to these variables. Moreover, the mean scores of each variable are compared with the attendance rate. Male and female participants with at least %50 or more attendance rate are also analyzed for the self-efficacy. Additionally, based on the assessment scale of our study, each item in the self-efficacy scale is evaluated as sufficiency ($\mu \geq 3.40$) and insufficiency ($\mu < 3.40$). Insufficient items are highlighted (as bold) in the tables.

4.1 Descriptive Statistics

This part is divided into two sub-parts. The first sub-part analyzes the descriptive statistics of items for the participants without taking absenteeism into account whereas the second part only analyzes the mean scores of the items for the participants with at least %50 or more attendance rate to find out whether there are significant difference among the participants with regular attendance.

4.1.1 General Self-Efficacy without Absenteeism

The number, mean and standard deviation of the scores of the items in the study are presented in the Table 4. The overall score of the items is calculated as 3.93 at the beginning and, 3.91 at the end of the course. It seems that there is subtle decrease in the self-efficacy of the students at the first glance. For example, the item 1 in Table 1 illustrates the confidence of participants for "making plans" is increased from 3.96 to 4.14 after the delivery of the course. On the other hand, the item 3 indicates that the self-efficacy of the participants related to "doing a job" had decreased after the course. As seen in the Table 4, the mean score of all the items, except the item 2, are computed to be sufficient. To conclude, regardless of the course delivery, it can easily be interpreted that the expected level of self-efficacy for all items except the item 2 is sufficient for the participants.

4.1.2 General Self-Efficacy with Absenteeism

The mean and standard deviation of the items are recalculated based on the attendance of the students as illustrated in Table 5. All the students in Table 5 attended at least 50% of the courses either face-to-face or through distance education or both. The overall scores of the students in the Table 5 are calculated as 4.03 at the beginning and 4.14 at the end of the course. As seen in the Table 5, the self-efficacy of students who attend the course regularly (at least 50% of the course) has increased. As seen in the Table 5, expected level of self-efficacy is calculated as sufficient for all items except the item 2.

Table 4. Analysis Results of the Self-Efficacy Scale without Absenteeism

Item	Pre-Test			Pro-Test			Change
	f	μ	σ	f	μ	σ	
1	57	3.96	0.597	28	4.14	0.651	+
2	55	**3.18**	1.002	28	**3.00**	1.089	-
3	55	4.40	0.596	28	4.11	0.629	-
4	57	3.91	0.912	28	3.86	0.705	-
5	57	4.19	0.875	27	3.89	1.050	-
6	55	4.18	0.865	28	4.18	0.863	o
7	57	4.26	0.745	28	4.11	0.786	-
8	57	3.86	0.766	27	3.59	0.971	-
9	55	3.91	0.823	27	4.04	0.706	+
10	53	4.00	0.832	28	4.04	0.793	+
11	57	3.72	0.861	28	3.93	0.858	+
12	56	4.21	0.680	28	4.21	0.686	o
13	55	3.49	1.136	27	3.63	0.742	+
14	56	3.59	1.005	27	3.52	0.975	-
15	56	3.54	1.250	26	4.23	0.652	+
16	57	4.30	0.823	28	4.18	0.905	-
17	52	4.02	0.960	28	4.21	0.630	+
Avg.		3.93			3.91		-

Yet, the overall mean scores of the items has increased from 4.03 to 4.14. Moreover, the number of the items with positive change has also increased.

4.2 Inferential Statistics

The mean scores of the items used in the study are compared for the participants with various variables such as gender and learning mode to verify significance of differences, namely between male and female and between face-to-face and distance learning modes.

Table 5. Analysis Results of the Self-Efficacy Scale with Absenteeism

Item	Pre-Test			Pro-Test			Change
	f	μ	σ	f	μ	σ	
1	10	3.70	0.949	10	4.40	0.516	+
2	10	3.50	0.850	10	**3.30**	0.949	-
3	9	4.44	0.527	10	4.10	0.876	-
4	10	4.00	0.816	10	4.20	0.422	+
5	10	4.50	0.527	10	4.40	0.699	-
6	10	4.30	0.675	10	4.60	0.516	+
7	10	4.50	0.528	10	4.20	0.789	-
8	10	4.10	0.568	10	3.80	1.033	-
9	10	4.10	0.876	10	4.20	0.789	-
10	9	4.00	0.866	10	4.40	0.699	+
11	10	3.60	1.174	10	3.80	1.033	+
12	9	4.44	0.527	10	4.40	0.699	-
13	10	3.40	0.843	10	3.60	0.699	+
14	10	3.40	0.966	10	3.70	1.059	+
15	10	3.50	1.269	10	4.20	0.632	+
16	10	4.20	1.229	10	4.70	0.483	+
17	8	4.13	0.641	10	4.40	0.699	+
Avg.		4.03			4.14		+

Moreover, the mean scores of all the items that are lower than the expected level of sufficiency ($\mu = 3.40$) are highlighted in bold.

4.2.1 Learning Mode without Absenteeism

Much attention has been drawn to differences between distance and face-to-face education in several aspects such as attendance, school success, undergraduate and graduate programs.

Akaslan (2019) found that there is a significant difference between distance and face-to-face education on the students' school success. Similarly, the self-efficacy of students in distance and face-to-face education are compared in our study. As seen in Table 6, the overall mean scores of the students' self-efficacy in terms of their learning mode are different.

While the overall mean score of the students in distance education increased from 3.86 to 3.99, it decreased from 4.06 to 4.00 without considering the attendance rate of the students in the course. Moreover, the assessment scale used in our study indicates that the mean score of the item 2 in the stage of pre- and pro-test for both distance and face-to-face learning mode and item 8 in the stage of pro-test for only distance learning mode is under the expected level of efficacy.

Table 6. Analysis Results of the Self-Efficacy Scale for Learning Mode Differences without Absenteeism

Item	Distance						F2F					
	Pre-Test			Pro-Test			Pre-Test			Pro-Test		
	f	μ	σ	f	μ	σ	f	μ	σ	f	μ	σ
1	30	3.97	0.490	15	4.20	0.676	11	3.82	0.874	8	4.13	0.641
2	28	**3.21**	1.031	15	**3.20**	1.207	11	**3.09**	1.044	8	**2.50**	0.926
3	30	4.33	0.661	15	4.27	0.594	10	4.50	0.527	8	4.00	0.756
4	30	3.77	0.935	15	4.00	0.756	11	4.27	0.647	8	4.00	0.535
5	30	4.17	0.874	15	4.07	1.163	11	4.18	1.168	8	4.00	0.756
6	29	4.07	0.961	15	4.27	0.799	11	4.36	0.505	8	4.38	0.744
7	30	4.17	0.834	15	4.07	0.884	11	4.55	0.522	8	4.38	0.744
8	30	3.80	0.847	14	**3.36**	1.082	11	3.91	0.701	8	3.88	0.991
9	29	4.07	0.651	14	4.14	0.770	11	3.91	0.944	8	4.00	0.756
10	26	4.12	0.766	15	4.13	0.834	11	4.00	0.775	8	4.25	0.707
11	30	3.83	0.699	15	4.07	0.799	11	3.45	1.128	8	3.88	1.126
12	29	4.21	0.726	15	4.40	0.632	11	4.36	0.505	8	4.25	0.707
13	30	3.40	1.133	14	3.93	0.616	11	3.73	1.009	8	3.50	0.756
14	29	3.48	1.056	14	3.71	1.139	11	3.64	0.924	8	3.38	0.916
15	30	3.50	1.280	13	4.31	0.630	11	3.55	1.293	8	4.25	0.707
16	30	4.13	0.973	15	4.07	1.100	11	4.45	0.522	8	4.63	0.518
17	28	3.82	1.020	15	4.20	0.561	10	4.50	0.527	8	4.63	0.518
Avg.		3.86			3.99			4.06			4.00	

4.2.2 Learning Mode with Absenteeism

Akaslan (2019) found that the compulsory school attendance in distance education has a positive effect on the success of the students registered in English course.

Therefore, the results of the self-efficacy scale are analyzed for learning mode differences by considering the attendance rate of the students in the course. Table 7 illustrates the analysis results of the self-efficacy scale for the students with attendance rate of 50 percent or more. As illustrated in the Table 7, the overall mean scores of the items increased from 3.96 to 4.24 in distance education and from 3.78 to 3.97 in face-to-face education. Moreover, the mean scores of all the items in distance education after the course are computed as more than the expected level of efficacy based on our assessment scale. However, the item 14 is still under the expected level of efficacy in face-to-face education.

Table 7. Analysis Results of the Self-Efficacy Scale for Learning Mode Differences with Absenteeism

Item	Distance						F2F					
	Pre-Test			Pro-Test			Pre-Test			Pro-Test		
	f	μ	σ	f	μ	σ	f	μ	σ	f	μ	σ
1	5	3.80	0.447	4	4.50	0.577	6	3.50	1.049	5	4.40	0.548
2	5	3.80	0.837	4	4.00	0.816	6	**3.17**	0.983	5	**2.80**	0.837
3	5	4.20	0.447	4	4.25	0.957	5	4.40	0.548	5	3.80	0.837
4	5	3.60	1.140	4	4.25	0.500	6	4.00	0.000	5	4.00	0.000
5	5	4.60	0.548	4	4.75	0.500	6	4.33	0.516	5	4.20	0.837
6	5	4.20	0.837	4	4.50	0.577	6	4.17	0.408	5	4.60	0.548
7	5	4.40	0.548	4	3.75	0.957	6	4.33	0.516	5	4.40	0.548
8	5	4.00	0.707	4	3.75	0.957	6	4.00	0.632	5	3.60	1.140
9	5	4.20	0.837	4	4.25	0.957	6	3.50	1.049	5	4.00	0.707
10	4	4.25	0.500	4	4.50	0.577	6	3.67	0.816	5	4.20	0.837
11	5	4.00	0.707	4	3.75	0.957	6	**3.00**	1.095	5	3.60	1.140
12	4	4.75	0.500	4	4.75	0.500	6	4.00	0.000	5	4.00	0.707
13	5	3.60	0.548	4	3.75	0.500	6	**3.17**	0.753	5	3.40	0.894
14	5	**3.20**	0.837	4	4.25	0.957	6	**3.33**	0.816	5	**3.20**	1.095
15	5	**3.20**	1.304	4	4.25	0.500	6	3.50	1.049	5	4.00	0.707
16	5	4.00	1.732	4	4.75	0.500	6	4.17	0.408	5	4.60	0.548
17	4	3.75	0.500	4	4.00	0.816	5	4.20	0.447	5	4.60	0.548
Avg.		3.96			4.24			3.78			3.97	

4.2.3 Gender without Absenteeism

Keung and So (2005) states that the difference between female and male is always posited to be a controversial issue as it is not consistently observed. Table 8 shows that male participants ($\mu = 4.00$ and $\mu = 3.96$) show higher self-efficacy comparing to the female ones ($\mu = 3.72$ and $\mu = 3.81$) with respect to the use of overall mean score of the 17 items for the pre-test and pro-test of the study, respectively. However, after the course, although the self-efficacy of male respondents is still higher, the self-efficacy of female counterparts has increased notably. Moreover, Table 8 also indicates whether the expected level of sufficiency of items is sufficient or not. As seen in the Table 8, the items 2, 13, 14, and 15 for pre-test and item 2, and 11 for pro-test are highlighted as insufficiency for female participants since the mean score is lower than 3.40. On the other hand, the items 2 for pre-test and pro-test are highlighted as insufficiency for male individuals since the mean score is lower than 3.40.

Table 8. Analysis Results of the Self-Efficacy Scale for Gender Differences without Absenteeism

Item	Female						Male					
	Pre-Test			Pro-Test			Pre-Test			Pro-Test		
	f	μ	σ	f	μ	σ	f	μ	σ	f	μ	σ
1	16	3.69	0.704	9	4.11	0.601	41	4.07	0.519	19	4.16	0.688
2	15	**3.13**	0.834	9	**2.78**	0.833	40	**3.20**	1.067	19	**3.11**	1.197
3	15	4.20	0.676	9	3.89	0.601	40	4.48	0.554	19	4.21	0.631
4	16	3.75	0.931	9	3.78	0.441	41	3.98	0.908	19	3.89	0.809
5	16	4.13	0.719	9	4.00	1.000	41	4.22	0.936	18	3.83	1.098
6	16	3.94	0.680	9	4.22	0.441	39	4.28	0.916	19	4.16	1.015
7	16	4.31	0.602	9	4.11	0.601	41	4.24	0.799	19	4.11	0.875
8	16	3.81	0.834	9	3.56	0.726	41	3.88	0.748	18	3.61	1.092
9	16	4.00	0.632	9	4.00	0.500	39	3.87	0.894	18	4.06	0.802
10	13	3.77	0.725	9	4.00	0.707	40	4.08	0.859	19	4.05	0.848
11	16	3.56	0.814	9	**3.33**	0.707	41	3.78	0.881	19	4.21	0.787
12	15	4.20	0.414	9	4.00	0.707	41	4.22	0.759	19	4.32	0.671
13	16	**3.19**	1.047	9	3.56	0.726	39	3.62	1.161	18	3.67	0.767
14	15	**3.13**	1.060	9	3.56	0.882	41	3.76	0.943	18	3.50	1.043
15	16	**3.31**	1.078	8	3.75	0.463	40	3.63	1.314	18	4.44	0.616
16	16	4.13	0.619	9	4.22	0.667	41	4.37	0.888	19	4.16	1.015
17	14	3.93	0.997	9	4.00	0.707	38	4.05	0.957	19	4.32	0.582
Avg.		3.72			3.81			4.00			3.96	

Table 9. Analysis Results of the Self-Efficacy Scale for Gender Differences with Absenteeism

Item	Female						Male					
	Pre-Test			Pro-Test			Pre-Test			Pro-Test		
	f	μ	σ	f	μ	σ	f	μ	σ	f	μ	σ
1	6	**3.33**	0.816	5	4.40	0.548	6	4.17	0.753	5	4.40	0.548
2	6	3.67	0.516	5	**3.20**	0.837	6	**3.17**	1.169	5	3.40	1.140
3	5	4.20	0.447	5	3.80	0.837	6	4.50	0.548	5	4.40	0.894
4	6	3.50	0.837	5	4.00	0.000	6	4.33	0.516	5	4.40	0.548
5	6	4.33	0.516	5	4.40	0.894	6	4.67	0.516	5	4.40	0.548
6	6	4.00	0.000	5	4.40	0.548	6	4.50	0.837	5	4.80	0.447
7	6	4.33	0.516	5	4.00	0.707	6	4.50	0.548	5	4.40	0.894
8	6	3.83	0.753	5	3.80	0.837	6	4.17	0.408	5	3.80	1.304
9	6	3.83	0.753	5	4.00	0.707	6	4.00	1.265	5	4.40	0.894
10	5	3.60	0.894	5	4.20	0.837	6	4.33	0.516	5	4.60	0.548
11	6	**3.33**	0.516	5	**3.20**	0.837	6	3.83	1.472	5	4.40	0.894
12	5	4.00	0.000	5	4.00	0.707	6	4.67	0.516	5	4.80	0.447
13	6	**3.33**	0.516	5	3.40	0.894	6	3.67	1.033	5	3.80	0.447
14	6	**3.33**	0.816	5	3.40	1.140	6	3.50	1.049	5	4.00	1.000
15	6	**3.17**	0.753	5	3.80	0.447	6	3.83	1.472	5	4.60	0.548
16	6	4.17	0.408	5	4.60	0.548	6	4.17	1.602	5	4.80	0.447
17	4	4.25	0.500	5	4.20	0.837	6	4.00	0.632	5	4.60	0.548
Avg.		3.69			3.93			4.12			4.35	

4.2.4 Gender with Absenteeism

Table 9 shows that male participants ($\mu = 4.12$ and $\mu = 4.35$) show higher self-efficacy comparing to the female ones ($\mu = 3.69$ and $\mu = 3.93$) with respect to the use of overall mean score of all the items for the pre-test and pro-test of the study, respectively. However, after the course, although the self-efficacy of male respondents is still higher, the self-efficacy of female counterparts has increased notably.

Moreover, Table 9 also indicates whether the expected level of sufficiency of items is sufficient or not. As seen in the Table 9, the items 1, 11, 13, 14, and 15 for pre-test and item 2, and 11 for pro-test are highlighted as insufficiency for female participants since the mean score is lower than 3.40. On the other hand, the items 2 for pre-test are highlighted as insufficiency for male individuals since the mean score is lower than 3.40.

5. Conclusion

The purpose of our study is to compare the self-efficacy of the students before and after attending a course. The 3D Schematic Drawing and PCB Design has been taught within the 4 weeks. The students had the opportunity to attend the course either face-to-face or online.

Moreover, the course records are published in our YouTube Channel to ensure students do not miss any topics while they keep attending the course (Leukolion Informatics, 2021). Our findings indicate that the overall scores of the self-efficacy of students changes when they regularly attend the course.

The results of our study reveals that the mean scores of almost all items are computed over our expected level of efficacy without considering any variables such as gender, attendance rate and learning mode. This indicates that the students registered in our course have sufficient level of self-efficacy.

Moreover, our study also suggests that the attendance rate has significant impact on the self-efficacy of the students. Analysis results of the self-efficacy points that students with more attendance rate have more level of self-efficacy regardless of their gender or learning mode.

Whilst the findings of our study reveals that the self-efficacy of the students before and after the course is sufficient, it is important to take the limitation of our study into account when interpreting its findings. For example, the designed course is announced through social media and the website of Harran University by using a poster. Therefore, some potential students cannot be reached because of the type of announcement.

Moreover, announcing the course via the Internet might be also criticized for finding out the difference between the face-to-face and distance learning modes because individuals who are already online might be already motivated to take our course in distance learning mode. However, we tend to conclude that such a bias is remarkably low in our study because all the students are invited through the Internet, whereas several participants preferred taking the course face-to-face.

The implication for researchers is that it is critical to examine the effects of self-efficacy on students by applying more specific tasks relevant to software usage in engineering like 3D Schematic Drawing and PCB Design in our case. For example, the effects of self-efficacy on students might be analyzed by applying more specific courses related to 3-D such as modeling, texturing, animating, lighting and rendering. Moreover, students should be encouraged to design and generate a product at the end of the course. In our case, the students were able to design a counter at the end of the course as illustrated in Fig. 2.

The study is limited to 79 individuals registered the course. Hence, inferential statistics such as independent sample T-test, one-way ANOVA and chi-square test are not used to verify statistical significance of differences in mean scores on gender and learning mode variables. Hence, future studies can explore the effect of more specific tasks on students and can apply more advanced inferential statistics with sufficient number of students.

In addition, we have conducted a pre-achievement and a pro-achievement test consisting of approximately 100 questions to determine the increase or decrease in the learning level of the students. The data analysis is ongoing. We plan to publish the analysis of these results in our future work.

Acknowledgments

We would like to express our gratitude to all the students for joining our course either online or face-to-face for 4 weeks and for providing valuable information. Moreover, we would like to inform our reader that some findings of our study are presented in the 10^{th} International Congress on Engineering, Architecture and Design, December, 24, 25, and 26, 2022, Istanbul, Türkiye. Additionally, Ethics Committee Approval is obtained for the research with the consent of the Harran University Social and Human Sciences Ethics Committee at the session dated 11.02.2020 and with the decision numbered 2020/11.

References

Adams, S. (2014). The 10 Skills Employers Most Want In 2015 Graduates. http://onforb.es/1xt6Aiv. Accessed: 2023-19-02.

Akaslan, D. (2017). Yüksek Öğretimde Okul Başarısını Etkileyen Faktörlerin İncelenmesi. *Researcher*, 5(4):224 – 241.

Akaslan, D. (2019). Distance or Face-to-Face Education for Language Learning A Case of English. In *The 12th International Conference on Innovation in Language Learning*, Floransa, Italy.

Altıntaş, V., Çakır, A., and Küçüksille, E. U. (2018). Genetik Algoritma ile Baskı Devre Yerleşim Optimizasyonu. *Teknik Bilimler Dergisi*, 8(2):5 – 10.

Ashraf, R., Godbey, J., Shrikhande, M., and Widman, T. (2018). Student Motivation and Perseverance: Do They Explain College Graduation? *Journal of the Scholarship of Teaching and Learning*, 18(3):87–115.

Aydin, C. and Tasci, D. (2005). Measuring Readiness for e-Learning: Reflections from an Emerging Country. *Educational Technology and Society*, 8:244–257.

Bandura, A. (1982). Self-Efficacy Mechanism in Human Agency. *American Psychologist*, 37(2):122–147.

Bandura, A. (1997). Self-Efficacy: The Exercise of Control. *Journal of Cognitive Psychotherapy*, 13:158 – 166.

Bandura, A. (2006). Guide for Constructing Self-Efficacy Scales (Revised). *Self-efficacy beliefs of adolescents*, 5:307–337.

Birişçi, S., Kul, U., Aksu, Z., Akaslan, D., and Çelik, S. (2018). A Scale Development Study to Determine Web 2.0 Practical Content Development Self-Efficacy Belief (W2SEBS). *Educational Technology Theory and Practice*, 8(1):187 – 208.

Burkhert, J. (2022). PCB Design From Start To Finish. Technical report, San Jose, CA.

Cervone, D. (2000). Thinking About Self-Efficacy. *Behavior Modification*, 24(1):30–56. PMID: 10641366.

Charras, J. P., Tappero, F., and Jon, E. (2023). KiCad EDA, Reference Manual. https://docs.kicad.org/6.0/en/kicad/kicad.html. Accessed: 2023-31-01.

Chuvgunova, O. and Kostromina, S. (2016). Planning as a Learning Skill of Students. *Procedia - Social and Behavioral Sciences*, 217:132–138.

Compeau, D. R. and Higgins, C. A. (1995). Computer Self-Efficacy: Development of a Measure and Initial Test. *MIS Quarterly*, 19(2):189–211.

Diptrace (2023a). Diptrace 3D Modeling. https://diptrace.com/diptrace-software/3d-modeling/. Accessed: 2023-31-01.

Diptrace (2023b). Schematic and PCB Design Software. https://diptrace.com. Accessed: 2023-31-01.

Dontre, A. (2021). The Influence of Technology on Academic Distraction: A Review. *Human Behavior and Emerging Technologies*, 3:379–390.

Gauvain, M. and Rogoff, B. (1989). Collaborative Problem Solving and Children's Planning Skills. *Developmental Psychology*, 25:139–151.

Gist, M. E. (1987). Self-Efficacy: Implications for Organizational Behavior and Human Resource Management. *The Academy of Management Review*, 12(3):472–485.

Goodman, P. S. and Atkin, R. S. (1984). Effects of Absenteeism on Individuals and Organizations. In *Carnegie Mellon University Research Showcase CMU*.

Hernández, E. H., Moreno-Murcia, J. A., Cid, L., Monteiro, D., and Rodrigues, F. (2020). Passion or Perseverance? The Effect of Perceived Autonomy Support and Grit on Academic Performance in College Students. *International Journal of Environmental Research and Public Health*, 17(6).

Heslin, P. and Klehe, U. (2006). Self-Efficacy. In Rogelberg, S. G., editor, *Encyclopedia of Industrial/Organizational Psychology*, volume 2, pages 705–708. Thousand Oaks: Sage.

Igbaria, M. and Iivari, J. (1995). The Effects of Self-Efficacy on Computer Usage. *Omega*, 23(6):587–605.

Ingham, M. (2018). *The Relationship Between Stem Opportunities and Student Perseverance*. PhD thesis, University of Wisconsin-Platteville.

Keung, K. and So, T. (2005). The e-Learning Readiness of Teachers in Hong Kong. In *Fifth IEEE International Conference on Advanced Learning Technologies (ICALT'05)*, pages 806–808.

Kwashnak, K. (2020). A Basic Introduction for Designing a Printed Circuit Board (PCB) with EAGLE eCAD/CAM Software. Technical report, Belcamp, MD.

Kızanlıklı, M. M. and Silik, C. E. (2019). Turizm Eğitimi Alan Lisans Öğrencilerinin Öz Yeterliklerinin Akademik Başarı ve Bireysel Özellikler Açısından İncelenmesi. *Afyon Kocatepe Üniversitesi Sosyal Bilimler Dergisi*, 21(1):269 – 286.

Leukolion Informatics (2021). DipTrace ile 3-Boyutlu Şematik Çizim ve Baskı Devre Tasarımı. https://www.youtube.com/watch?v=PiobKyY29F4&list=PL8917yoKRc3RSk8EJsF1z-cJAo56CKca9. Accessed: 2023-21-02.

Luszczynska, A. and Schwarzer, R. (2015). Social Cognitive Theory. *Predicting Health Behaviour*, pages 127–169.

Masenyani, O. M., Tebogo, M. M., Rabelani, N. M., and Mokgadi, M. (2018). The Effects of Absenteeism on Nurses Remaining on Duty at a Tertiary Hospital of Limpopo Province. *Curationis*, 41(1):e1–e5.

MEB (2018). Elektrik Elektronik Teknolojisi: Lehimleme ve Baskı Devre. http://www.megep.meb.gov.tr/mte_program_modul/moduller/Lehimleme%20ve%20Bask%C4%B1%20Devre.pdf. Accessed: 2023-31-01.

Mohamed, S., Ul-Saufie, A. Z., Ahmad, N., Ahmat, H., and Zahari, M. (2018). Factors Influencing Student Absenteeism in the University. In *Proceeding of the 25th National Symposium on Mathematical Sciences (SKSM25)*, volume 1974, page 050013.

Montrose, M. I. (2000). *Printed Circuit Board Design Techniques for EMC Compliance: A Handbook for Designers*. Wiley-IEEE Press.

Muchinsky, P. M. (1977). Employee Absenteeism: A Review of the Literature. *Journal of Vocational Behavior*, 10(3):316–340.

Purvis, A., Rodger, H., and Beckingham, S. (2016). Engagement or Distraction: The use of Social Media for Learning in Higher Education. *Student Engagement and Experience Journal*, 5.

Pérez, D. F., Lainez, N. R., and Lagos, H. C. (2022). Experimental Scope of an Electrical Energy Consumption Device Based on Multi-Microprocessors, Local Printed Circuit Boards and Internet of Things (IoT). In *2022 IEEE 40th Central America and Panama Convention (CONCAPAN)*, pages 1–6.

Raj, L. D. W., Roja, K., Theresa, J. S., Sathyavani, M., and Sumithra, M. (2019). Elegant Way of Designing Printed Circuit Board via Multilayer Technique Using Ultiboard 12.0. In *2019 IEEE International Conference on System, Computation, Automation and Networking (ICSCAN)*, pages 1–5.

Sadaka, M., Radu, I., and Di Cioccio, L. (2010). 3D integration: Advantages, Enabling Technologies and Applications. In *2010 IEEE International Conference on Integrated Circuit Design and Technology*, pages 106–109.

Sakız, G. (2013). Başarıda Anahtar Kelime: Öz-yeterlik. *Uludağ Üniversitesi Eğitim Fakültesi Dergisi*, 26(1):185 – 210.

Sherer, M., Maddux, J. E., Mercandante, B., Prentice-Dunn, S., Jacobs, B., and Rogers, R. W. (1982). The Self-Efficacy Scale: Construction and Validation. *Psychological Reports*, 51(2):663–671.

Silvestre, S., Salazar, J., and Marzo, J. (2019). *Printed Circuit Board (PCB) Design Process and Fabrication*. Czech Technical University of Prague. Faculty of Electrical Engineering.

Sreedhar, R., Mahato, R., Chaturvedi, A., and Jaiswal, P. K. (2021). 3D PCB Designing of Protecting Circuit Using Fusion 360. *Asian Journal For Convergence In Technology (AJCT) ISSN -2350-1146*, 7(1):63–65.

Vernon, T. and Peckham, D. (2002). The Benefits of 3D Modeling and Animation in Medical Teaching. *Journal of Audiovisual Media in Medicine*, 25(4):142–148. PMID: 12554292.

Williams, M., Burden, R., Poulet, G., and Maun, I. (2004). Learners' Perceptions of Their Successes and Failures in Foreign Language Learning. *The Language Learning Journal*, 30:19–29.

Wood, J., Kirschenbauer, S., Döllner, J., Lopes, A., and Bodum, L. (2005). Using 3D in Visualization. In Dykes, J., MacEachren, A. M., and Kraak, M.-J., editors, *Exploring Geovisualization*, International Cartographic Association, pages 293–312. Elsevier, Oxford.

Yıldırım, F. and Ilhan, I. O. (2010). Genel Özyeterlilik Ölçeği Türkçe Formunun Geçerlilik ve Güvenilirlik Çalışması. *Türk Psikiyatri Dergisi*, 21(4).

Zumbahlen, H. (2008). Printed Circuit Board Design Issues. In Zumbahlen, H., editor, *Linear Circuit Design Handbook*, pages 821–895. Newnes, Burlington.

International Journal of Advanced Virtual Reality

Volume: 1, Issue: 1, Page: 36-43, Year: 2023
http://www.journals.leukolion.com

The Metaverse in Supply Chain Management: Applications and Benefits

Shantanu Trivedi[1] and Saurav Negi[2]

[1] *University of Petroleum and Energy Studies, India, meetshantanu2010@gmail.com, ORCID: 0000-0001-7905-0358*
[2] *Modern College of Business and Science, Oman, saurav.negi@mcbs.edu.om, ORCID: 0000-0002-5553-0098*

Article History:
Received: 21 Nov 2022
Revised: 17 Feb 2023
Accepted: 25 Feb 2023
Online: 27 Feb 2023

Keywords:
Metaverse
Virtual Reality
Artificial Intelligence
Supply Chain
Logistics Operations

Abstract
Businesses are keen to implement new technologies like virtual reality, artificial intelligence (AI), augmented reality, big data, etc. as they see profitable business applications. The supply chain and the larger business community have been paying attention to Metaverse as one of the technology disruptions. The metaverse is being enhanced by several variables, including mobile-based always-on access and virtual currency linkage with reality. Additionally, the growth of the Metaverse and Non-Fungible Tokens (NFT) has taken the metaverse to a new level. This paper performs a comprehensive analysis of the metaverse's attributes, uses, and prospects in global supply chains. The current metaverse-focused study discloses the state of the research and outlines future research goals by reviewing and analysing recent articles that reveal metaverse uses across multiple supply chain activities. It has been demonstrated that the metaverse has several features that help businesses improve supply chain efficiency and customer engagement, including increased visibility into operations, facilities, inventory, and capacity. These characteristics fuelling the metaverse's application in supply chain management and logistics operations. The study further found that metaverse-related research has been extremely growing in the areas of healthcare, retail, and infrastructure, while there is still scope for study in the field of supply chain security and traceability. Finally, it is emphasized that metaverse-related research in logistics, supply chain operations, and agriculture supply chains has the potential to be explored.

Contents

How to Cite

Trivedi, S. and Negi, S. (2023). The Metaverse in Supply Chain Management: Applications and Benefits. *International Journal of Advanced Virtual Reality*, 1(1), 36-43.

1. Introduction

The metaverse is one of the most key inventions in the everyday lives of individuals, including training, transportation systems, manufacturing and construction. It is also one of the most promising technologies which actualize virtual reality and was considered one of the important technologies at the Consumer Electronics Show (CES) held in 2022 (Lee et al., 2022). The establishment of ubiquitous computing infrastructure is taking place in the appropriate industries as the metaverse emerges as a new trend in a variety of industries, including education, retail, and gaming.

Also, in light of the metaverse's launch, several users can utilize the various metaverse applications in mobile and personal computer contexts (Lee et al., 2021). However, few studies have been conducted on mobile metaverse applications. Considering the increasing number of users of the metaverse, it is important to analyze user experience to provide the metaverse application users with improved services (Yavuz et al., 2021).

The phrase "METAVERSE," created by joining the prefix "meta" (which denotes transcending) with the word "universe," designates a made-up artificial setting that is interconnected with the real world. The phrase "metaverse" first debuted in Neal Stephenson's 1992 science fiction novel Snow Crash (Joshua, 2017).

According to Stephenson's description in this novel, the metaverse is a massive virtual setting that exists alongside the real world and allows individuals to converse via virtual avatars. Since its inception as a computer-generated cosmos, the concept of the metaverse has been described by a variety of ideas, including lifelogging, collective virtual space, embodied internet/ spatial internet, a mirror world, and an omniverse: a space for cooperation and simulation (Lee et al., 2021).

The metaverse's improved internal and external communication capabilities could be advantageous to almost all supply chain levels. More connectivity options enable a direct collaborative approach with suppliers, which decreases production costs and accelerates value chain synchronisation. This link would enable seamless and efficient cost talks between suppliers and customers, making the entire chain more responsive and transparent (Trivedi, 2022).

Despite having too many advantages of a metaverse in supply chain and logistics, diminutive research has been done to identify the existing state of literature, application, and research direction for the metaverse applications in the supply chain. The present study gives an overview of existing literature as well as gaps and potential research directions.

Analysis of papers published in journals, articles, and reports to help improve existing information about metaverse application in the supply chain. This work, on the other hand, adds new dimensions to future investigation. After prior conversations, three leading research questions (RQs) have emerged as:

RQ1: What is the present state of knowledge and comprehension of the usage of the metaverse in supply chains?

RQ2: What are the benefits of metaverse applications across various functions of supply chains?

RQ3: What are the future research directions for metaverse applications in supply chain management based on existing work and identified possible research gaps?

The research is divided into five components. The first section includes an introduction to the topic as well as a summary of the guiding research questions that were identified after a careful review of the literature. The second section includes a literature review.

The third section outlines the approaches used to identify and organise the literature using our classification system. The fourth section reports on the study's findings and conclusions. The study's fifth component finishes with recommendations for future research.

2. Literature Review

This section covers the background of supply chain and highlights the role of metaverse in supply chain management and its benefits to the business organisation.

2.1 Supply Chain Management

Global value chains are changing because of new industry capabilities, expanding demand, and developing country industry capabilities, as well as a wave of new technologies (Lund et al., 2019). In a supply chain, several different businesses typically work together to manufacture a product and deliver it to the consumer. A supply chain consists of producers of raw materials and components, product assemblers, wholesalers, retailer merchants, and transportation firms (Londe and Masters, 1994). Further, Mentzer et al. (2001), highlighted that a supply chain is the grouping of businesses that coordinates the marketing of goods or services, and that to adopt supply chain management, operations from sourcing to manufacture and distribution must be integrated.

A study conducted by Prajogo and Jan (2012) suggested that operations performance is significantly impacted by logistics integration. Information technology (IT) capabilities and information exchange have a substantial impact on logistics integration Rai et al. (2006) found that information technology-enabled supply chain integration capabilities improve business performance significantly and sustainably, particularly in terms of operational excellence and revenue growth. Management should prioritise the development of an integrated IT infrastructure and its application in the development of process skills for integrating resource flows between a company and its supply chain partners.

Pan (2008) highlighted the fact that supply chain management uses current information technology extensively to reinforce supply network weaknesses, increase operating efficiency, lower operating costs, and build quick reaction strategies. The research conducted by Yuliana et al. (2022) proposed that by utilizing Technology, information sharing, and engagement with supply chain partners, a manufacturing organization might maintain the performance of its supply chain during the Covid-19 pandemic. Precise information can aid decision-makers in making accurate judgments, and information sharing among supply chain nodes can significantly enhance the supply chain's effectiveness (Zhao et al., 2022).

In a study, conducted by Dev et al. (2020) suggested that using a reverse logistics model simulation that includes operations like inventory and production planning policy, additive manufacturing, and proposed to visualise an arrangement of an RFID-enabled and cloud-based ERP system that enables computing product returns with the inbuilt Bass model algorithm module, the effectiveness of the virtual world in an Industry 4.0 environment is investigated.

The study also recommended that the manager should consider the "optimum" promotional investment that enables moving multiple suppliers to the cloud-based cyber-physical-social network system as a common platform, despite the availability of Industry 4.0 capabilities based on cyber-physical and social networks.

Future research may examine environmental and economic performance considering the impact of the disposal of returns, according to the study. For the supply chain to effectively handle both the online and metaverse parts of product sale, as well as the ensuing financial payments and flows, these two factors must be coordinated and connected.

A study by Papagiannidis and Bourlakis (2010) proposed a possible integration of the metaverse with aspects of the traditional supply chain for better distribution and retailing experience. Moreover, the study suggested that research is required that could shed light on the supply chain challenges faced by retailers operating in the metaverse, and operational challenges that are originating due to supply chain complexity in various environments.

2.2 Metaverse in Supply Chain Management

The physical and virtual worlds can now be integrated thanks to the advancement of new information technologies at the start of the twenty-first century. Building digital twins is becoming increasingly popular in industrial engineering, especially in supply chains (Marmolejo-Saucedo, 2022). The "meta supply chain" effort, which has already seen rapid growth, has increased the supply chain industry's digital prospects (Dwivedi et al., 2022).

Applications of the metaverse are frequently used in new operational models developing virtual and augmented reality to improve the experience of customers and suppliers (Li, 2020a). The consumer journey evolves because of a merged experience of social platforms, e-commerce features, games, and smart retail (Tueanrat et al., 2021), but also the company's operating procedures, impacting the supply chain's overall effectiveness. Operations in the metaverse merge physical and digital components of manufacturing, supply chain, and logistics processes in a way that has never been done before (Ivanov and Dolguib, 2021).

Immersive engagement with the supply chain at all points, from any place, has the ability to revolutionise the manufacturing and logistics sectors and give the supplier and all other operations management stakeholders the knowledge they need to make informed decisions (Li, 2020b). Companies may now take advantage of the real-time data offered from numerous places, the variety of labor-market situations, as well as cultural and structural differences, without incurring additional costs or wasting time. Operations and supply chain management are affected significantly by the metaverse; these effects can be seen in physical, digital, and meta-supply chain formats (Dwivedi et al., 2022).

2.3 Benefits of Metaverse in Supply Chain Management

The Analysis Group estimates that within ten years, the metaverse will boost the world economy by $3 trillion. Global logistics sector behemoths like DP World are investigating how to leverage the metaverse for a variety of services, such as simulating warehouse and port operations, container and vessel maintenance inspections, safety training, and other practical applications (Sharma, 2022). As per the study conducted by Alpala et al. (2022), metaverse applications can save logistical costs like transportation and procurement of materials and supplies, and users can rehearse as many times as necessary before engaging in real-world practice.

Jürgens (2021) explained how the metaverse may facilitate the measurement, analysis, interaction, and resolution of supply chain management issues. Complex datasets that reflect supply chain end-to-end processes will be gathered and modelled in the metaverse. Buyers can comprehend and engage with virtual models of new or updated products thanks to virtual sourcing. Testing and exercising quality control across huge volumes of products could become considerably easier in a 3D environment because quality is crucial for supply chain compliance and customer delight.

With 3D representations of how items are created, delivered, and sold, the Metaverse will improve supply chain transparency. This would also mean that interested parties would have access to lead times, transit periods, shipping delays, and potentially real-time shipping charges. This transparency and visibility will boost trust and effectiveness among supply chain partners across industries (Kathiala, 2022).

The Metaverse will introduce a new style of client engagement that is closely related to the logistics business. The method will not only create a more detailed process simulation, but it may also inspire the development of immersive virtual worlds to improve training in warehouses and industrial facilities. There are programmes that build digital twins and develop work routines, uncover inefficiencies, and multiply productivity.

Warehouse simulation and digital twins can also help improve logistics and supply chain operations efficiency (Singh, 2022).

3. Materials and Methods

The overall method is to do an exploratory study that includes accessible synthesis on applications, practices, and other literature on metaverse and supply chain applications. To incorporate information gathered on the metaverse and supply chain, the study conducted a literature review. This paper summarised information gathered from literature review.The extant literature on the metaverse, virtual reality, and its applications in logistics and supply chain management, including peer-reviewed journal publications, unpublished / accepted studies, reports, and policies, has been analysed and studied. A systematic search was used to collect papers using phrases like "metaverse in the supply chain", "metaverse in logistics", "extended reality in the supply chain", "metaverse in warehousing", "metaverse in retail", "metaverse in transportation", and "metaverse in distribution".

Various research databases such as Scopus, Google Ccholar, and Research Gate were searched for related papers. Also, the studies related to the field were searched in Emerald, Science Direct, Inderscience, T&F, IGI Global, etc. The authors have referred to various international journals, mainly Scopus-indexed journals. Some of them are the International Journal of Operations & Production Management, International Journal of Information Systems and Supply Chain Management, International Journal of Information Management, Technovation, Computers, Materials & Continua, Applied Sciences, Mobile Networks and Applications, International Journal of Physical Distribution and Logistics Management, Supply Chain Management - an International Journal, Journal of Business Logistics, Production Planning & Control, Journal of Cleaner Production, Resources, Conservation and Recycling, Journal of retailing and consumer services, Technology in Society, etc.

Existing practices and the measures that are taken to integrate metaverse in the supply chain would benefit the participating entities in improving the supply chain performance and overall profitability. Also, it will ultimately improve customer service, experience, and overall satisfaction.This work also seeks to collect and analyse data acquired from a set of individual metaverse investigations using a literature review, assisting in finding trends that require confirmation and pointing out and offering new routes for future research. Rather than being restricted to the findings of a small number of articles, the desk research technique used for this paper yielded a greater range of relevant data, providing a clear description of a metaverse in supply chain studies.

The findings of previous studies were analysed and combined to produce the best possible outcome on the topic, while knowledge gathered from current metaverse research aids in identifying knowledge gaps.

4. Findings and Discussion

This section presents the applications of the metaverse in different components of the supply chain such as procurement, manufacturing, logistics, and retailing.

4.1 Applications of Metaverse in Multi-echelons of Supply Chains

A study by Scaff (2022) explained how some of the major supply chain challenges can be removed with metaverse, and how metaverse is providing more visibility and sustainability across the supply chain. The study also showed that the metaverse is assisting businesses in removing supply restrictions by giving them improved visibility into processes, facilities, inventory, and capacity. It gives a better grasp of what consumers desire, making demand completely "knowable."

Understanding both perspectives could help balance supply and demand. Think about a shop and its suppliers having a "collaboration space" in the metaverse. Teams can virtually meet in this space to go over anticipated sales predictions, estimated production schedules, and any supplier restrictions that might have an impact on manufacturing volume.

Also, they may virtually tour important ports to identify potential shipment delays caused by congestion and simulate potential alternatives to keep goods moving in the right direction using an immersive supply chain network map. Some of the applications of metaverse across various functions of supply chains are as follows:

4.1.1 Sourcing and Procurement

The collaboration between all parties involved in a supply chain will be enhanced by the metaverse, both inside and internationally. It entails enabling limitless and contemporaneous cooperation throughout the value chain, not just with direct vendors' vendors for cost engineering and innovation. Through increased collaboration, the entire supply chain will be more efficient and transparent, including cost talks between buyers and sellers.

The margin of error for production would improve product quality and service, lower customer churn and return rates, and promote more extensive production-optimized design collaboration. Reduced quality control expenses and travel expenses to vendor locations can lead to even more efficiencies (Kathiala, 2022). Virtual sourcing has become a more feasible option for companies and has made it possible for buyers to understand and interact with virtual models of new or updated products.

To cite an example, the "3D Virtual Showroom Feature" launched by Alibaba last year enabled procurement teams and potential vendors to browse and examine products using virtual reality technology.

4.1.2 Manufacturing

Physical manufacturing can also be simulated, and the processes can be optimized by simulating them in a metaverse environment. Before actual production, many scenarios for the distribution of assets and labour resources can be tested. The simulated manufacturing experience will result in waste control and environmental sustainability, as well as lower manufacturing process costs (Brydges, 2021). A tailored experience will also increase the customer's pleasure and engagement, which is important, and the supply chain relationships will continue to be stronger than ever (Dwivedi et al., 2022).

Additionally, the Metaverse will enable the digital simulation of goods, manufacturing procedures, and facilities to optimise resource allocation throughout the supply chain, run production scenarios, and even conduct operator training in a more realistic setting. By doing this, it is possible to prevent physical manufacturing facilities from starting and stopping as well as lengthy downtimes and learning curves in factories when there is a change in the type of product being created.

This will have significant effects on satisfying consumer demands for personalised products, which have been difficult to create affordably in conventional facilities designed for mass production (Kathiala, 2022). Workers can use Metaverse to change the factory's capacity, tools, and workforce to maximise productivity. For instance, it is anticipated that BMW's adoption of Nvidia's "Omniverse" metaverse platform to coordinate the production of automobiles at 31 facilities will increase production planning efficiency by about 30% (Chang et al., 2022).

4.1.3 Logistics Operation

The traditional logistics function can be transformed using the metaverse. Future packing and loading of items into unmanned vehicles or drones for final delivery to the destination will undergo dramatic changes (Dwivedi et al., 2022). Before constructing physical sites for storage and inventory management, XR (extended Reality), augmented reality, and virtual reality can be used to design warehouses (Kovács, 2020).

Operator training can be carried out without interfering with regular business operations and where changes to warehouse flow and layout can be tested. If the number of SKUs increases or the properties of the products change, improved space efficiency will result from dynamic space modelling, slotting, and racking optimization.

Although optimization and slotting have always been crucial, the move towards smaller and even micro-fulfilment centres, where storage space is at a premium, has made them even more crucial (Kathiala, 2022).

4.1.4 Retailing

It's big business to sell items that users can utilise in the metaverse. By 2026, a quarter of the world's population would spend at least one hour each day in the Metaverse, according one of the most recent Gartner reports. This will occur for a variety of reasons, including job, study, fun, gaming, and shopping. During this transition, retailers will generate real revenue from the sale of digital things from the metaverse.

The lack of expenses associated with running a physical business or supply chain is one of its specific benefits. Retailers are learning, however, how the metaverse might function as a platform for online sales of tangible goods. For instance, at the ComplexLand 3.0 metaverse event in May 2022, early adopter of the metaverse retail space Pacsun recently ran a multidimensional digital commerce endeavour.

While Walmart says its existing omnichannel retail footprint drives 230 million customers into its 10,500 stores and dozens of global eCommerce properties each week, even a 1% pickup of Roblox's equally large user base would bring a material boost in visitors (Pymnts, 2022). Flipkart, the Indian e-commerce behemoth, just debuted its "Flipverse" metaverse.

After creating an 'avatar' and a pseudonym for themselves, users may begin buying on the Flipkart app. Flipkart already has collaborations with over 20 different businesses for its Flipverse. Among the brands on the list are Colgate, Lavie, Noise, Puma, Noise, Nivea, Tokyo Talkies, Campus, VIP, Ajmal Perfumes, Himalaya, and Butterfly India. When a consumer comes at a counter and chooses a product in a virtual world, the Flipverse summarises the features and product information.

If the user chooses to claim or purchase the deal at that time, the app directs them to the product page (Kar, 2022). The applications of metaverse in supply chain functions and the benefits it offers to the organizations are presented in Fig. 1. To summarize the findings, in the context of a supply chain, a metaverse can play several roles, which are as follows:

- Collaboration: Collaboration between various supply chain participants, such as suppliers, manufacturers, distributors, and clients, can be facilitated via a metaverse. Users can communicate with one another virtually, share knowledge, suggestions, and criticism, and collaborate to enhance the efficacy and efficiency of the supply chain.

- Simulation: A metaverse can be used to simulate different scenarios in a supply chain, allowing users to test the impact of changes to the supply chain before implementing them in the real world. This can help to minimize risk and improve decision-making.
- Visualization: With the use of a metaverse, users can see how resources, information, and products move through a supply chain in a virtual setting. This can assist users in identifying bottlenecks, inefficiencies, and other supply chain issues and developing plans to address them..
- Training: A metaverse can be used to train users in different aspects of a supply chain, including logistics, inventory management, and quality control. Users can interact with virtual objects and environments to learn new skills and techniques, and to practice applying them in different scenarios.

Overall, a metaverse can provide a flexible and immersive platform for users to collaborate, visualize, simulate, and train in the context of a supply chain. By leveraging the power of virtual reality and other advanced technologies, a metaverse can help to improve the efficiency, effectiveness, and resilience of a supply chain, and to create new opportunities for innovation and growth.

4.2 Future Research Directions

Using metaverse technology in supply chain operations opens a new research field. To enable people to acquire a high-quality virtual experience without indulging in it to the point that it interferes with daily life, additional research can be done to strike a balance between the virtual and the real worlds (Chang et al., 2022). Moreover, the research direction can focus on analysing how a metaverse might affect a particular industry's supply chain, such as the FMCG, agricultural, or automotive supply chains. Research can also be done to understand how adding other Industry 4.0 technologies like IoT, Robotics, and AI improves supply chain performance. Another direction for more research and development efforts is to create metaverse settings based on virtual reality for the smart factory, smart warehousing, and modular design and development, as previously suggested by Alpala et al. (2022).

5. Conclusion

Despite the complexity and interconnectedness of global supply chains, many businesses continue to use laborious paper processes and old, isolated databases. They were unable to quickly recognise and respond to unanticipated geopolitical and climate-related obstacles during the pandemic as a result, leaving them vulnerable to supply chain shocks, working capital liquidity issues, and increased regulatory and reputational risk.

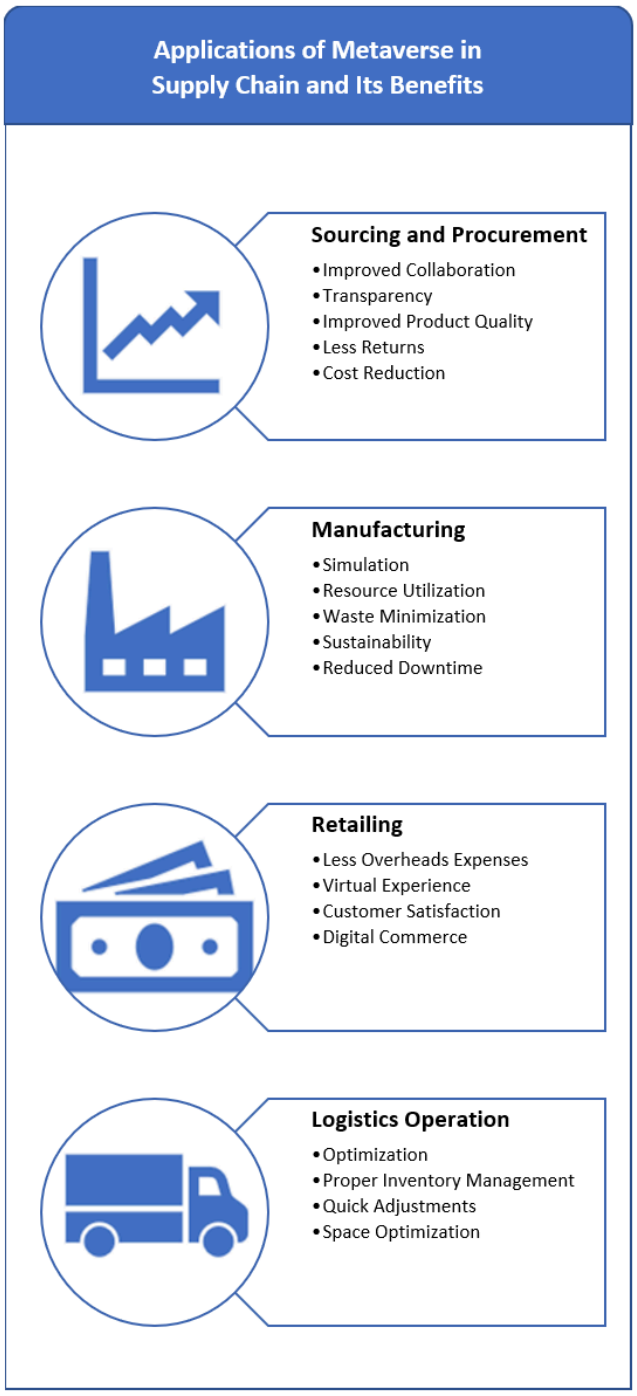

Figure 1. Applications of metaverse in supply chain functions and the benefits

The metaverse's immersive features have the potential to be extremely useful and have many applications to deal with this kind of complex and dynamic circumstances. The goal of the current study is to provide important insight into the use, advantages, and status of increasing acceptance of the metaverse from various supply chain echelons and affected corporate and societal sectors.

The study emphasized the applications of a metaverse in different areas of the supply chain such as procurement and sourcing, manufacturing, logistics operations, and retailing. Moreover, the examples of companies that successfully adopted the metaverse for improving and advancing their supply chain are also highlighted in this study. Future studies should examine the characteristics of developing metaverse retailing as well as if existing retail business models and marketing strategies need to be modified to be more effective in this new business environment. According to a study, companies should build their promotional methods using a comprehensive and all-encompassing plan, especially if they wish to compete in the metaverse stage. Finally, the authors suggest several potential study directions and emphasise the urgent necessity for policy formulation addressing the metaverse issue.

The study is limited to secondary data-based research that can serve as a foundation for supply chain academicians and scholars to understand the emerging trend of the metaverse and its applications in various components of the supply chain, ultimately resulting in supply chain performance and overall organisational growth. A primary / empirical based study can also be carried out in a particular supply chain considering the present study.

References

Alpala, L. O., Quiroga-Parra, D. J., Torres, J. C., and Peluffo-Ordó nez, D. H. (2022). Smart Factory Using Virtual Reality and Online Multi-User: Towards a Metaverse for Experimental Frameworks. *Applied Sciences*, pages 1–12.

Brydges, T. (2021). Closing the Loop on Take, Make, Waste: Investigating Circular Economy Practices in the Swedish Fashion Industry. *Journal of Cleaner Production*, pages 1–8.

Chang, L., Zhang, Z., Li, P., Xi, S., Guo, W., Shen, Y., Xiong, Z., Kang, J., Niyato, D., Qiao, X., and Wu, Y. (2022). 6G-enabled Edge AI for Metaverse: Challenges, Methods, and Future Research Directions. *Journal of Communications and Information Networks*, 07(02):107–121.

Dev, N. K., Shankar, R., and Qaiser, F. H. (2020). Industry 4.0 and Circular Economy: Operational Excellence for Sustainable Reverse Supply Chain Performance. *Resources, Conservation and Recycling*, pages 1–15.

Dwivedi, Y. K., Hughes, L., Baabdullah, A. M., Ribeiro-Navarrete, S., Giannakis, M., Al-Debei, M. M., Dennehy, D., Metri, B., Buhalis, D., Cmk, C., Conboy, K., Doyle, R., Rr, D., Dutot, V., Felix, R., Goyal, D. P., Gustafsson, A., Hinsch, C., Jebabli, I., Janssen, M., Kim, Y., Kim, J., Koos, S., Kreps, D., Kshetri, N., Kumar, V., Ooi, K., Papagiannidis, S., Pappas, I., Polyviou, A., Park, S., Pandey, N., Queiroz, M. M., Raman, R., Rauschnabel, P. A., Shirish, A., Sigala, M., Spanaki, K., Wei-Han Tan, G., Tiwari, M. K., Viglia, G., and SF., W. (2022). Metaverse Beyond the Hype: Multidisciplinary Perspectives on Emerging Challenges, Opportunities, and Agenda for Research, Practice and Policy. *International Journal of Information Management*, 66(10254):2.

Ivanov, D. and Dolguib, A. (2021). A Digital Supply Chain Twin for Managing the Disruption Risks and Resilience in the Era of Industry 4.0. *Production Planning & Control*, pages 775–788.

Joshua, J. (2017). Information Bodies: Computational Anxiety in Neal Stephenson's Snow Crash. *Interdisciplinary Literary Studies*, pages 17–47.

Jürgens, J. (2021). The Metaverse of the Supply Chain. https://topo.cc/the-metaverse-of-the-supply-chain/. Accessed: 2023, Feb 27.

Kar, S. (2022). With Flipverse, Flipkart Brings Shopping into the Metaverse. https://www.moneycontrol.com/news/business/with-flipverse-flipkart-brings-shopping-into-the-metaverse-9343471.html. Accessed: 2023, Feb 27.

Kathiala, R. (2022). Supply Chain Management Review. https://www.scmr.com/article/look_out_supply_chain._here_comes_the_metaverse. Accessed: 2023, Feb 27.

Kovács, G. (2020). Special Optimization Process for Warehouse Layout Design. In K. Jármai, . K. V., editor, *Lecture Notes in Mechanical Engineering.*, pages 194–205. Springer, Singapore.

Lee, L.-H., Braud, T., Zhou, P., Wang, L., Xu, D., Lin, Z., and Hui, P. (2021). All One Needs to Know about Metaverse: A Complete Survey on Technological Singularity, Virtual Ecosystem, and Research Agenda. *Journal of Latex Class Files*, pages 1–66.

Lee, S. H., Lee, H., and Kim, J. H. (2022). Enhancing the Prediction of User Satisfaction with Metaverse Service Through Machine Learning. *Computers, Materials & Continua*, pages 4983–4997.

Li, F. (2020a). Leading Digital Transformation: Three Emerging Approaches for Managing the Transition. *International Journal of Operations & Production Management*, pages 809–817.

Li, F. (2020b). The Digital Transformation of Business Models in the Creative Industries: A Holistic Framework and Emerging Trends. *Technovation*, pages 1–10.

Londe, B. J. and Masters, J. M. (1994). Emerging Logistics Strategies: Blueprints for the next centuary. *International*

Journal of Physical Distribution and Logistics Management, pages 35–47.

Lund, S., Manyika, J., Woetzel, J., Bughin, J., Krishnan, M., Jeongmin, S., and Muir, M. (2019). *Globalization in Transition: The Future of Trade and Value Chains*. McKinsey Global Institute, Chicago.

Marmolejo-Saucedo, J. A. (2022). Digital Twin Framework for Large-Scale Optimization Problems in Supply Chains: A Case of Packing Problem. *Mobile Networks and Applications*, pages 2198–2214.

Mentzer, J. T., DeWitt, W., Keebler, J. S., Min, S. N., Smith, C. D., and Zacharia, Z. G. (2001). Defining Supply Chain Management. *Journal of Business Logistics*, pages 1–25.

Pan, X. (2008). Information Technology in Logistics and Supply Chain Management. In *IEEE International Conference on Automation and Logistics, ICAL 2008*, pages 2185–2188, Qingdao. IEEE.

Papagiannidis, S. and Bourlakis, M. A. (2010). Staging the New Retail Drama: At a Metaverse Near You! *Journal of Virtual Worlds Research*, pages 425–446.

Prajogo, D. and Jan, O. (2012). Supply Chain Integration and Performance: The Effects of Long-term Relationships, Information Technology and Sharing, and Logistics Integration. *International Journal of Production Economics*, pages 514–522.

Pymnts (2022). Walmart Extends Run of Digital Expansion with New Roblox Pact. https://www.pymnts.com/news/retail/2022/walmart-extends-run-of-digital-expansion-with-new-roblox-pact/. Accessed: 2023, Feb 27.

Rai, A., Patnayakuni, R., and Seth, N. (2006). Firm Performance Impacts of Digitally Enabled Supply Chain Integration Capabilities. *MIS Quarterly: Management Information Systems*, pages 225–246.

Scaff, R. (2022). 4 Ways The Metaverse will Benefit Supply Chain Networks. https://www.accenture.com/us-en/blogs/business-functions-blog/metaverse-supply-chain-networks. Accessed: 2023, Feb 27.

Sharma, A. (2022). DP World to Tap into Metaverse to Solve Supply Chain Challenges. https://www.thenationalnews.com/business/technology/2022/05/26/dp-world-to-tap-into-metaverse-to-solve-supply-chain-challenges/. Accessed: 2023, Feb 27.

Singh, G. (2022). Blockchain: Financial Express. https://www.financialexpress.com/blockchain/how-metaverse-can-impact-the-future-of-the-logistics-industry/2688045/. Accessed: 2023, Feb 27.

Trivedi, S. (2022). Procurement/Supply Chain Management: Management Enthusiast. https://managemententhusiast.com/metaverse-and-its-role-in-supply-chain-management/. Accessed: 2023, Feb 27.

Tueanrat, Y., Papagiannidis, S., and Alamanos, E. (2021). A Conceptual Framework of the Antecedents of Customer Journey Satisfaction in Omni-channel Retailing. *Journal of Retailing and Consumer Services*, pages 61–72.

Yavuz, M., Çorbacıoğlu, E., NuriBaşoğlu, A., Unsal Daim, T., and Shaygan, A. (2021). Augmented Reality Technology Adoption: Case of a Mobile Application in Turkey. *Technology in Society*, 109:1598–10160.

Yuliana, O. Y., Purwanto, G. R., and Siagian, H. (2022). The Effect of Information Technology Implementation on Supply Chain Performance through Information Sharing and Supply Chain Collaboration. *Current Applied Science and Technology*, pages 1–14.

Zhao, N., Liu, X., Wang, Q., and Zhou, Z. (2022). Information Technology Driven Operational Decisions in a Supply Chain with Random Demand Disruption and Reference Effect. *Computers and Industrial Engineering*, pages 49–53.