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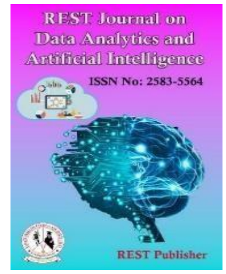

Impact of Artificial Intelligence and Robotics on Human Resource Management: A Systematic Review

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Abstract: *Artificial intelligence (AI) and robotics have become central to modern technological advances, shaping industries and transforming human interactions. This research examines the theoretical foundations of AI and robotics, their implications for human resource management, and their broader impact on economic growth, labor dynamics, and organizational structures. By systematically reviewing the academic literature, this study seeks to elucidate the main advantages and difficulties related to AI integration. This research is significant as it addresses the growing influence of AI and robotics on businesses, society and policymaking. It provides insights into their applications in HRM, healthcare and urban development, while also exploring ethical concerns and difficulties with regulations. Organizations, legislators, and researchers must comprehend these ramifications in order to successfully negotiate the rapidly changing technology landscape. Alternatives taken as Articulated robots, Cartesian robots, Delta robots, Cylindrical Robots. Evaluation Parameters taken as Includes Payload capacity, Workspace, Accuracy, Repeatability, Maintenance cost, Programmable flexibility. The results show that articulated robots received the highest ranking, whereas Cylindrical Robots received the lowest ranking. An articulated robot has the highest value for artificial intelligence and robotics according to the PROMETHEE approach.*

Keywords: *Artificial Intelligence (AI), Robotics, Human Resource Management (HRM), Machine Learning, Automation.*

1. INTRODUCTION

Research on artificial intelligence and robotics is based on the theoretical framework related to automation, robotics, artificial intelligence, and machine learning. Within this body of literature, these technologies can act as both independent and dependent variables. As dependent variables, they are studied to understand the factors that influence their adoption and use, while as independent variables, they are examined for their impact on various outcomes, including labor dynamics, productivity, economic growth, and organizational structures. [2] Even while scholarly research on intelligent automation including robotics and artificial intelligence is expanding quickly, little is known about how it affects managing human resources (HRM) for both employees and organizations (firms). This study seeks to organize current scholarly works on intelligent automation and elucidate its main advantages and difficulties for human resource management. After conducting 45 publications that examined robotics, artificial intelligence, and other cutting-edge technologies were found through a systematic evaluation of 13,136 potentially pertinent research published in esteemed journals in HRM, international business (IB), general management (GM), and information management (IM) in the context of HRM. [3] The need for intelligent robots is highlighted by the fact that traditional robots were developed with the intention of being general-purpose devices, but making them capable of performing a wide range of tasks is still expensive. Reports from PwC and the Center for Internet and Society, which emphasize the difficulties in creating a sustainable ecosystem for emerging technologies, also serve as inspiration for the study. The need for policy-oriented research to better understand the use and effects of AI on people, organizations, and governments is emphasized by ongoing discussions among academics and practitioners. [4] Over time, the fields of AI and robotics have developed in isolation. AI researchers have focused on abstract problems and algorithms, while robotics experts, often from mechanical and electrical engineering backgrounds, have specialized in sensorimotor functions. However, as both fields have advanced and interest in autonomous systems has grown, this gap is gradually narrowing. This special issue examines the current state and development of integrated AI and robotics, highlighting key directions in the evolution of machine intelligence. [5] Despite initial concerns, early technological advances freed people from routine, monotonous jobs. Decades later, society faces difficulties integrating cutting-edge technologies like FDA-approved surgical robots, self-driving automobiles, and artificial intelligence (AI) systems that resemble human behavior in a disruptive, “stimulus-provoking” way. While many of these technologies are modeled on human cognitive architecture, advances in artificial intelligence draw inspiration from human cortical systems and visual pathways. [6] Policymakers urgently need to adopt evidence-based regulations to address the advances in AI and robotics, along with concerns about control, management, and ownership. Numerous monotonous manufacturing jobs previously performed by humans have already been automated. Meanwhile, the public faces growing security and privacy issues with the development of driverless cars, maintenance robots, drones, and technologies for human repair and improvement. Significant concerns emerge as robots acquire the capacity to learn and make judgments on their own. Their actual intellect is put to the test in terms of their standing as "moral beings," as they function independently of their creators. There are significant concerns over how they can handle moral dilemmas in their behavior and relationships with people as they depend on algorithmic decision-making. [7] A revolutionary approach to patient data management, including the gathering and linking of digital photos, Prescription databases, deprivation indexes, cancer databases, surgical outcome registries, and pre-operative records will be necessary to integrate artificial intelligence into regional anesthesia. A versatile substitute for conventional statistical techniques, machine learning is excellent at finding patterns in large, complicated datasets. The NHS is in a unique position to use AI to evaluate the effects of regional anesthesia on both immediate and long-term clinical results and adverse consequences because it can aggregate data from all hospitals. [8] The creation and uptake of robotic surgery have been closely correlated with the development of AI. Using robotics for treatments like nephrectomy, prostatectomy, and cystectomy, urology has been at the forefront of laparoscopic surgical innovation. Prior research on robotic surgical perceptions and patient comfort offers important information on how the general public feels about AI in healthcare. The pervasive ignorance of AI's potential and existing uses is a recurrent topic in this study, despite the great optimism and prestige surrounding emerging technology. This study aims to examine how the general public views artificial intelligence in healthcare and assess the ways in which demographic variables impact views on AI and robots in cancer detection and treatment. [9] Three major areas of strategic interest were determined by a stakeholder-needs analysis and literature review: Internet of Things (IoT), robotics, and artificial intelligence (AI). These technologies are essential for both safety and security as well as for the expansion of the world economy. With strong evidence of their potential to spur digital innovation and transform business models, the Internet of Things (IoT), artificial intelligence (AI), and robots were acknowledged as leading technologies in 2018. Businesses must get ready for these revolutionary challenges ahead of time, considering the profound effects that artificial intelligence and robots will have on the economy of the future. The difficulties of the quickly changing AI employment market are highlighted in the 2019 AI Annual Report, which also notes the concurrent tendencies of "unconditional convergence" and "unconditional differentiation" in work requirements. [10] Artificial intelligence aligns with the pursuit of efficiency but differs from previous innovations by automating cognitive rather than manual tasks. As a continuation of the digital revolution and advancements in computer science, AI enables the rapid and seamless execution of computational tasks. What sets AI apart is its adaptability, in contrast to traditional static algorithms. The key distinction can be summarized as follows: While a standard algorithm is designed to do a certain task, a machine learning algorithm is designed to learn how to perform a task. For tasks with low complexity, the traditional approach remains more efficient, requiring less time and fewer resources. [11] While some of these ethical concerns may seem futuristic and unrelated to everyday technologies like ATMs, self-checkout machines, and touchscreen ordering systems, many are already impacting society, with others soon to follow. There is growing concern that failing to address these ethical issues now could leave us unprepared when technological advancements make them unavoidable. This paper aims to highlight key ethical challenges both current and future pertaining to artificial intelligence use and robotics in service industries. [12] The swift development of digital technologies, such as digital communication, infrastructure, and new developments, is changing many facets of social life, including human connections, work, behavior, and production and consumption. ICT developments also open up new avenues for more integrated and effective urban management, which propels the shift to "smart cities." In urban settings, technologies like big data, 5G networks, the Internet of Things, and high-speed internet are becoming more and more important. Furthermore, Robotics and artificial intelligence (AI) applications in urban environments has increased due to the growth of smart cities and automation. [13] Among the three technologies, robotics scenarios were found to require the most technological advancements and time before they could benefit special education students. This is primarily because current applications are more prevalent in non-parallel fields like manufacturing. In contrast, artificial intelligence scenarios already exist in similar environments, such as medical practice, but developing customized versions for special education could still be costly and time-intensive. Lastly, computer simulation applications presented the fewest technical challenges, as they have counterparts that closely align with potential uses in special education, such as training simulators used in business. [14] In Europe, where many organizations are actively promoting AI-Robotics interactions, this comeback is especially robust. For instance, almost one-third of the 260 members of the Euron network focus on robotics cognition an decision-making processes. This percentage is also represented in robotics projects under FP6 and FP7 (about 100 overall). Furthermore, a large number of other European research teams outside of Euron and beyond EU-funded programs are making significant contributions to the AI-Robotics synergy. However, a narrow focus on deliberative capabilities in robotics does not fully capture the breadth of European efforts in this field. [15] At this stage, "embodied AI" (together with robotics) is used for customer service and mobility. Autonomous mobility devices, like people-moving pods and drones, and self-driving cars have advanced significantly during the last ten years. Travelers are assisted in airports with mobile, interactive robots, such as autonomous carts (like KLM's Care-E) and robots that provide customer assistance (such as Josie Pepper at Munich Airport). These robots are capable of self-learning and real-time question responding abilities, enabling them to improve responses through frequent interactions. Additionally, mechanical and interactive robots are employed in airport retail and hospitality services to assist travelers. Meanwhile, digital travel companions and smartphone-based chat bots are essential in providing information about navigation and way finding. [16] Combining artificial intelligence (AI) with robots is quickly emerging as a key factor in the development of new markets, innovative technologies, and higher levels of productivity in already-established industries. AI's useful uses in real-world situations are becoming more widely acknowledged as it develops further in robotics. With applications ranging from self-driving cars to customer service, healthcare, and both industrial and service robotics, artificial intelligence (AI) is significantly changing industries and enhancing daily life. [17] Ongoing advancements the possibility for computer consciousness, sentience, and rationality is apparent in artificial intelligence and robotics. With the advancement of these technologies, there has been debate over whether they should be granted rights; however, such rights can only be considered in conjunction with corresponding responsibilities and duties. This marks a significant next step in the evolution of the field. Addressing these complexities necessitates a philosophical exploration of moral responsibility in AI and robotics.

2. MATERIALS AND METHODS

Alternatives:

Articulated robots: Robots with rotating joints that provide flexibility and a wide range of motion, often resembling a human hand. These robots typically have multiple degrees of freedom and are widely used in industrial automation.

Cartesian robots: Often referred to as gantry robots, these move in a straight line and function on three linear axes (X, Y, and Z). They are frequently utilized for CNC machining, 3D printing, and pick-and-place tasks because of their exceptional precision.

Delta robots: High-speed parallel robots with three arms attached to a single base are known as delta robots, primarily used for fast pick-and-place applications. Their lightweight design allows for rapid movements with high accuracy.

Cylindrical robots: Robots with a cylindrical coordinate system that allows movement along a vertical column with both rotational and linear motion. These robots are used in tasks such as assembly, handling, and welding.

Evaluation Parameters:

Load capacity includes: Indicates that a system, machine, or robot considers or calculates the maximum load that it can handle while performing its tasks. This includes the total weight of objects, tools, or materials that it can carry, lift, or manipulate without affecting its performance, accuracy, or stability.

Workspace: The three-dimensional areas in which a robot can effectively operate, determined by its structure, arm reach, and joint limitations.

Accuracy: The ability of a robot to accurately position itself at a given point, measured as the difference between the intended and actual position.

Repeatability: The capacity of a robot to repeatedly return to the same location under the same circumstances, which is important for tasks that require stability.
Maintenance cost: The costs associated with servicing, repairing, and replacing components of a robot throughout its operational life.
Programmable flexibility: The ability of a robot to be reprogrammed for different tasks without significant hardware changes, improving its versatility in various applications.

Method: The simplicity, clarity, and stability of the PROMETHEE procedures define a new class of outranking techniques in multi criteria analysis. To create a valued outranking relation, these techniques make use of the idea of a generalized criterion. All necessary metrics are easily determined by decision-makers due to their obvious economic significance. There are two methods: PROMETHEE I offer a partial ranking of a finite set of viable actions, while PROMETHEE II offers a complete ranking. The stability of the outcomes from both methods is also examined, and a comparison with the ELECTRE III method is also out [18]. [19] The nature of the problem determines which MCDA methods decision-makers use, and the outranking PROMETHEE method provides a useful way to assess complicated challenges using partial and complete ranking. In contrast to other approaches, PROMETHEE assumes that decision-makers can decide on criteria weights on their own and does not offer help on this topic (Wang and Yang, 2006). Combining PROMETHEE with weighting methods like AHP, Entropy, SMART weighting, and the Simos procedure is advised in order to improve the model. [20] When designing and developing good for a range of engineering applications, choosing the right material is a difficult task. In order to select materials for an automotive instrument panel, this research presents a fuzzy PROMETHEE (Preference Ranking Organization Method for Enrichment Evaluation) approach that makes use of trapezoidal fuzzy interval numbers. By using a fuzzy decision-making framework to solve material selection problems, it makes a distinctive contribution to the literature. To evaluate the method's ranking performance, it is shown, verified, and contrasted with three additional fuzzy MCDM techniques: fuzzy VIKOR, fuzzy TOPSIS, and fuzzy ELECTRE. Furthermore, Spearman's correlation coefficient is used to examine the connections between these approaches and the suggested fuzzy PROMETHEE scenarios. [21] The purpose of this work is to illustrate and validate the PROMETHEE technique, which incorporates both fuzzy and crisp criteria, for a variety of manufacturing decision-making scenarios. To ascertain the relative relevance of criteria, the method is combined with the analytic hierarchy process (AHP) and introduces a ranking value judgment on a fuzzy conversion scale for qualitative criteria. The improved PROMETHEE technique for industrial decision-making is described in the section that follows. [22] An essential issue for every electronuclear program is the management of radioactive waste. Since there can be decades between the production of electricity and the ultimate disposal of garbage in geological formations, figuring out how to fund waste disposal is one of the main challenges. The requirement to select a time period and disposal location adds to the problem's complexity. Furthermore, the viewpoints of other stakeholders, such as power providers, customers, and government agencies, must be taken into account during the decision-making process. The PROMETHEE techniques and the GAIA geometric representation have been used in a multi criteria analysis to address this. These techniques work well for issues with a large number of choices and few, highly conflicting criteria. [23] An effective method for handling multi-attribute decision-making situations with intuitionistic fuzzy information is the idea of intuitionistic fuzzy soft sets (IFSSs). Choosing how to rank options using intuitionistic fuzzy values is a major problem in IFSS-based decision-making. An expanded version of the Preference Ranking Organization Method for Enrichment Evaluation (PROMETHEE) that makes use of IFSSs is presented in this work. The work focuses on creating three different preference structures and matching utility functions, in addition to proposing a number of novel ideas, including intuitionistic fuzzy membership (or non-membership) deviation matrices, preference matrices, and aggregated preference matrices. These are created by using the aggregated intuitionistic fuzzy preference matrix to analyze the positive, negative, and net flows of alternatives. [24] Brans created the PROMETHEE method, an outranking technique that compares options in pairs to assess them. For each pair of options, the approach first evaluates each criterion independently. PROMETHEE uses preference functions, which represent the level of preference between options from the viewpoint of the decision-maker, to quantify preference differences. Higher values suggest a greater preference difference between the choices, and these functions assign values between 0 and 1. [25] This kind of information is strategically useful in helping decision-makers choose one course of action over another. Technical and economic elements are examples of variables that can be effectively managed with numerical models. However, other variables, particularly those related to environmental concerns, frequently require qualitative assessment, whether subjective or not. As a result, not all the components of an environmentally sustainable energy project may be adequately captured by conventional evaluation techniques like cost-benefit analysis and major financial indicators (e.g., NPV, ROI, IRR). Decision-makers can benefit greatly from the flexible approach that multi-criteria techniques provide which combines and assesses a variety of variables. The application of a multi-criteria approach to a real-world scenario in line with sustainable development goals is presented in this study. [26] Because different professions demand different talents and different criteria to evaluate those skills, employee appraisal and selection are essential business activities. To assess candidates' performance according to the particular job requirements for each category, a flexible and suitable approach is required. Compared to other methods, PROMETHEE is a rating system that is comparatively straightforward in both idea and implementation. In this study, qualitative data is represented using a 2-tuple linguistic technique, whereas quantitative data is represented using crisp values. Each candidate's outranking index and ranking order are then determined using the linguistic PROMETHEE approach. [27] In contrast to previous research, this strategy uses fuzzy distance-based preference structures in the PROMETHEE method. For each criterion, pairwise comparisons of alternatives are performed using fuzzy Hamming distances. The second section gives a summary of the PROMETHEE method before going into detail about the suggested strategy. After introducing fuzzy numbers and associated algebraic operations in the third section, the fuzzy PROMETHEE method is briefly explained, along with a literature review and formulation. A numerical example is provided in the fourth part to provide a detailed illustration of the suggested approach. In order to emphasize the contributions of the technique, the findings and conclusions are finally presented. Numerous industries, including banking, industrial site planning, human resource management, investments, tourism, chemistry, healthcare, ethics, mechanics, and management, have found success with the PROMETHEE technique. Its effectiveness stems from its solid mathematical underpinnings and practicality in real-world applications [28]. [29] Numerous areas have been investigated, including chemistry, business and financial management, manufacturing and assembly, logistics and transportation, energy management, society, hydrology, and water management. Papers from a variety of fields, including medicine, agriculture, education, design, government, and sports, were included in the previous section. Even if an academic work pertains to two distinct fields, applicant papers were categorized according to the most relevant topic in a subsequent evaluation to avoid duplication. The choice of the most suitable subject was given careful consideration. [30] The Analytical Hierarchy Process (AHP) is used to determine the criterion weights, which are then employed in the PROMETHEE technique to choose the optimal model. In order to identify which of six laptop models each with distinct specifications is the best, the article uses cutting-edge algorithms and a priority ranking methodology.

3. ANALYSIS AND DISSECTION

TABLE 1. Artificial Intelligence Robotics

	Artificial Intelligence Robotics					
	Includes Payload capacity	Workspace	Accuracy	Repeatability	Maintenance cost	Programmable flexibility
Articulated robots	1550	1900	5.5	2.35	35.5	0.096
Cartesian robots	1380	1670	9.5	3.24	18.9	0.093
Delta robots	1460	1128	9.8	8.86	29.6	0.869
Cylindrical Robots	1586	1450	7.5	9.16	55.4	0.152
Max	1586	1900	9.8	9.16	55.4	0.869
Min	1380	1128	5.5	2.35	18.9	0.093
max-Min	206	772	4.3	6.81	36.5	0.776
	206	772	4.3	6.81	36.5	0.776

Table 1 presents a comparative analysis of different types of artificial intelligence (AI) robotics, focusing on key performance parameters such as payload capacity, workspace, accuracy, repeatability, maintenance cost, and programmable flexibility. Among the robots, cylindrical robots exhibit the highest payload capacity at 1,586, while cartesian robots have the lowest at 1,380**.** Articulated robots offer the largest workspace **at** 1,900, whereas delta robots have the most limited workspace of 1,128. In terms of accuracy**,** delta robots lead with a 9.8 rating, while articulated robots score the lowest at 5.5. However, when considering repeatability, cylindrical robots achieve the highest value at 9.16, compared to articulated robots, which have the lowest at 2.35. Regarding maintenance costs, cylindrical robots incur the highest expenses (55.4), whereas cartesian robots are the most cost-effective, with a maintenance cost of 18.9. Finally, delta robots provide the greatest programmable flexibility (0.869), in contrast to cartesian robots, which have the lowest flexibility at 0.093. The range between the maximum and minimum values across parameters highlights notable variations, with workspace differing by 772 units, accuracy by 4.3, and maintenance cost by 36.5, demonstrating the diverse capabilities and trade-offs between different robotic systems.

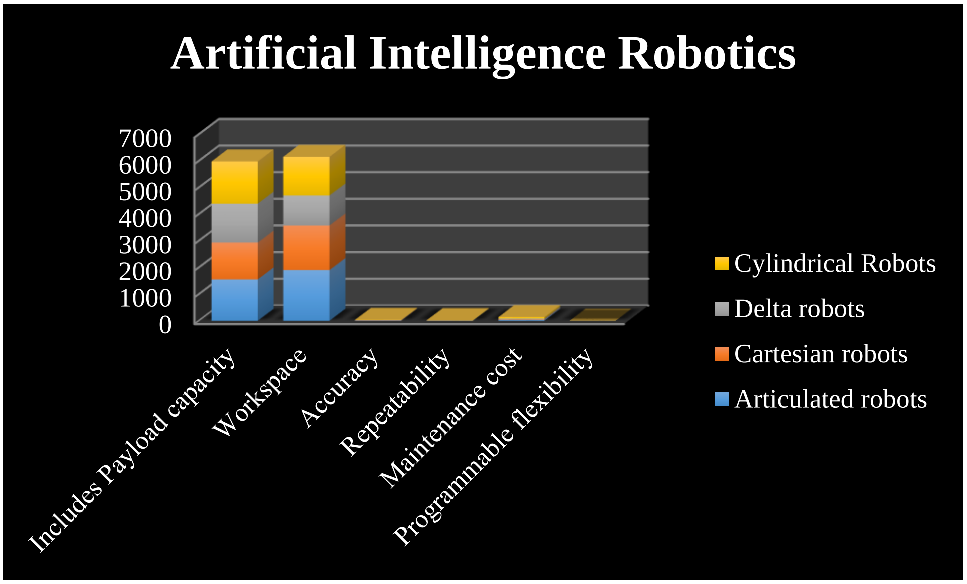

FIGURE 1. Artificial Intelligence Robotics

The table in Figure 1 provides key performance metrics for different types of artificial intelligence robotics, including payload capacity, workspace, accuracy, repeatability, maintenance cost, and programmable flexibility. Each robot type has unique characteristics that make it suitable for specific applications. Articulated robots have the highest payload capacity (1550 units) and the largest workspace (1900 units), making them suitable for tasks requiring extended reach and strength. However, they have moderate accuracy (5.5) and repeatability (2.35) compared to other types. Their maintenance cost (35.5) is significant, but their programmable flexibility (0.096) is relatively low. Cartesian robots exhibit high accuracy (9.5) and moderate repeatability (3.24) while maintaining low maintenance cost (18.9). Their work area (1670 units) and load capacity (1380 units) make them useful for precise linear motion. Delta robots stand out in terms of accuracy (9.8) and repeatability (8.86), but have a small work area (1128 units). Their high maintenance cost (29.6) and programmable flexibility (0.869) mean they are well suited for high-speed, repeatable tasks such as packaging and sorting. Cylindrical robots offer the highest repeatability (9.16), but have the highest maintenance cost (55.4). Their load capacity (1586) and moderate work area (1450) mean they are suitable for specialized applications that require precision and durability.

TABLE 2. Normalized Matrix

	Normalized Matrix					
	Includes Payload capacity	Workspace	Accuracy	Repeatability	Maintenance cost	Programmable flexibility
Articulated robots	0.8252427	1	0	0	0.4547945	0.003866
Cartesian robots	0	0.7020725	0.9302326	0.1306902	0	0
Delta robots	0.3883495	0	1	0.9559471	0.2931507	1
Cylindrical Robots	1	0.4170984	0.4651163	1	1	0.0760309

The normalized matrix in Table 2 compares different robot types based on six key criteria: payload capacity, workspace, accuracy, repeatability, maintenance cost, and programmable flexibility. Each value represents a normalized score from 0 to 1, where higher values indicate better performance in that category. Articulated robots excel in workspace (1.0) and have a high payload capacity (0.825), making them ideal for tasks requiring large reach and strength. However, they score poorly in accuracy (0.0) and repeatability (0.0), limiting their suitability for precision tasks. Their maintenance cost is moderate (0.454), and they have almost no programmable flexibility (0.0039). Cartesian robots achieve the highest accuracy (0.930) but have a lower workspace (0.702) compared to articulated robots. Their repeatability is low (0.131), and they offer no flexibility (0.0), making them suitable for tasks requiring precision but limited adaptability. Delta robots demonstrate the highest accuracy (1.0) and excellent repeatability (0.956), making them well-suited for high-speed, precise operations. They also have the highest programmable flexibility (1.0) but suffer from limited workspace (0.0). Cylindrical robots stand out in payload capacity (1.0), repeatability (1.0), and maintenance cost efficiency (1.0). However, they offer limited accuracy (0.465) and flexibility (0.076), making them reliable but less adaptable solutions.

TABLE 3. Pair wise Comparison

	Pair wise Comparison					
	Includes Payload capacity	Workspace	Accuracy	Repeatability	Maintenance cost	Programmable flexibility
D12	0.8252427	0.2979275	-0.9302326	-0.1306902	0.4547945	0.003866
D13	0.4368932	1	-1	-0.9559471	0.1616438	-0.996134
D14	-0.1747573	0.5829016	-0.4651163	-1	-0.5452055	-0.0721649
D21	-0.8252427	-0.2979275	0.9302326	0.1306902	-0.4547945	-0.003866
D23	-0.3883495	0.7020725	-0.0697674	-0.825257	-0.2931507	-1
D24	-1	0.2849741	0.4651163	-0.8693098	-1	-0.0760309
D31	-0.4368932	-1	1	0.9559471	-0.1616438	0.996134
D32	0.3883495	-0.7020725	0.0697674	0.825257	0.2931507	1
D34	-0.6116505	-0.4170984	0.5348837	-0.0440529	-0.7068493	0.9239691
D41	0.1747573	-0.5829016	0.4651163	1	0.5452055	0.0721649
D42	1	-0.2849741	-0.4651163	0.8693098	1	0.0760309
D43	0.6116505	0.4170984	-0.5348837	0.0440529	0.7068493	-0.9239691

Table 3 provides a pairwise comparison of various robot performance metrics, including payload, workspace, accuracy, repeatability, maintenance cost, and programmable flexibility. The values indicate the relative differences between robot types, where positive values indicate higher performance on that metric compared to the connected counterpart, while negative values indicate lower performance. For example, D12 (the first robot compared to the second robot) shows that the first robot has higher payload (0.825) and workspace (0.2979), but significantly lower accuracy (-0.9302) and slightly lower repeatability (-0.1307). Conversely, the reverse comparison with D21, with the opposite values, confirms this relationship. Similarly, D31 indicates that the third robot is superior in accuracy (1) and repeatability (0.9559) compared to the first robot, but significantly inferior in work area (-1) and load capacity (-0.4369). D42 shows that the fourth robot has higher load capacity (1) and repeatability (0.8693) compared to the second robot, but has lower accuracy (-0.4651).

TABLE 4. Preference Value

	Preference Value					
	Includes Payload capacity	Workspace	Accuracy	Repeatability	Maintenance cost	Programmable flexibility
	0.2336	0.1652	0.3355	0.1021	0.0424	0.1212
D12	0.1927767	0.0492176	0	0	0.0192833	0.0004686
D13	0.1020583	0.1652	0	0	0.0068537	0
D14	0	0.0962953	0	0	0	0
D21	0	0	0.312093	0.0133435	0	0
D23	0	0.1159824	0	0	0	0
D24	0	0.0470777	0.1560465	0	0	0
D31	0	0	0.3355	0.0976022	0	0.1207314
D32	0.0907184	0	0.023407	0.0842587	0.0124296	0.1212
D34	0	0	0.1794535	0	0	0.1119851
D41	0.0408233	0	0.1560465	0.1021	0.0231167	0.0087464
D42	0.2336	0	0	0.0887565	0.0424	0.0092149
D43	0.1428816	0.0689047	0	0.0044978	0.0299704	0

Table 4 presents the preference values for various robot performance metrics, including payload, workspace, accuracy, repeatability, maintenance cost and programmable flexibility. The values reflect the level of preference for each attribute in different pairwise comparisons, indicating the importance of each metric in decision-making. The overall preference weights show that accuracy (0.3355) is the most important factor, followed by payload (0.2336) and repeatability (0.1021). Maintenance cost (0.0424) and programmable flexibility (0.1212) have relatively low importance, indicating that accuracy and operational efficiency take precedence over cost-effectiveness in robotics selection. For individual comparisons: D31 (third robot vs. first) has the highest accuracy preference (0.3355) and repeatability (0.0976), making it a strong contender for tasks requiring precision. D42 (fourth robot vs. second) ranks highest in load capacity (0.2336) and repeatability (0.0888), indicating its suitability for handling heavy loads with high reliability. D14 (first robot vs. fourth) scores zero on all measures, indicating that it is less preferred compared to the fourth robot.

TABLE 5. Positive flow, Negative Flow, Net flow

	Positive flow, Negative Flow, Net flow		
	positive flow	Negative Flow	Net flow
Articulated robots	0.845286	0.4033677	0.4419184
Cartesian robots	0.2148477	0.3225771	-0.1077294
Delta robots	0.3924286	0.2121163	0.1803124
Cylindrical Robots	0.3170196	0.8315209	-0.5145013

Table 5 provides data on positive flow, negative flow, and net flow for different types of robots, highlighting their overall performance in various operational situations. Articulated robots show the highest positive flow at 0.845286, indicating strong performance and adaptability. Their negative flow, 0.4033677, is moderate, resulting in a positive net flow of 0.4419184, which makes them very advantageous in automation. Cartesian robots show a positive flow of 0.2148477, but a slightly higher negative flow of 0.3225771, leading to a negative net flow of -0.1077294. This suggests that these robots may have limitations in flexibility or performance, perhaps due to the restricted movement in their linear axes. Delta robots perform relatively well, with a positive flow of 0.3924286 and a low negative flow of 0.2121163, and a positive net flow of 0.1803124. Their high-speed precision capabilities contribute to their favorable net effect. However, cylindrical robots have the lowest performance in net flow, with a significantly high negative flow of 0.8315209 compared to a positive flow of 0.3170196, resulting in a net flow of -0.5145013. This indicates major limitations, which may be due to the range of motion or inefficiency in practical applications.

TABLE 6. Rank

	Rank
Articulated robots	1
Cartesian robots	3
Delta robots	2
Cylindrical Robots	4

Table 6 presents the ranking of different types of robots based on their performance, efficiency, or overall effectiveness in specific applications. Articulated robots hold the top position, ranked 1st, which aligns with their high positive flow and favorable net flow from the previous table. Their versatility, precision, and adaptability in complex tasks make them the most effective robotic type among the four. Delta robots are ranked 2nd, reflecting their strong performance, particularly in high-speed and precision-oriented tasks. Their positive net flow supports this ranking, showing they are a reliable option for industries requiring rapid and accurate movements. Cartesian robots are placed 3rd, indicating that while they have some advantages, their efficiency may be limited due to constraints in movement and flexibility. Their slightly negative net flow suggests they may not perform as well in dynamic environments compared to articulate or delta robots. Finally, cylindrical robots rank 4th, confirming their lower efficiency and high negative flow. Their limited range of motion and adaptability likely contribute to their lower performance in comparison to the other robot types. This ranking suggests they may be less suitable for applications requiring flexibility and precision.

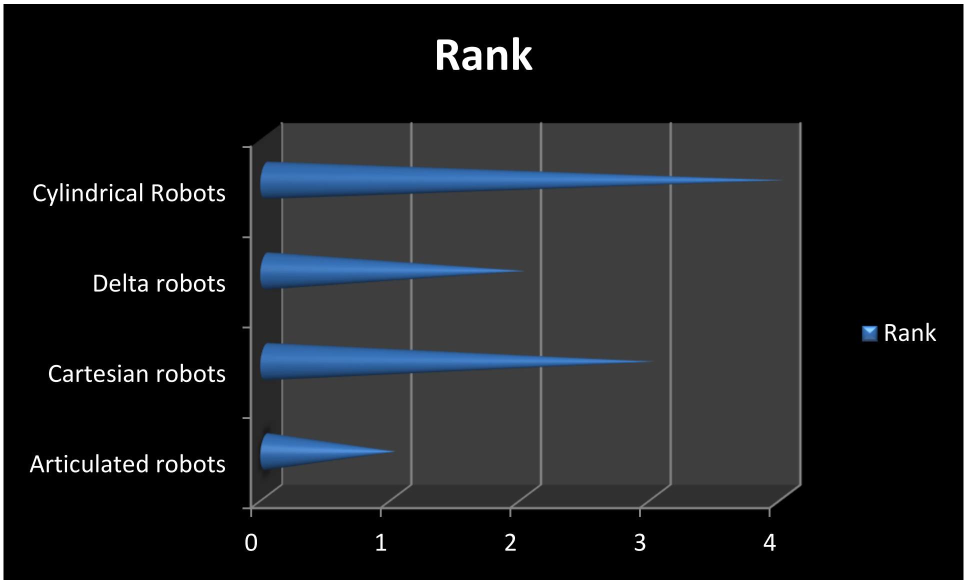

FIGURE 2. Rank

Figure 2 presents the ranking of four types of robots based on their overall performance, efficiency, or suitability for specific applications. Articulated robots secure the 1st rank, indicating their superior capabilities in automation. Their high flexibility, precision, and ability to perform complex movements make them the most effective option. This ranking aligns with their strong positive net flow, as observed in previous data, reinforcing their dominance in industrial and manufacturing applications. Delta robots are ranked 2nd, demonstrating their high-speed efficiency and accuracy, particularly in applications such as packaging and sorting. Their lightweight design and quick response time contribute to their strong performance, justifying their placement above Cartesian and cylindrical robots. Cartesian robots rank 3rd, suggesting that while they offer accuracy and simplicity, they may lack the flexibility and speed of higher-ranked robots. Their lower net flow supports this ranking, indicating that their performance may be more suitable for specific, controlled tasks rather than highly dynamic environments. Cylindrical robots take the 4th rank, highlighting their lower adaptability and efficiency. Their restricted range of motion and higher negative flow suggest they may not be as effective in diverse industrial applications compared to the other robot types. This ranking reflects their limitations in modern automation.

4. CONCLUSION

The rapid advancement of artificial intelligence and robotics has significantly transformed industries, economies, and societal structures. These technologies have evolved from mere automation tools to complex, adaptive systems capable of cognitive decision-making, self-learning, and autonomous operations. Theoretical frameworks in AI and robotics research highlight their role as both dependent and independent variables, illustrating their dual impact on adoption dynamics and broader economic and labor market changes. Despite substantial academic interest, critical gaps remain in understanding their implications, particularly in policymaking, ethics, and human resource management. Among the main worries is the effect of intelligent automation on the workforce. While AI and robotics have historically eliminated mundane, repetitive tasks, they now challenge skilled professionals in areas such as healthcare, finance, and even creative industries. The adoption of AI-driven decision-making in HRM raises ethical and operational challenges, including bias in hiring algorithms, data privacy concerns, and the evolving employer-employee relationship. Systematic reviews of existing research indicate a growing need for policy interventions to manage these transitions effectively. Furthermore, the integration of AI in robotics has led to significant breakthroughs in autonomous systems, from self-driving vehicles to robotic surgical assistants. These advancements raise fundamental questions about accountability, ethics, and the role of AI in society. The distinction between human and machine intelligence is becoming increasingly blurred, leading to debates about AI consciousness, rights, and moral responsibility. While technological progress offers undeniable benefits, including efficiency, precision, and economic growth, its unchecked expansion poses risks related to job displacement, security, and ethical dilemmas in decision-making. To navigate these challenges, policymakers, researchers, and industry leaders must work collaboratively to establish evidence-based frameworks that ensure ethical creation and application of AI. Legal requirements, ethical standards, and multidisciplinary research efforts are necessary to balance innovation with societal well-being. As AI and robotics continue to advance, the key focus must remain on sustainable and inclusive growth, ensuring that technological progress benefits humanity rather than exacerbating existing inequalities. In conclusion, the future of AI and robotics depends not only on technological breakthroughs but also on how society chooses to integrate, regulate, and adapt to these rapidly evolving systems.

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