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Assaying the Copyright Law Jurisprudence in the Age of Artificial Intelligence:A Comparative Study

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Abstract: The emergence of Artificial Intelligence (AI) as a potent creative force has thrown copyright regime into a whirlwind of challenges. At the heart of this inferno lies the perplexing question of authorship: can machines wield the pen and lay claim to intellectual property rights protection over their creations and whether AI, devoid of intention or consciousness, truly be considered an author or is it merely a sophisticated tool in the hands of human creators, nullifying itsclaim to authorship. The research paper divulges in to complex issue of copyright protection to AI- generated works and further examine how the various recent judicial pronouncements have impactedthe copyright regime with special reference to 'authorship' and 'ownership' to the AI-generated works. The author aims to dissect the intricate knot of authorship and ownership in the context of AI,untangling the challenges they pose to existing legal frameworks.
Keywords: Artificial Intelligence, Copyright law, Authorship, Ownership, Intellectual Property

1. Introduction

The swift development and rise of Artificial Intelligence (herein referred as AI) has not only proven to be a boon for stakeholders1). But it has also posed various challenges to the existing legal frameworks and Intellectual Property Rights regime is one of the many domains in the legal field which is marked by a paradigm shift2). The anthropocentric-based Intellectual Property laws are struggling to adapt and incorporate the complex AI-generated works under its regime, as the 'work' of creativity and innovations has always been subjected to human efforts3). However, the incubation of artificial intelligence has diverted the attention of stakeholders, legislators, and policymakers across various jurisdictions to delve into the dilemma whether the 'works' generated by AI or non-human creators with minimal or without human intervention falls within the ambit of current intellectual property regime4).

Over the past decade, the machines, computers, or devices empowered by artificial intelligence have been subject to producing magnificent literature, artistic and musical works which were traditionally attested only to humans5). 'Flow-Machines' is an AI model that creates or composes the music independently without human intervention or in collaboration with other human authors by "combining music rules generated by analysing a variety of music with advanced software technology to help creators to freely create various styles of melodies based on their own concepts6)." 'Amper' is the first AI of its kind to compose and produce an entire music album which was developed by a software company comprising of technical experts and professional musicians7). The researchers of Future University Hakodate developed and trained an AI programme which wrote a novel entitled, 'The Day A Computer Writes A Novel'and was nominated for Hoshi Schinichi Award8). Though the novel written by AI was not purely independent and free from human intervention as the parameters were set by the developers but ultimately AI did create a copyrighted work which was nominated for an award9).

Similarly, a 3D painting entitled 'The Next Rembrandt' was generated by an AI after analysing more than thousands of works of the renowned Dutch artist Rembrandt Harmenszoon Van Rijn10). The goal of Next Rembarndt project was to produce a new Rembrandt painting bearing similar properties of the original Rembrandt painting11). Such growing trends in the field of technology indicates the intrusion of Artificial Intelligence in the domain of Intellectual Property Rights12). The traditional anthropocentric approach implying that only a human author
can be accredited with the copyright protection for original and creative works has been posed with several complex legal

issues due to the unprecedented progress in the field of Artificial Intelligence13).

2. Challenges to Jurisprudential Foundation of Intellectual Property Rights by AI

The genesis of the Intellectual Property regime has its roots derived from the John Locke's Natural Right Based Theory, Jeremy Bentham's Theory of Utilitarian, Kant and Hegel's Personhood Theory and Reward Theory14). According to Locke's Natural right theory, an author has a natural right over his intellectual endeavour because of the labour and creativity put into by the author15). Imbibing the principle of Locke's theory, the AI should be considered an author or owner of its generated work, since the end-product or the outcome is result of AIs own computation (labour) without any interference of human16).

Fig1 Challenges to Jurisprudential Foundation of Intellectual Property Rights by AI

Therefore, giving copyright ownership to a programmer or end user for AI-generated work would be against the principle of Natural Right Theory17). Under the International Intellectual Property regime, Copyright is usually granted to original artistic, literary, musical, and

dramatic works18). Copyright is a statutory right which aims to grant protection to the original and creative works of human intellect19). Copyright law does not extend its protection to the mere ideas, but provides protection to ideas into the form of expression, i.e in tangible form20). The term 'Original' denotes creativity and does not amount to novelty21). Hence, 'Originality' is the quintessential requirement to be eligible for Copyright protection. For 'Originality of Work', the copyright law derives its jurisprudence from the following two doctrines22).

'The Sweat of the Brow': According to this doctrine 'originality' or 'substantial creativity' is not the foremost requirement of copyright23). This doctrine states that a copyright protection is granted to an author based on his significant labor, skill and hard work which is put into creation of his/her work, even if it lacks significant creativity and originality24). The sweat of the brow doctrine was further elucidated in the landmark ruling of University of London Press v. University Tutorial Pressi where the court held that "an author's expression need not be an original form rather the pre-requisite requirement is that the work must not be copied and it must originate from the author25)." Further, in India this doctrine was recognized and followed in Burlington Home Shopping v. Rajnish Chibber where the court held that 'compilation of work' by the author would be granted with copyright protection26).

'Modicum of Creativity': The test of 'originality' saw a paradigm shift from 'Sweat of the Brow' doctrine to doctrine of 'Modicum of Creativity' by US Supreme court in Fiest Publications v. Rural Telephone Service Company Inc. where the court negated the 'Sweat of the Brow' doctrine and emphasized that for a 'work' to be 'original' it must not only be the product of independent creation27). but there must be a display of 'modicum of creativity' by the author, i.e. there must be a minimum level of creativity applied by the author in its work28). Similarly, in India the Supreme Court while negating the 'Sweat of the Brow' doctrine in Eastern Book Company v. D.B. Modakii followed the doctrine of 'Modicum of Creativity' doctrine and held that "to establish copyright the creativity standard applied is not that something must be novel but some amount of creativity is required in the work to claim protection under copyright" and further the court introduced the notion of "flavour of minimum requirement of creativity29)".

Initially, the machines or computer were introduced to assist the programmers in the outcome of a desired result, where the programmers were the real originators of the final output. Such works were referred as Computer Assisted Works (CAW)30). However, the rapid change and advancement in technology has seen Artificial Intelligence come to the fore, which eventually

has side-lined the Computer Assisted Works to Computer Generated Works (CGW)31). Though CAWs do not carry any issue with respect to copyright protection since it merely acts to get the desired result32). Whereas CGW has posed a challenge to Copyright protection where the AI-enabled software/programme is the actual originator of the final output 33). Hence the question of whether AI-generated 'works' fulfils the criteria of 'originality' or 'creativity' is very much debatable as artificial intelligence rely on the existing data and programmes by human34).

3.1 Complexities arising out of AI-generated works under Copyright Laws

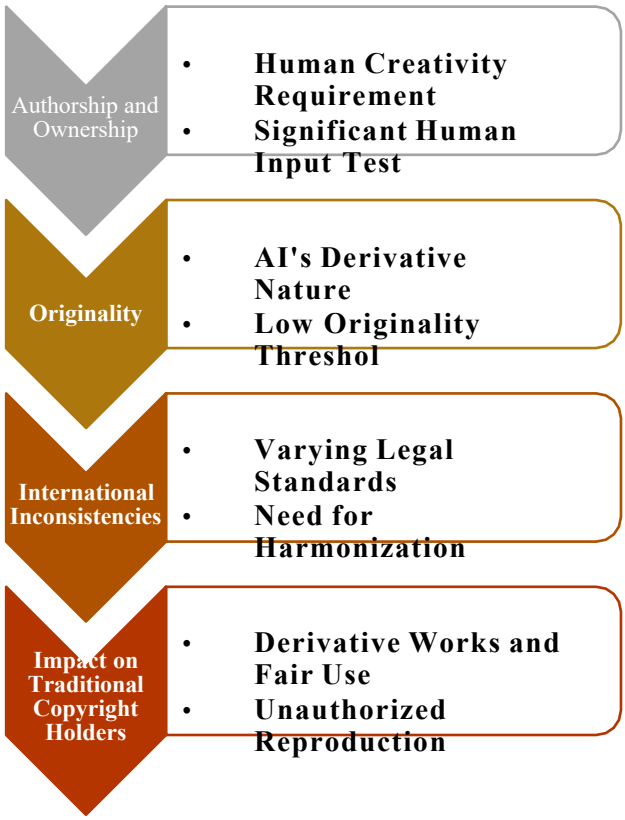

Fig. 2: Challenges of AI-generated works under Copyright Laws

At the heart of the copyright conundrum lies the perplexing question of authorship35). Can AI, devoid of intention and consciousness, truly be considered an author36). Traditional copyright law hinges on the idea of a "fixed, tangible medium of expression," authored by a human whose

creativity and ingenuity manifest in the work37). Whereas, the works generated by artificial intelligence is largely based upon the data and algorithms which eventually poses a query that whether the Artificial Intelligence trained on the complex algorithms and data which has been programmed by the humans falls within the ambit of copyright law and does it exhibit the 'originality' which is the foremost requirement for copyright protection38). Once the issue of authorship is addressed, the conundrum of ownership comes to the fore39). The question as to who owns the copyright of the works generated by artificial intelligence, whether it is the programmer who designed and programmed the AI, or is it the user of such work who used it as a creative tool or is it the AI itself40). The current existing copyright regime further complicates the issue of ownership of AI being an owner of copyrighted work41). If the AI generated work exhibits originality and autonomy and fulfils all the requirement of copyright protection, can it be provided with the copyright protection which is held in reserve for the human authors42). Hence, the current copyright framework which is largely based on anthropocentric approach i.e. only humans can be an author or owner of a copyrighted work, struggles to incorporate the creative and

original work under its ambit which is generated by AI43).

Recently, the United States Copyright Office on March 16, 2023 while delving into the issue of 'authorship' & 'ownership' to AI-generated works, published the "Copyright Registration Guidance: Works Containing Material Generated by Artificial Intelligence"44). The guidance specifically states that "US Copyright Office will not register works produced by a machine or mere a mechanical process that operates randomly or automatically without any creative input or intervention from a human author45)." Hence this implies that US copyright emphasizes and requires 'human authorship' for the purpose of registering copyrighted works as the expression 'author' in the US Copyright act excludes non-humans46). Further in assessing the AI-generated work, the US Copyright Office further clarified in its submission that it would make an analysis case by case and would see that "whether the 'work' is basically one of human authorship, with a computer or other device merely being an assisting instrument, or whether the traditional elements of authorship in the work (literary, artistic, or musical expression or elements of selection, arrangement, etc.) were conceived and executed not by [a human] but by a machine47)."

Various jurisdictions across the globe are dealing with immense challenge by bringing their laws and legal structure in consonance with the rapid growing of advanced technologies48).

Though legal systems require ample time to evolve in contrast to the ever-changing nature of technological developments, a reasonable and extensive discussion with the respective stakeholders is required to bring any kind of major changes in the legal structure with regards 'ownership' and 'authorship' to AI-generated autonomous works49).

3. Analysis of Copyright Protection to AI-generated works under various International Jurisdictions

As of now, there is no comprehensive legal framework with respect to Artificial Intelligence generated works to be regulated under Intellectual Property regime50). The current Intellectual Property regime across the world stems from the perception that original and creative work can be produced by the human intellect only51). Article 3 of Berne Convention lays down the criteria for eligibility of 'works and states that the 'author' of the 'works' seeking copyright protection should be a national of one of the signatory countries or he/she should be the first to publish the work52). Further, from the definition of 'published works provided in article 3 it is inferred that the 'author' can only be humans and not machines53).

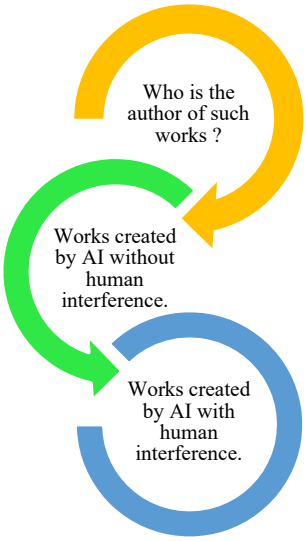

Fig. 3 Diagrammatic representation of copyright protection to 'works' generated by AI with and without human interference

United States of America

Section 17 of the Copyright Law of the United States, provides that the copyright protection would be garnered to the 'author' of the works54). Though the term 'author' has not been defined explicitly in the said statute but the issue of human authorship and non-human authorship has been delved by the US courts in various judgements55). In the landmark case of Naruto v Slater (also known as 'Monkey Selfie' case) the US District Court of Northern District of California dealt with the question of animal ownership in photographic work and held that copyright does not authorize animals to file copyright

infringement suits56). The court elaborated that the court observed that copyright law while providing protection to 'works created by the 'author' largely identifies author as a person and therefore for a 'work' to be qualified for the copyright protection must be created by a human entity57).

European Union

Under the current European Union laws, there is still a debate going on that whether the AI- generated works should be provided with the copyright protection58). There are no specific provisions in European Union legislation which suggests that the 'author' of the original creation of works should be human only but various copyright directive does require an 'own intellectual creation' by the 'author'59). The CJEU's interpretation of the term 'originality' in the leading case of Infopaq International A/S v Danske Dagbaldes Forening (2009), where CJEU held that the copyright protection would apply to only those 'works' which would "reflect the author's own intellectual creation" and therefore keeping AI-generated works out of the ambit of copyright protection60).

However, EU Parliament's Legal Affairs Committee's study on European Civil law rules in robotics has observed that there is a very sluggish progress in the copyright regime with respect to AI-generated works61). Therefore in its draft report it demanded criteria for 'own intellectual creation' for protectable works which are created by the robots and computers62). Similarly, following Infopaq, the European Union courts have emphasised the concept of 'the author's own intellectual creation' to mean works where its author expresses his creative ability in an original manner by making free and creative choices and thus stamps his "personal touch" on the works 63). Hence from the above judicial pronouncements it is construed that the court requires some kind of human input if it states that creation must reflect author's personality64).

Germany

Under German copyright law, section 2(2) of German Copyright Act provides protection for "personal intellectual creations" whereas section 7 of German Copyright Act defines 'author' as the 'creator of the work'65). Thereby, it can be inferred that the author of personal intellectual creations can only be humans and the machine generated works are kept out of the ambit of the copyright protection law in Germany66). Further, in German copyright regime, to qualify the criteria of 'originality' there must be some personal touch of the author's personality in the work created67).

United Kingdom

The UK Copyright, Designs and Patents Act, 1988 (CDPA) by adding a new provision (Section 178) provides an authorship of computer-generated work (without any human intervention) to any person by whom 'the arrangements necessary' for the creation of work has been undertaken68). However, as per section 9(3) of CDPA it is unclear as to which 'person' should undertake the 'the arrangements necessary' for the creation of work? Further, the determination of 'originality' by the AI-generated works is unclear as well69).

China

The Shenzhen Nanshan District People's Court in 2019 held that an article produced/generated by an AI system 'Dreamwriter' is liable for protection under copyright70). Dreamwriter is an intelligent data-based writing assistance system which was developed by Tencent Technology Co71). Ltd. In 2018, an article written by 'Dreamwriter' was published Tencent on its website with a note at the end stating that "This article was automatically written by Tencent's robot Dreamwriter"72). The defendant without the plaintiff's prior authorization published the same article and consequently a suit was filed by Tencent for copyright infringement73). The court held the defendant liable for infringement and stated that the article generated by the AI system 'Dreamwriter' is liable for copyright protection under the Chinese Copyright law74).

Australia

The current Australian Copyright regime does not provide copyright protection to AI-generated autonomous works75). Though, the definition of 'literary work' under the Australian Copyright Act, 1968 expressly provides protection to the computer programs76). The Australian Copyright act provides that the 'author' of a work in which copyright subsists, the person must be a 'qualified person'77). Section 32 of the act defines 'qualified person' which states that 'qualified person' is an Australian citizen or a person resident in Australia78). Hence, AI is neither a citizen nor a legal person. In the landmark judgment of Achos Pty Ltd v Ucorp Pty Ltd the court held that any inventions made by a computer cannot be shielded with

protection under copyright law as such invention is not produced by a human79).

India

Similar to the UK Copyright, Designs and Patents Act, 1988 (CDPA), section 2(d)(vi) of the Indian Copyright Act, 1957 provides that, "author' means in relation to any literary, dramatic, musical or artistic work which is computer-generated, the person who causes the work to be created" 80). It can be seen through expression from the above-mentioned section that it clearly mentions that for the purpose of computer-generated works, the person causing the work to happen will be considered as an author81). Here, the interpretation of section 2(d)(vi) patently implies that it does not exclusively recognise computers to be intelligent as humans as it only recognises those computers which are controlled or operated by the humans82).

Further, after 2012 Copyright Amendment, Section 57 was incorporated in Copyright Act, 1957 which talks about the 'Moral Rights' of the author which includes Right of Paternity and Right of Integrity83). However, these provisions merely suggests that Artificial Intelligence does not find copyright protection under the current regime84). Further, in Eastern Book Co. v D. B. Modak, the Supreme Court ruled that for a 'work' to qualify copyright protection must meet the standards of 'modicum of creativity85).' In this case the court held that for a 'work' to qualify copyright protection there must be 'minimal degree of creativity' and 'there must be some substantive variation and not merely a trivial variation86).

1. A Sui-Generis system to protect Artificial Intelligence creations

After analysing the legal structure of various international jurisdiction, it is very pertinent to note that all the national laws governing 87). IPR has adopted a traditional anthropocentric approach where an AI devoid of legal personality would not suffice in protecting its autonomous generative work under the aegis of copyright laws. Unlike humans, AI would not be liable for copyright infringement88). It would be the person behind the AI whether, legal person or natural person, who will be held liable for the infringement caused by the AI designer89). But also, if the AI designer copy another AI design and produce a work, then the issue of copyright infringement would not at all arise, because the AI lacks human authorship and originality90). Since, AI works lacks human authorship, it generally ends up in a public domain, which is another cause of concern because there is very little incentive offered to fashion companies to invest in AI-generated designs91). AI-generated designs falling in public domain would give free access to others and copy it92).

Hence it is suggested to the legislators and policy makers to withdraw their attention from the conventional anthropocentric approach and create a new Sui-Generis system to accommodate and re-evaluate the AI-generated works which does not fit in the conventional Intellectual Property rights regime93).

4. Conclusions & Suggestions

The interplay between AI and IP law presents a complex and dynamic landscape. Navigating these challenges will require thoughtful collaboration between legal scholars, policymakers, technologists, and ethicists94). Embracing innovation while prioritizing fairness, transparency, and ethical considerations is crucial for shaping an IP framework that fosters responsible and beneficial AI development95). This addressing these challenges collaboratively, it can ensure that the ever-evolving world of AI flourishes within a robust and adaptable legal framework96). It fosters creativity, protects genuine originality, and ultimately serves the broader good of society97). With the advent of Artificial Technology, we are currently entering into the stage where most of the creative works and information will be produced by the intelligent machines without any kind of human intervention98).

Therefore, while considering as to how to provide copyright protection and authorship to the AI-generated works, we should also seek to preserve the bond between intelligent machines and their works99). Further, the current moral rights regime which is granted to human authors for their creative work could well become a useful source of information in near future to vest such rights in AI systems as well100). Further, in the absence of a comprehensive legislation to protect the AI-generated works, what are the options and challenges to current IP regime is a topic to be delved into101). In pursuit of providing IP protection to the AI-generated works, the international institutions and the national laws should be reformed to acknowledge the rising phenomena of Artificial Intelligence technology and provide the AI-generated works with adequate legal protection102).

References

1) Adrien Bécue, Isabel Praça, and João Gama, "Artificial intelligence, cyber-threats and Industry 4.0: Challenges and opportunities", Artificial Intelligence Review 54, no. 5: 3849- 3886 (2021).
2) Vasiliki Liagkou, Chrysostomos Stylios, Lamprini Pappa, and Alexander Petunin, "Challenges and opportunities in industry 4.0 for mechatronics, artificial intelligence and cybernetics", Electronics 10, no. 16: 2001 (2021).
3) Nath, Shyam Varan, Ann Dunkin, Mahesh Chowdhary, and Nital Patel, "Industrial Digital Transformation: Accelerate digital transformation with business optimization, AI, and Industry 4.0", Packt Publishing Ltd. (2020).
4) Mohd Javaid, Abid Haleem, Ravi Pratap Singh, and Rajiv Suman, "Artificial intelligence applications for industry 4.0: A literature-based study", Journal of Industrial Integration and Management 7, no. 01: 83-111(2022).
5) Amit Kumar Tyagi, Terrance Frederick Fernandez, Shashvi Mishra, and Shabnam Kumari, "Intelligent automation systems at the core of industry 4.0", 1-18 (2020).
6) Zohaib Jan, Farhad Ahamed, Wolfgang Mayer, Niki Patel, Georg Grossmann, Markus Stumptner, and Ana Kuusk, "Artificial intelligence for industry 4.0: Systematic review of applications, challenges, and opportunities", Expert Systems with Applications 216:19456 (2023).
7) T. Dhanabalan, and A. Sathish, "Transforming Indian industries through artificial intelligence and robotics in industry 4.0", International Journal of Mechanical Engineering and Technology 9, no. 10: 835-845 (2018).
8) Mohsen Soori, Behrooz Arezoo, and Roza Dastres, "Virtual manufacturing in industry 4.0: A review", Data Science and Management (2023).
9) Sunil Mithas, Zhi-Long Chen, Terence JV Saldanha, and Alysson De Oliveira Silveira, "How will artificial intelligence and Industry 4.0 emerging technologies transform operations management?", Production and Operations Management 31, no. 12: 4475-4487 (2022).
10) Dmitry Ivanov, Alexandre Dolgui, and Boris Sokolov, "The impact of digital technology and Industry 4.0 on the ripple effect and supply chain risk analytics", International journal of production research 57, no. 3: 829-846 (2019).
11) Sathyan Munirathinam, "Industry 4.0: Industrial internet of things (IIOT)", In Advances in computers, vol. 117, no. 1, pp. 129-164 (2020).
12) Mohd Javaid, Abid Haleem, Ravi Pratap Singh, Rajiv Suman, and Ernesto Santibañez Gonzalez, "Understanding the adoption of Industry 4.0 technologies in improving environmental sustainability", Sustainable Operations and Computers 3: 203-217 (2022).
13) Nguyen Dinh Trung, Dinh Tran Ngoc Huy, and Trung-Hieu Le, "IoTs, machine learning (ML), AI and digital transformation affects various industries-principles and cybersecurity risks solutions", Management 18, no. 10.14704 (2021).
14) Panagiotis Trakadas, Pieter Simoens, Panagiotis Gkonis, Lambros Sarakis, Angelos Angelopoulos, Alfonso P. Ramallo-González, Antonio Skarmeta et al., "An artificial intelligence-based collaboration approach in industrial iot manufacturing: Key concepts, architectural extensions and potential applications", Sensors 20, no. 19: 5480 (2020).
15) Petar Radanliev, David De Roure, Max Van Kleek, Omar Santos, and Uchenna Ani, "Artificial intelligence in cyber physical systems", AI & society 36: 783-796 (2021).
16) Alexander Sigov, Leonid Ratkin, Leonid A. Ivanov, and Li Da Xu, "Emerging enabling technologies for industry 4.0 and beyond", Information Systems Frontiers: 1-11(2022).
17) Jan Rymarczyk, "Technologies, opportunities and challenges of the industrial revolution 4.0: theoretical considerations", Entrepreneurial business and economics review 8, no. 1: 185- 198 (2020).
18) David Mhlanga, "Industry 4.0 in finance: the impact of artificial intelligence (ai) on digital financial inclusion", International Journal of Financial Studies 8, no. 3: 45 (2020).
19) Shahryar SOROOSHIAN, and Shrikant PANIGRAHI, "Impacts of the 4th Industrial Revolution on Industries", Walailak Journal of Science and Technology (WJST) 17, no. 8: 903- 915 (2020).
20) Mohd Javaid, Abid Haleem, Raju Vaishya, Shashi Bahl, Rajiv Suman, and Abhishek Vaish, "Industry 4.0 technologies and their applications in fighting COVID-19 pandemic", Diabetes & Metabolic Syndrome: Clinical Research & Reviews 14, no. 4: 419-422 (2020).
21) Tanveer Ahmad, Hongyu Zhu, Dongdong Zhang, Rasikh Tariq, A. Bassam, Fasee Ullah, Ahmed S. AlGhamdi, and Sultan S. Alshamrani, "Energetics Systems and artificial intelligence: Applications of industry 4.0", Energy Reports 8: 334-361 (2022).
22) Theresa Sobb, Benjamin Turnbull, and Nour Moustafa, "Supply chain 4.0: A survey of cyber security challenges, solutions and future directions", Electronics 9, no. 11: 1864 (2020).
23) Jiafu Wan, Jiafu, Xiaomin Li, Hong-Ning Dai, Andrew Kusiak, Miguel Martinez-Garcia, and Di Li, "Artificial-

intelligence-driven customized manufacturing factory: key technologies, applications, and challenges", Proceedings of the IEEE 109, no. 4: 377-398 (2020).
24) Paula Fraga-Lamas, Sérgio Ivan Lopes, and Tiago M. Fernández-Caramés, "Green IoT and edge AI as key technological enablers for a sustainable digital transition towards a smart circular economy: An industry 5.0 use case", Sensors 21, no. 17: 5745 (2021).
25) Kaushik Kumar, Divya Zindani, and J. Paulo Davim. Industry 4.0: developments towards the fourth industrial revolution. Cham, Switzerland: Springer, (2019).
26) Andreas Felsberger, Fahham Hasan Qaiser, Alok Choudhary, and Gerald Reiner, "The impact of Industry 4.0 on the reconciliation of dynamic capabilities: Evidence from the European manufacturing industries", Production Planning & Control 33, no. 2-3: 277-300 (2022).
27) Kali Charan Rath, Alex Khang, and Debanik Roy, "The Role of Internet of Things (IoT) Technology in Industry 4.0 Economy", In Advanced IoT Technologies and Applications in the Industry 4.0 Digital Economy, pp. 1-28. CRC Press, (2024).
28) Elnaz Asadollahi-Yazdi, Paulin Couzon, Nhan Quy Nguyen, Yassine Ouazene, and Farouk Yalaoui, "Industry 4.0: revolution or evolution?", American Journal of Operations Research 10, no. 06: 241 (2020).
29) Norbert Meyendorf, Nathan Ida, Ripudaman Singh, and Johannes Vrana, "NDE 4.0: Progress, promise, and its role to industry 4.0", NDT & E International:102957 (2023).
30) Ray Y. Zhong, Xun Xu, Eberhard Klotz, and Stephen T. Newman, "Intelligent manufacturing in the context of industry 4.0: a review", 616-630 (2017).
31) Angelos Angelopoulos, Emmanouel T. Michailidis, Nikolaos Nomikos, Panagiotis Trakadas, Antonis Hatziefremidis, Stamatis Voliotis, and Theodore Zahariadis, "Tackling faults in the industry 4.0 era—a survey of machine-learning solutions and key aspects",109 (2019).
32) Chao Lu, Jiafei Lyu, Liming Zhang, Aicheng Gong, Yipeng Fan, Jiangpeng Yan, and Xiu Li, "Nuclear power plants with artificial intelligence in industry 4.0 era: Top-level design and current applications—A systemic review", IEEE Access 8: 194315-194332 (2020).
33) Bhanu Chander, Souvik Pal, Debashis De, and Rajkumar Buyya, "Artificial intelligence- based internet of things for industry 5.0", Artificial intelligence-based internet of things systems: 3-45 (2022).
34) Violeta Sima, Ileana Georgiana Gheorghe, Jonel Subić, and Dumitru Nancu, "Influences of the industry 4.0 revolution on the human capital development and consumer behavior: A systematic review", Sustainability 12, no. 10: 4035 (2020).
35) Ming-Lang Tseng, Thi Phuong Thuy Tran, Hien Minh Ha, Tat-Dat Bui, and Ming K. Lim, "Sustainable industrial and operation engineering trends and challenges Toward Industry 4.0: A data driven analysis", Journal of Industrial and Production Engineering 38, no. 8: 581-598 (2021).
36) Sara Anastasi, Marianna Madonna, and Luigi Monica, "Implications of embedded artificial intelligence-machine learning on safety of machinery", Procedia Computer Science 180: 338- 343 (2021).
37) Yogesh K. Dwivedi, Laurie Hughes, Elvira Ismagilova, Gert Aarts, Crispin Coombs, Tom Crick, Yanqing Duan et al., "Artificial Intelligence (AI): Multidisciplinary perspectives on emerging challenges, opportunities, and agenda for research, practice and policy", International Journal of Information Management 57: 101994 (2021).
38) M. S. Sumathi, Vipin Jain, G. Kalyan Kumar, and Zarrarahmed Z. Khan, "Using Artificial Intelligence (AI) and Internet of Things (IoT) for Improving Network Security by Hybrid Cryptography Approach", 1133-1139 (2023).
39) Dhawan Singh, and Abinash Singh, "Role of building automation technology in creating a smart and sustainable built environment", 412-420 (2023).
40) Rosario Huerta-Soto, Flory Francis, Maximiliano Asís-López, and Jeidy Panduro-Ramirez, "Implementation of Machine Learning in Supply Chain Management process for Sustainable Development by Multiple Regression Analysis Approach (MRAA)", 1113-1119 (2023).
41) Joshila Grace LK, Apichit Maneengam, Pradeep Kumar KV, and Joel Alanya-Beltran, "Design and Implementation of Machine Learning Modelling through Adaptive Hybrid Swarm Optimization Techniques for Machine Management", 1120-1126 (2023).
42) Jeff Morgan, Mark Halton, Yuansong Qiao, and John G. Breslin, "Industry 4.0 smart reconfigurable manufacturing machines", Journal of Manufacturing Systems 59: 481-506 (2021).
43) Sunil Kr Singh, Sunil Kr Sharma, Dipesh Singla, and Shabeg Singh Gill, "Evolving requirements and application of SDN and IoT in the context of industry 4.0, blockchain and artificial intelligence", Software Defined Networks:

Architecture and Applications: 427-496 (2022).
44) Elvira Nica, and Vojtech Stehel, "Internet of things sensing networks, artificial intelligence-based decision-making algorithms, and real-time process monitoring in sustainable industry 4.0", Journal of Self-Governance and Management Economics 9, no. 3: 35-47 (2021).
45) Piotr F Borowski, "Innovative processes in managing an enterprise from the energy and food sector in the era of industry 4.0", Processes 9, no. 2: 381 (2021).
46) Tanveer Ahmad, Dongdong Zhang, Chao Huang, Hongcai Zhang, Ningyi Dai, Yonghua Song, and Huanxin Chen, "Artificial intelligence in sustainable energy industry: Status Quo, challenges and opportunities", Journal of Cleaner Production 289:125834 (2021).
47) Serge-Lopez Wamba-Taguimdje, Samuel Fosso Wamba, Jean Robert Kala Kamdjoug, and Chris Emmanuel Tchatchouang Wanko, "Influence of artificial intelligence (AI) on firm performance: the business value of AI-based transformation projects", Business process management journal 26, no. 7: 1893-1924 (2020).
48) Vladimir V. Popov, Elena V. Kudryavtseva, Nirmal Kumar Katiyar, Andrei Shishkin, Stepan I. Stepanov, and Saurav Goel, "Industry 4.0 and digitalisation in healthcare", Materials 15, no. 6: 2140 (2022).
49) Yang Lu, "Artificial intelligence: a survey on evolution, models, applications and future trends", Journal of Management Analytics 6, no. 1: 1-29 (2019).
50) Pekka Ruotsalainen, and Bernd Blobel, "How a service user knows the level of privacy and to whom trust in pHealth systems?", 39-48 (2021).
51) Piotr F Borowski, "Digitization, digital twins, blockchain, and industry 4.0 as elements of management process in enterprises in the energy sector", Energies 14, no. 7: 1885 (2021).
52) Chun Hsion Lim, Steven Lim, Bing Shen How, Wendy Pei Qin Ng, Sue Lin Ngan, Wei Dong Leong, and Hon Loong Lam, "A review of industry 4.0 revolution potential in a sustainable and renewable palm oil industry: HAZOP approach", Renewable and Sustainable Energy Reviews 135: 110223 (2021).
53) Joachim Vogt, "Where is the human got to go? Artificial intelligence, machine learning, big data, digitalisation, and human–robot interaction in Industry 4.0 and 5.0: Review Comment
on: Bauer, M.(2020). Preise kalkulieren mit KI-gestützter Onlineplattform BAM GmbH, Weiden, Bavaria, Germany", AI & SOCIETY 36, no. 3: 1083-1087 (2021).
54) Rimalini Gadekar, Bijan Sarkar, and Ashish Gadekar, "Key performance indicator based dynamic decision-making framework for sustainable Industry 4.0 implementation risks evaluation: reference to the Indian manufacturing industries", Annals of Operations Research 318, no. 1: 189-249 (2022).
55) Feng Tao, Muhammad Shoaib Akhtar, and Zhang Jiayuan, "The future of artificial intelligence in cybersecurity: A comprehensive survey", EAI Endorsed Transactions on Creative Technologies 8, no. 28: e3-e3 (2021).
56) Yong Chen, Yang Lu, Larisa Bulysheva, and Mikhail Yu Kataev, "Applications of blockchain in industry 4.0: A review", Information Systems Frontiers: 1-15 (2022).
57) Dimitris Mourtzis, John Angelopoulos, and Nikos Panopoulos, "A Literature Review of the Challenges and Opportunities of the Transition from Industry 4.0 to Society 5.0", Energies 15, no. 17:6276 (2022).
58) Jiafu Wan, Jun Yang, Zhongren Wang, and Qingsong Hua, "Artificial intelligence for cloud-assisted smart factory", IEEE Access 6: 55419-55430 (2018).
59) Raffaele Cioffi, Marta Travaglioni, Giuseppina Piscitelli, Antonella Petrillo, and Fabio De Felice, "Artificial intelligence and machine learning applications in smart production: Progress, trends, and directions", Sustainability 12, no. 2: 492 (2020).
60) Iker Laskurain-Iturbe, Germán Arana-Landín, Beñat Landeta-Manzano, and Naiara Uriarte-Gallastegi, "Exploring the influence of industry 4.0 technologies on the circular economy", Journal of Cleaner Production 321: 128944 (2021).
61) Jürgen Kai-Uwe Brock, and Florian Von Wangenheim, "Demystifying AI: What digital transformation leaders can teach you about realistic artificial intelligence", California management review 61, no. 4: 110-134 (2019).
62) Trung Nguyen, Raymond G. Gosine, and Peter Warrian, "A systematic review of big data analytics for oil and gas industry 4.0", IEEE access 8: 61183-61201 (2020).
63) Abdo Hassoun, Miguel A. Prieto, María Carpena, Yamine Bouzembrak, Hans JP Marvin, Noelia Pallarés, Francisco J. Barba et al, "Exploring the role of green and Industry 4.0 technologies in achieving sustainable development goals in food sectors", Food Research International 162:112068 (2022).
64) Saeid Nahavandi, "Industry 5.0—A human-centric solution", Sustainability 11, no. 16: 4371 (2019).

65) Jiehan Zhou, Shouhua Zhang, Qinghua Lu, Wenbin Dai, Min Chen, Xin Liu, Susanna Pirttikangas, Yang Shi, Weishan Zhang, and Enrique Herrera-Viedma, "A survey on federated learning and its applications for accelerating industrial internet of things", arXiv preprint arXiv:2104.10501 (2021).
66) Ignacio de la Peña Zarzuelo, María Jesús Freire Soeane, and Beatriz López Bermúdez, "Industry 4.0 in the port and maritime industry: A literature review", Journal of Industrial Information Integration 20: 100173 (2020).
67) Alejandro Sánchez-Sotano, Alberto Cerezo-Narváez, Francisco Abad-Fraga, Andrés Pastor-Fernández, and Jorge Salguero-Gómez, "Trends of digital transformation in the shipbuilding sector", In New Trends in the Use of Artificial Intelligence for the Industry 4.0. IntechOpen, (2020).
68) Syed Asad Abbas Bokhari, and Seunghwan Myeong, "The influence of artificial intelligence on e-Governance and cybersecurity in smart cities: A stakeholder's perspective", IEEE Access (2023).
69) Atif Ali, Arif Wicaksono Septyanto, Iqra Chaudhary, Hussam Al Hamadi, Haitham M. Alzoubi, and Zulqarnain Fareed Khan, "Applied artificial intelligence as event horizon of cyber security", 1-7 (2022).
70) Aleksandra Kuzior, "Technological unemployment in the perspective of Industry 4.0", Virtual Economics 5, no. 1: 7-23 (2022).
71) Ocident Bongomin, Gilbert Gilibrays Ocen, Eric Oyondi Nganyi, Alex Musinguzi, and Timothy Omara, "Exponential disruptive technologies and the required skills of industry 4.0", Journal of Engineering 2020, no. 1: 4280156 (2020).
72) Diego GS Pivoto, Luiz FF de Almeida, Rodrigo da Rosa Righi, Joel JPC Rodrigues, Alexandre Baratella Lugli, and Antonio M. Alberti, "Cyber-physical systems architectures for industrial internet of things applications in Industry 4.0: A literature review", Journal of manufacturing systems 58: 176-192 (2021).
73) Ritika Gupta, "Industry 4.0 adaption in indian banking Sector—A review and agenda for future research", 24-32 (2023).
74) Jiafu Wan, Xiaomin Li, Hong-Ning Dai, Andrew Kusiak, Miguel Martinez-Garcia, and Di Li, "Artificial-intelligence-driven customized manufacturing factory: key technologies, applications, and challenges", 377-398 (2020).
76) Shariful Islam Mir, KM Ariful Kabir, Md Shariful Islam, and Bidyut Baran Saha, "The perception of consumers towards microalgae as an alternative food resource in Bangladesh: a contingent valuation approach", 1-17 (2023).
77) Minakshi Kar, and Neha Bothra,"Pandemic and Indian Education: Evolving Perspectives from Higher Education", 18-28 (2023).
78) Nailya Moldakhanova, Sayat Alimkulov, and Zhanibek Smagulov, "Analysis of changes in the ecological space of the Ili River delta (due to reduced flow of the Ili River)", 29-35 (2023).
79) Maha Abdallah Alshareef, "Visualization for the Transformation of Saudi Universities to Green Human Resource Management", 1-14 (2024)
80) Neha Yadav, and Dhanalekshmi Gopinathan, "Graph Based Analytics and Review of Knowledge Graph Field by Using Two Decade Data-Finding Paradigms and Opportunities". 15-31 (2024).
81) M S Sumathi, Vipin Jain, G. Kalyan Kumar, and Zarrarahmed Z. Khan, "Using Artificial Intelligence (AI) and Internet of Things (IoT) for Improving Network Security by Hybrid Cryptography Approach", 1133-1139 (2023).
82) Rosario Huerta-Soto, Flory Francis, Maximiliano Asís-López, and Jeidy Panduro-Ramirez, "Implementation of Machine Learning in Supply Chain Management process for Sustainable Development by Multiple Regression Analysis Approach (MRAA)", 1113-1119 (2023).
83) Novandra Rhezza Pratama, and Rifqi Fauzan, "Digital Technology Adaptation Strategy Formulation for Television Media Company in Indonesia Using SWOT-Fuzzy AHP-TOPSIS", 547-554 (2024).
84) Dhawan Singh, and Abinash Singh, "Role of building automation technology in creating a smart and sustainable built environment", 412-420 (2023).
85) Joshila Grace LK, Apichit Maneengam, Pradeep Kumar KV, and Joel Alanya-Beltran, "Design and Implementation of Machine Learning Modelling through Adaptive Hybrid Swarm Optimization Techniques for Machine Management", 1120-1126 (2023).
86) Hemant Kumar Chaudhary, Kartikeya Saraswat, Harshita Yadav, Hrithik Puri, Asha Rani Mishra, and Sansar Singh Chauhan, "A real time dynamic approach for management of vehicle generated traffic", 289-299 (2023).
87) Novandra Rhezza Pratama, and Rifqi Fauzan, "Digital Technology Adaptation Strategy Formulation for Television Media Company in Indonesia Using SWOT-Fuzzy AHP-TOPSIS." 547-554 (2024).
88) Dodi Sudiana, Jamilatun Nisa, Mia Rizkinia, Ratih Dewanti Dimyati, Nanin Anggraini, Indra Riyanto, Anton Satria Prabuwono, and Josaphat Tetuko Sri Sumantyo, "Monitoring the Distribution of Mangrove Area using Synthetic

Aperture Radar (SAR) and Optic Remote Sensing Data Fusion based on Deep Learning in Kotabaru Regency, Indonesia", 536-546 (2024).
89) Catur Apriono, Herry Tony Andhyka, and Fitri Yuli Zulkifli, "Effects of Polarization and Different Tissue on Terahertz Cancer Imaging", 525-535 (2024).
90) Moh Khairul Imam Assidiqqi, and Radon Dhelika, "Design of a Rotary-Based Feeding System for Improving the Performance of Eddy Current Separator", 493-500 (2024)
91) Didik Kusmayadi, Andyka Kusuma, and IGW Samsi Gunarta, "An Analysis on E-Scooter Preference for the First and Last Mile Trip in Tourist Area", 481-492 (2024).
92) Moch Syaiful Anwar, Myrna Ariati Mochtar, Efendi Mabruri, and Eddy S. Siradj, "Study of Creep Resistance on the High Chrome Heat Resistant Steel for Component Steam Boiler Power Generation", 470-480 (2024).
93) Myrna Ariati Mochtar, and Wahyuaji Narottama Putra, "Effect of Austenitizing Temperature and Holding Time on Microstructure, Hardness, and Retained Austenite Amount of HSLA Steel as Automotive Components Material", 462-469 (2024).
94) Amalia Suzianti, Sarah Malemta Peranginangin, and Safira Nurul Fathia, "Strategic Design to Increase Consumer Purchase Intentions for Sustainable Fashion Products Using Theory of Planned Behavior", 448-461 (2024).
95) Rifki Rahman Nur Ikhsan, Jangkung Raharjo, and Basuki Rahmat, "Vectorized Lambda Iteration Method for Swift Economic Dispatch Analysis", 435-447 (2024).
96) Ankit Jain, Cheruku Sandesh Kumar, and Yogesh Shrivastava, "Fabrication and machining of metal matrix composite using electric discharge machining: a short review", 740-749 (2021).
97) Achmad T. Nugraha, Gunawan Prayitno, Abdul W. Hasyim, and Fauzan Roziqin "Social capital, collective action, and the development of agritourism for sustainable agriculture in rural Indonesia", 1-12 (2021).
98) Anthony Chukwunonso Opia, Mohd Kameil Abdul Hamid, Samion Syahrullail, Charles AN Johnson, Abu Bakar Rahim, and Mohammed B. Abdulrahman, "Nano-particles additives as a promising trend in tribology: a review on their fundamentals and mechanisms on friction and wear reduction", 777-798 (2021).
99) Norfazillah Talib, Nor Athira Jamaluddin, Tan Kai Sheng, Lee Woon Kiow, Haslina Abdullah, Said Ahmad, and Aslinda Saleh, "Tribological study of activated carbon nanoparticle in nonedible nanofluid for machining application," 454-460 (2021).
100) Mochamad Arief Budihardjo, Nany Yuliastuti, and Bimastyaji Surya Ramadan, "Assessment of greenhouse gases emission from integrated solid waste management in semarang city, central java, indonesia." 23-35 (2021).
101) Alok Bihari Singh, Chandni Khandelwal, Prabir Sarkar, Govind Sharan Dangayach, and Makkhan Lal Meena, "Theoretical and Methodological Contribution of Sustainable Practices to the Hospitality Industry", 2056-2073 (2023).
102) Ariana Soemanto, Ervan Mohi, Muhammad Indra al Irsyad, and Yohanes Gunawan, "The Role of Oil Fuels on the Energy Transition toward Net Zero Emissions in Indonesia: A Policy Review", 2074-2083 (2023).
103) Singh, B. & Kaunert, C. (2024). Transforming Smart City and Smart Sustainable Tourism Projecting Artificial Intelligence and IoT: Immersive Potential for Revolutionizing Urban Living and Enhancing Travel Experience. In K. Jermsittiparsert & P. Suanpang (Eds.), Technological and Managerial Approaches to Fostering Sustainable Travel (pp. 55-80). IGI Global. https://doi.org/10.4018/979-8-3693-8115-1.ch003
104) Raghav, A., Singh, B., Jermsittiparsert, K., Raghav, R., & Yadav, U. (2024). Artificial Intelligence in Environmental and Climate Changes: A Sustainable Future. In B. Singh, C. Kaunert, K. Vig, & S. Dutta (Eds.), Maintaining a Sustainable World in the Nexus of Environmental Science and AI (pp. 485-506). IGI Global. https://doi.org/10.4018/979-8-3693-6336-2.ch019
105) Kaushik, T. K., Ravish, Singh, A., Raghav, A., Singh, B., Arora, M. K., & Lal, S. (2024). Untapping Artificial Intelligence in Environmental and Sustainable Progression: Projecting Legal and Ethical Considerations. In B. Singh, C. Kaunert, K. Vig, & S. Dutta (Eds.), Maintaining a Sustainable World in the Nexus of Environmental Science and AI (pp. 109-130). IGI Global. https://doi.org/10.4018/979-8-3693-6336-2.ch005
106) Singh, B., Kaunert, C., Malviya, R., Lal, S., & Arora, M. K. (2024). Scrutinizing Consumer Sentiment on Social Media and Data-Driven Decisions for Business Insights: Fusion of Artificial Intelligence (AI) and Business Intelligence (BI) Foster Sustainable Growth. In A. Natarajan, M. Galety, C. Iwendi, D. Das, & A. Shankar (Eds.), Intersection of AI and Business Intelligence in Data-Driven Decision-Making (pp. 183-210). IGI Global. https://doi.org/10.4018/979-8-3693-5288-5.ch007
107) Singh, B., Kaunert, C., Jermsittiparsert, K., Lal, S., Arora, M. K., & Raghav, A. (2024). Ultimate Deep Learning Acclimatization With Artificial Intelligence Drones for Environment Shield and Climate Change: Lifting Sustainability

Towards Fostering SDG 13. In B. Singh, C. Kaunert, K. Vig, & S. Dutta (Eds.), Maintaining a Sustainable World in the Nexus of Environmental Science and AI (pp. 59-80). IGI Global. https://doi.org/10.4018/979-8-3693-6336-2.ch003

108) Singh, B., Kaunert, C., & Gautam, R. (2024). Harnessing Machine Learning Intelligence Against Cyber Threats: Navigating Legal and Ethical Challenges in Global Cyber Investigations. In F. Özsungur (Ed.), Empowering Entrepreneurial Mindsets With AI (pp. 319-352). IGI Global. https://doi.org/10.4018/979-8-3693-7658-4.ch016

109) Singh, B. & Kaunert, C. (2024). AI-Driven Strategies for Customer Engagement, Market Segmentation, and Resource Optimization: Projecting End User Satisfaction and Futuristic Growth of Business. In V. Nadda, P. Tyagi, A. Singh, & V. Singh (Eds.), AI Innovations in Service and Tourism Marketing (pp. 104-128). IGI Global. https://doi.org/10.4018/979-8-3693-7909-7.ch006

110) Singh, B. (2024). Negligence and Tortious Liability: Compensatory Aspects and Legal Provisions. National Journal of Environmental Law, 7(2), 21-25.

111) Singh, B. (2024). Melting Glaciers and High Rise Sea Level: Environment Impact Assessment and Life on Land SDG 15. National Journal of Environmental Law, 7(2), 16-20.

112) Singh, B., Kaunert, C. (2025). Dynamic Landscape of Artificial General Intelligence (AGI) for Advancing Renewable Energy in Urban Environments: Synergies with SDG 11—Sustainable Cities and Communities Lensing Policy and Governance. In: El Hajjami, S., Kaushik, K., Khan, I.U. (eds) Artificial General Intelligence (AGI) Security. Advanced Technologies and Societal Change. Springer, Singapore. https://doi.org/10.1007/978-981-97-3222-7_12

113) Singh, B., Kaunert, C. (2024). Blue Ocean and Machine Learning Trajectories SDG 14: Life Below Water for Handling Ocean Pollution: Metaverse Conserve Ocean Health Sustainability Through the Lens of Transboundary Legal-Policy Regulations as Articulating Space for Futuristic Changes. In: De, D., Sengupta, D., Tran, T.A. (eds) Artificial Intelligence and Edge Computing for Sustainable Ocean Health. The Springer Series in Applied Machine Learning. Springer, Cham. https://doi.org/10.1007/978-3-031-64642-3_4

114) Dutta, P. K., Singh, B., Towfeek, A.-S. K., Adamopoulou, J. P., Bardavouras, A. N., Bamwerinde, W., Turyasingura, B., & Ayiga, N. (2024). IoT Revolutionizes Humidity Measurement and Management in Smart Cities to Enhance Health and Wellness. Mesopotamian Journal of Artificial Intelligence in Healthcare, 2024, 110–117. https://doi.org/10.58496/MJAIH/2024/013

115) Singh, B., Kaunert, C., Malviya, R., Gautam, R., & Singh, G. (2024). Generative Artificial Intelligence in the Tourism-Hospitality Industry: Strengthening Customer Relationships, Delivering Better Experiences. In M. Talukder, S. Kumar, & P. Tyagi (Eds.), Hotel and Travel Management in the AI Era (pp. 275-300). IGI Global. https://doi.org/10.4018/979-8-3693-7898-4.ch013

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