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Innovation, Artificial Intelligence in Contingent Work-Force Management

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Abstract. In recent years, the global use of contingent workers is rapidly increasing despite the increasing quantity of artificial intelligence applications in business. The question is "how these companies leverage the use of artificial intelligence to enhance contingent workforce's management?". The ideal goal of this paper is to develop a purely conceptual application of innovation, artificial intelligence (AI) adjacent to contingent workforce management(CWM). The researcher used qualitative information gathered from various authors and observations to reinforce the usage of AI. One of the critical tools to integrate with contingent workforce management for reduction of time spent on human resource administrative tasks is AI. There must be a transformation of thinking, accepting positive organizational change, utilization of technology and openness to new technology to foster AI. Along with that, integrating contingent workforce management with AI reduces risks and costs, increases efficiency and quality of work. Innovation and Artificial intelligence have been used in five pillars performance of contingent workforce management to mitigate the challenges associated with it.

Keywords: Innovation, Artificial intelligence, Contingent workforce, Workforce management, Pillars, Workforce architecture

1. Introduction

In the 21st Century, changing of workplaces for the employee is increasing, and lifelong employment is coming to an end. The convergence of AI and the contingent workforce is expanding too. Contingent workforces are rapidly growing due to globalization, demographics, and technological- logical advancement and this growth pose challenges for human resource (HR) functions[11]. The integration of AI with technologies is poised to unlock the wealth of opportunities for businesses. AI has been an essential instrument in cost-cutting, fast in analyzing data, Quick decision making, quality control performance, compliance and risk, total talent management, forecasting and demand, scheduling and multichannel sourcing. Contingent workforce management simplified by AI software. It has eased hiring, automatic CV sorting, leveraging talent management as per the demands of clients in dynamic and innovative today's world. Innovation is the process of translating an idea or invention into a good or service that creates values or for which customers will pay (www.businessdictionary.com).

Artificial intelligence (AI); the ability of the digital computer or computer-controlled robot to perform tasks commonly associated with intelligent being (Encyclopedia Britannia) and Also AI can be defined as the simulation of human intelligence processes by machines especially computer system. A

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contingent workforce is a labour pool whose members are hired by an organization on-demand basis. An approximation of the size of the contingent workforce vary widely, partly because of the way contingent are defined[16, 17, 18].In the UK, the term contingent work commonly used to identify the organizations on the part-time, self-employed, temporary and or contractual basis [11]. The contingency workforce consists of freelancers, independent contractors, and consultants who are not on the company's payroll because they are not a full-time employee of the organization. A contingent workforce management program enhances leverage of the entire permanent employees and contingent workers while streamlining operations, reducing time waste, cutting costs and provide the data. Despite much research in this area, there still considerable ambiguity over precise exactly what contingent work is and its definition changes [12].

1.1. Problem statement

Many companies are striving using contingent workers because of staffing flexibility and apparent cost reduction. They still encounter compliance problems, poor company decision making, lack of proper planning, forecasting reduced performance and poor quality of work. This paper applies innovation, artificial intelligence (AI) adjacent to contingent workforce management. It uses qualitative information gathered from various authors and observations to come up with a new contingent workforce management model/architecture. From the very beginning some questions which need to be answered in this paper are;

- What are the key performance indicators of contingent workforce management?
- What are the main challenges which are facing contingent workforce management?
- What are the key areas of AI essential for contingent workforce management?
- Is it possible to integrate AI with contingent workforce management to address the challenges.?

2. Related Studies

Over an extended period, many studies on the use of AI in contingent workforce management conducted. For[15]explained the use of robotics systems in the precision and dexterity required to perform specific surgical procedures such as hysterectomies though in a manful sense. The robots are growing more capable of duplicating the mechanistic aspects of highly skilled jobs. Some kind of contingent skills will not be in demand if robots become high pervasive. There is a potential of computer gaming persons to become quite valuable to the military “pilots for uninhabited aerial Vehicles (UAVs) and other types of the military where needed. Advancement of AI in the contingent workforce management has significantly changed the type of workforce need. However, it does not guarantee the full replacement of the human element. The Author in [17], used artificial intelligence in teaching and learning in high education. The research conducted to leverage the new emerging technology to address the challenge of an institution of high education and student's learning mechanism. The [25]used the agent-based intelligent infrastructure of the contingent management system (CMS) to support information collection from distributed heterogeneous databases. CMS also involves the integration with enterprises legacy software systems, logistics planning and monitoring of contingency situation in an open, dynamic agent environment. The algorithm based on the cooperative game-theoretic model with fuzzy coalitions

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developed. [26], proposed a cooperative architecture for an intelligent decision support system for contingent Management. The framework embedded expert knowledge within the DSS to provide intelligent DSS using collaborative technologies by putting the decision-maker effectively in the loop of the decision process. The use of the structural domain and conceptual task modelling. Moreover, the decision support system defined as a computer-based system designed to actively interact with an individual decision-maker in order to assist him to make better decisions based on the information obtained.[28] used machine learning to build a help desk system for IT Service Management. The help desk developed uses accurate ticket classification of machine learning model to associate a help desk ticket with its correct service for the start and hence minimize ticket time resolution

3. Contingent Workforce Management

Workforce Management(WM) is an integrated set of processes that a company uses to optimize the productivity of its employees. CWM involves effectively forecasting labour requirements, creating and managing staff schedules to accomplish a particular task on a day-to-day and hour-to-hour basis. A comprehensive CWM system encompasses a range of activities within the broader framework of human resources management (HRM). Forecast and budgeting, staffing scheduling, time and attendance, employee performance management, compliance, payroll and benefits administration and vacation and leave planning are among the activities of CWM.

There is no doughty that technology is actively shaping the world of work. From digital talent engagement to artificial intelligence. The realm of innovation is a power spectrum to the concepts of the futures of workers. In today's organizations, advanced data analytics are changing the way humans work and interface with technology in order to complete their works. There is much fear that computers and robotics will compete with the decades-long process of automating works out of their jobs. The technology today and for the seeable future will argument five pillars of focus for a successful contingent workforce Management Program such as;

- Analytics and business intelligence – Data is a crucial key component of contingent workforce management,
- Talent engagement/management in most organization contingent labour touches multiple areas of the company, Spend/ Supplier management; eliminating rogue spend is just one realized cost-saving,
- Collaboration (HR, Procurement) Compliance management and risk mitigation; mitigating risk are primary concerns when dealing with an extended labour force.

The contingent workforce characterized by Temporary or agency workers, professional workers, projects or statements of work, independent contractors or free labour and graduates or intern. AI can do all the administration work. Candidate has self-selecting themselves. Four Key performance of workforce contingent management are:

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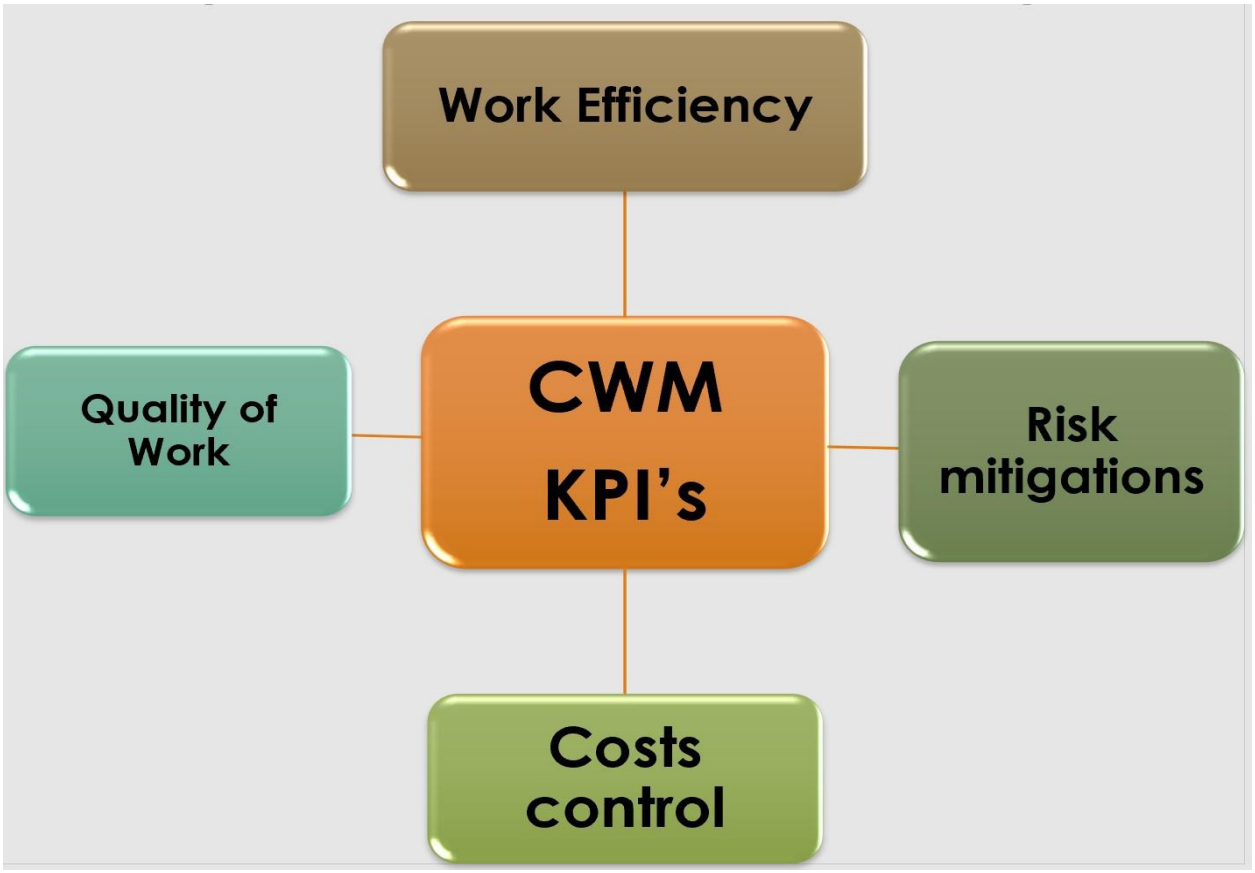

Figure 1: Key performance indicators of CWM

4. Benefits and risks of engaging contingency workforce management

The potential benefits of using a CWM system include improved employee efficiency, better labour planning, lower operational costs, adequate time, attendance tracking and better customer service. In contrast, the benefits of using contingent workforce management are limited administration burden, no need to pay employee taxes, social security and healthcare, immune from litigation and discrimination (without limits). No bonus or variable pay elements necessary. Scalable- constant quickly and with little or no notice required. No redundancy payments. Flexible and on-demand required, e.g. vehicles and office.

4.1. Top contingent labour pressures

- Strive for Better management of all facets of contingent labour.
- Mitigate contingent workforce risk.
- Increase contingent workforce visibility.
- Reduce contingent workforce cost

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5. Artificial intelligence domains which are applicable in CWM

Artificial intelligence is the development of a computer system that is capable of performing tasks that typically require human intelligence. Such tasks include decision making, object detection, solving a complex problem and other related challenges. There more than six domain of AI which can be applicable in contingent workforce management. The fundamental aspects of AI (1955) were simulating higher functions of the human brain, programming a computer to use inclusive language. It was supplementary of positioning hypothetical neurons in a way so that they can form thoughts.

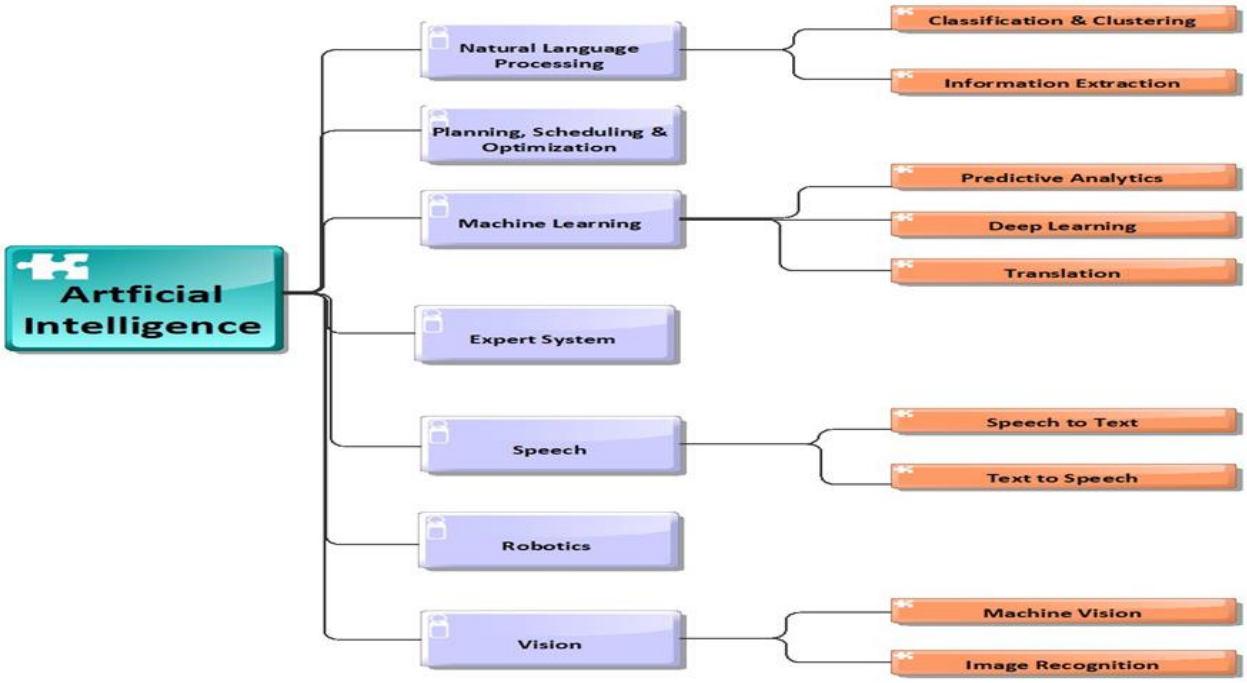

Figure 2: Branches of AI work with Contingent workforce management.

5.1. Machine Learning

Machine learning(ML) is the method that provides the ability to a computer system to automatically learn(compared to the data mining process) from the past data. ML improve its performance from experience without being programmed by the human being. It processes many quantities of data within a short time, the more the data the accurate is the model output. It is part of artificial intelligence which has three main activities, as shown in figure 3 below. Reinforcement learning, unsupervised learning and supervised learning and going dipper under the category of supervised learning. It is kind of learning which uses the labelled data to improve from past experienced data. Under supervised learning, there are two main activities; one is classification, and the other is the regressional analysis which grouped into one called Support Vector Machine.

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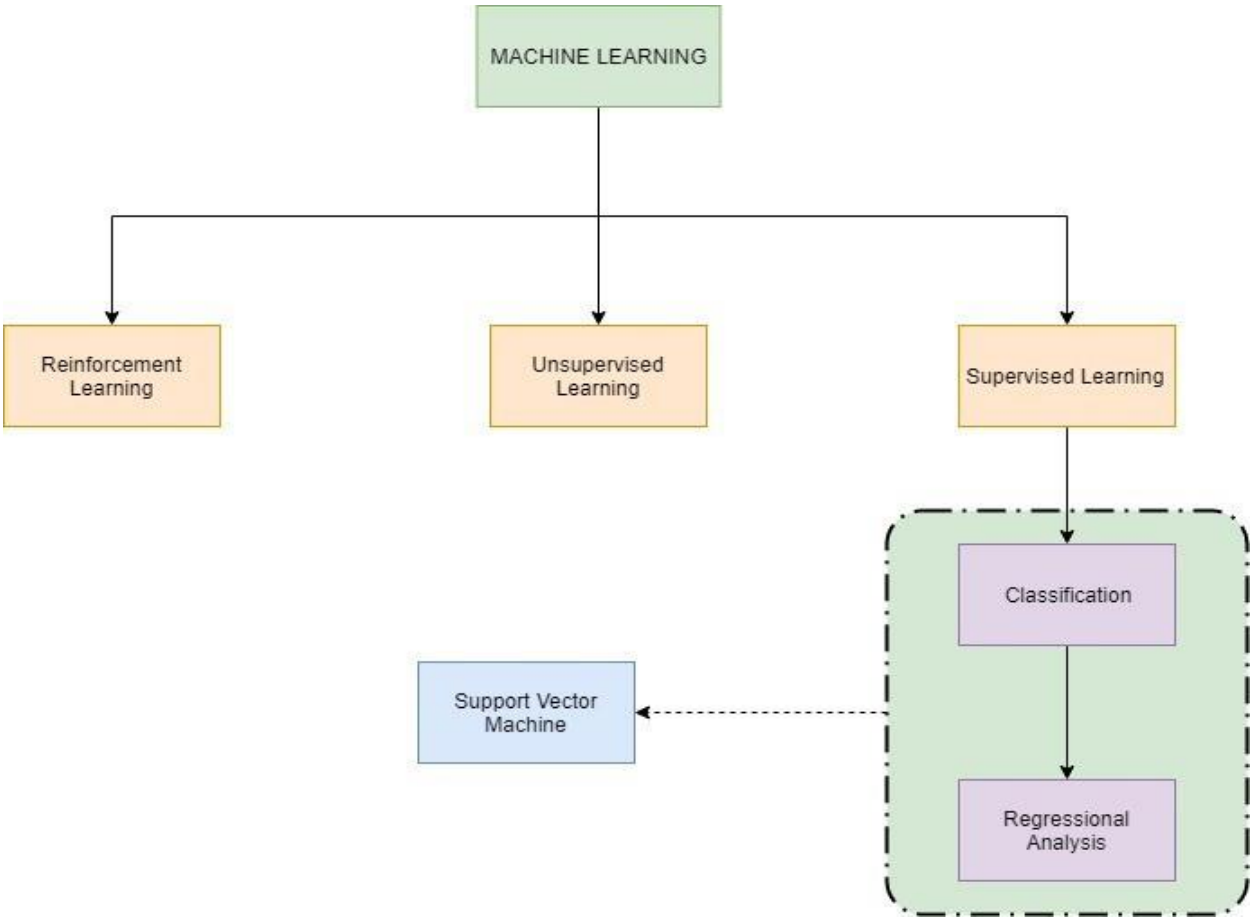

Figure 3: Machine learning.

5.2. Support Vector Machines

Support Vector Machine(SVM) comprises two operations under supervised machines learning algorithm as depicted in figure 3 above. It can make classification of things and predict what will happen on the depended variable. All that happen as a result of the change in independent variables weather in the linear model or non-linear model. The primary goal of the SVM is to find the optimal line (hyperplane)that maximally separates the two classes [42]. On top of that, SVM can make face recognition and speaker verification. Talking about classification, SVM is a powerful supervised machine learning which has the capability of classifying two separable patterns by use of two hyperplanes. The activation function can be any number of things such as sigmoid, hyperbolic tangent or modified linear equations, as shown in equation 2. Figure 4 below shows various inputs of the activation functions, where those inputs have to be weighed first before passing to the activation function. The weights of the weighted sum have to be adjusted first. After the application of the activation's factions' inputs, we can get the output. The outputs frequently are compared to the real perceptions. If it is not the same, then the adjustment of the sum of the weighted sum is made again and again until the transparent image obtained.

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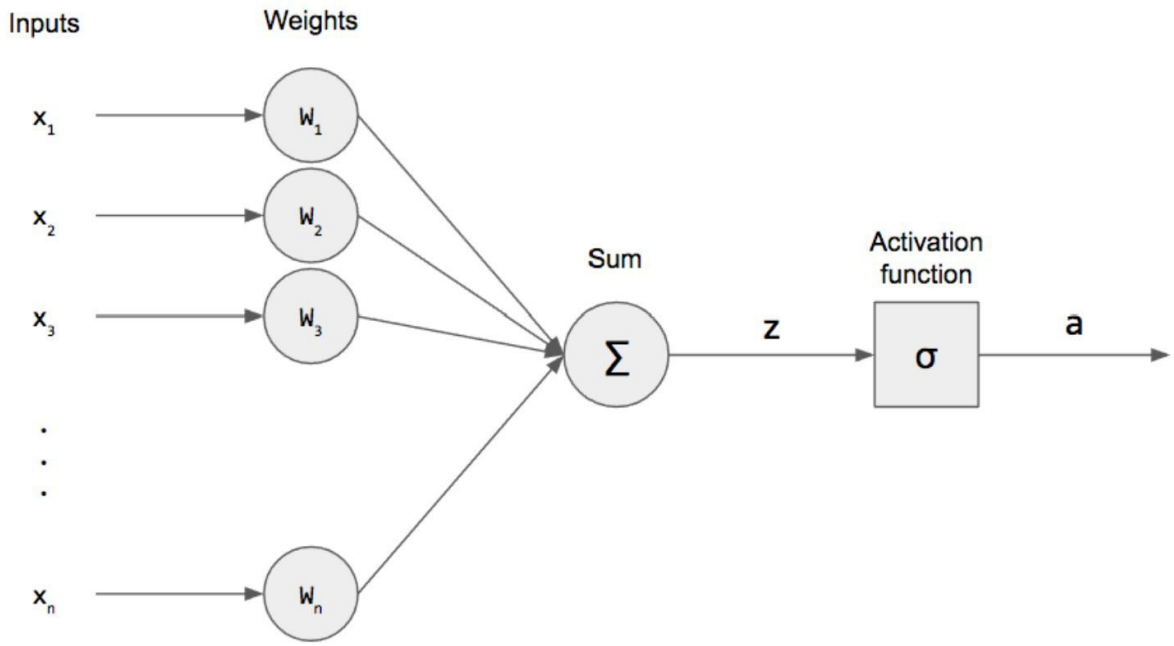

Figure 4: Activation function: Source: [42]

The hyperplane has the decision plane separated by ±1 class with the most significant margins, and the purpose is to minimize errors[39]. Sometimes SVM is expressed to answer two common pattern recognition problems. These two patterns put into the SVM algorithm. The resulting surface is a weighted mixture of elements of the training set. It is a binary classification method that is characterized by two lines that make the classification. The inputs to SVM is a set of(x_i, y_i)

Where x_i is the data input and y_i = −1 and 1

The output of an SVM algorithm is a set of $_s$ support vector s_i

a_i is weight coefficient and labels y_i of the support vectors and constant term b

The linear decision surface is [39]

whereas

$$wz + b = 0 \ (1)$$

$$w = \sum_{i=1}^{N_s} \alpha_i y_i s_i \ \ (2)$$

This equation extents to non-linear decision surfaces as

$$\sum_{i=1}^{N_s} \alpha_i y_i K(s_i, z) + b = 0 \ \ (3)$$

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For facial identification the is a gallery g_i of m known individuals. The probe p is the one to be identified; then the system will compute first the similar score of the probs and each of the gallery images. The similarity score between p and g_i is

$$\delta_j = \sum_{i=1}^{N_s} \alpha_i y_i K(S_i, g_i - p) + b \quad (4)$$

wherein the second the probe is identified as a person and has a minimum similarity score δ_j.

By using the knowledge of the Support vector machines, the company will be able to manage the contingent workforce. Face recognition and predicting the future trend of workers help to take risk analysis and mitigation measures and finally improves the performance of the organization through better management of the contingent workforce.

5.3. Genetic Algorithm

It is a meta-heuristic inspired by the process of natural selection. The process begins with a position of individuals called population, and each individual is a solution to the problem in place. An individual may be a set of variables called Genes. Genes are combined to form a chromosome in which we call a solution in the context of discipline in artificial intelligence. The following step is the fitness of the function. The fitness of the function observed how good it is and the observed through fitness score of values and all bases on probability [43, 44, 45, 46, 47]. The selection phase of selecting individual members who are fit selected for another perpetuation of the next generation.

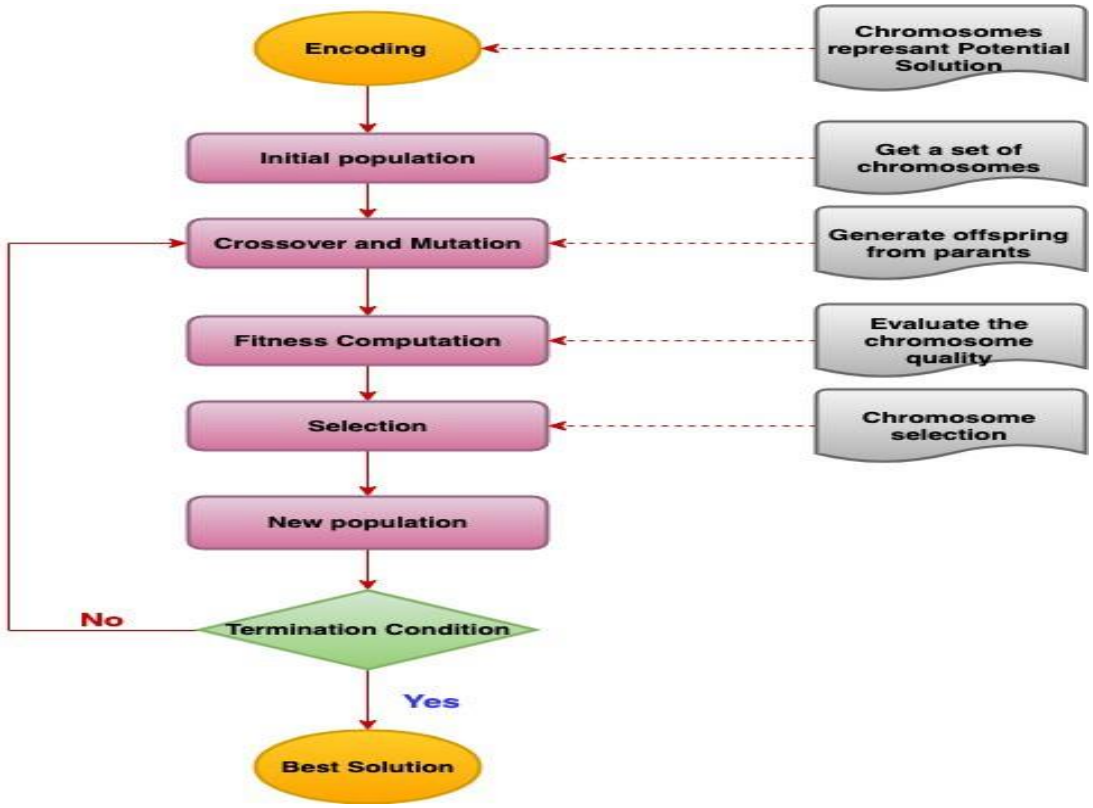

Figure 5: Genetic Algorithm process

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The best individuals selected are then crossed and then followed by mutation. Finally, termination takes place as long as the desired solution reached. Complex problems solved by the use of a Genetic Algorithm which is capable of finding the optimal solution [48, 49]. GA is a natural process of evolution when referring to biological science. It has the power of solving heuristics kind of problems. The genetic algorithm as a class of stochastic search algorithms has an advantageous selection method for discovering optimal solutions to a wide variety of problems. A genetic algorithm is a handy useful tool for selecting the best employee, during recruitments and normal work operations. When dealing with GA, the following parameter has been put in place; encoding method, chromosome length, population size, mating method/ crossover method, crossover rate, mutation method, mutation rate, fitness method, selection mechanism and termination [50, 51]

. The search problems by relying on bio-inspired operators such as mutation, crossover, and selection for GA has to be executed. There must be a specific sequence of tasks and start times (genes) represents one genome in our population.

(i) A useful selection method called "Fuzzy roulette wheel selection.

(ii) A new crossover operator that uses a hierarchical and item A new mutation operator that helps and maintaining population diversity and overcoming premature convergences[51].

5.4. Robotic Process Automation (RPA)

RPA is an umbrella term for tools that operate on the user interface of another computer system in the way a human would do [31]. It is the application of technology that enables computer software to partially or fully automate human activities which are manual, repetitive and rule-based. It usually performs " if-then-else rule of the structured statement [31]. RPA gives an institution the capacity to identify out a corporate process that is definable, repeatable and rules-based and allocate a software robot to accomplish the execution of that progression. It assumed that 22% of IT jobs could be replaced by robotic process automation in the coming years. All non-value adding steps had proven to improve significantly more than 40% [33]. RPA increases efficiency and effectiveness through the reduction of the workforce with the so-called "digital workforce" [33]. According to [32] RPA has technical infrastructure which includes; (i) Interactive client(Developer or Controller) (ii) Runtime Resource PC (1-10 Robots per pc) (iii) Application Server (Service, I per 100 robots) and (iv) Database(1 per environment). For [36], the RPA system includes IoT devices. It serves as part of a subnetwork for secured communication relating to contingent workforce management. Robotic is where machine mimics human actions, and the process is a sequence of steps to perform a task. Automation is executing any meaningful task when done without any human interventions[35, 36, 37].

For[34], explained that RPA is the wave of innovation that will change outsourcing strategies. This experiment was done in 2010 at the Telefonica O2 company and involved two high- Volume and low complexity processes. This company implemented Blue Prism as RPA. RPA does not involve any invention of software/technology for automating. The same RPA tool used to automate various projects involving different technologies and does not require any human intervention. In the market, there are more than 12 companies that are involved in RPA. The top three companies are Automate Anywhere

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Uipath and Blue Prism[38]. Automate Anywhere is suggested to be suitable for forwarding office (FOR) and Backward office Robotic (BOR). Uipath is doing well in FOR and Blue Prism is good at (BOR).

Robotic. The machine which mimics human actions.
***Process*.**The sequence of steps that lead to a meaningful activity. Think of the process of making apple juice.
Automation. Any process which is done by a robot without human intervention.
To sum up, mimicking human actions to perform a sequence of steps that lead to meaningful activity, without any human intervention is known as Robotic Process Automation.

RPA does not involve any invention of software/technology for automating. The same RPA tool can be used to automate various projects involving different technologies and does not require any human. The advantages of robotic process automation are;

- Enhanced ability to manage
- Better customer experience
- Cost reduction
- Improved service
- Rapid ROI
- Stability and flexibility
- Increased compliance
- Insights and analytics
- Eliminate repetitive work and
- RPA Enhances processes.

5.4.1 RPA Tool Features.

- **Web Automation** is the feature which allows to automate web interactions by identifies web elements and accurately manipulating them.
- **GUI Automation** is the process of simulating mouse and keyboard actions on windows and controls
- **Screen Scraping is** the process of extracting text from websites and win32 apps.
- **Microsoft automation is** automating Microsoft Office applications may be the most used feature of any RPA tool.
- **Citrix Automation** used to access the elements that make up virtual machines.

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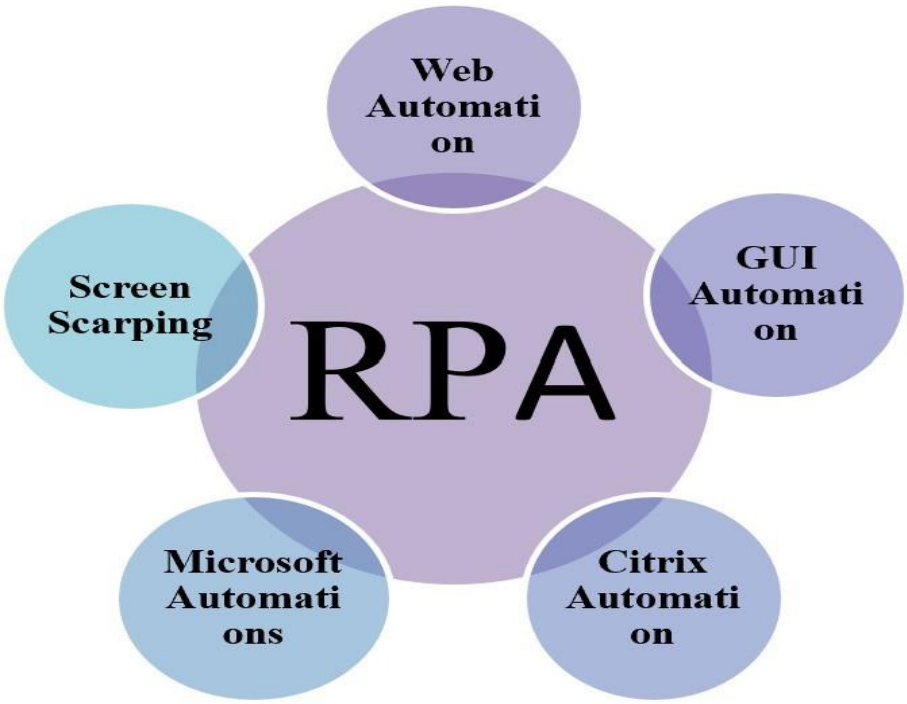

Figure 6: RPA tool features.

5.5. Expert System

The expert system is a computer program that uses artificial intelligence technology to solve complex problems in particular filed and enhance decision-making capability. It is a computer system that emulates the decision-making ability of a human expert and sometimes defined as a system that uses human experts to make complicated decisions. It simulates reasoning by applying knowledge and interfaces; it uses expert's knowledge as rules and data within the system and models the problem-solving ability of a human expert.

There are components of an expert system [41];

- Knowledgebase, collection of facts and database to allow storage and retrial.
- The reasoning or inferencing engine acts like a search engine that applies inference rules for information that matches the user's query and comprises a set of rules for making deductions from data.
- The user interface is the system that allows an expert user to query (question) the expert system.
- The explanation facility, explain to a user the chain of reasoning used to arrive at a particular conclusion. ES provides primary major application in intelligent decision-making for solving a specific problem of interest. Its applications are widespread due to its unique domain-index-pendent characteristics.

Edward Feigenbaum introduced Expert System during the Stanford Heuristic Programming Project. He is also known as the guru of expert systems. Benefits of Expert Systems a) Availability

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b) Fewer Production Costs c) Speed d) Less Error Rate e) Reducing Risk f) Steady response.

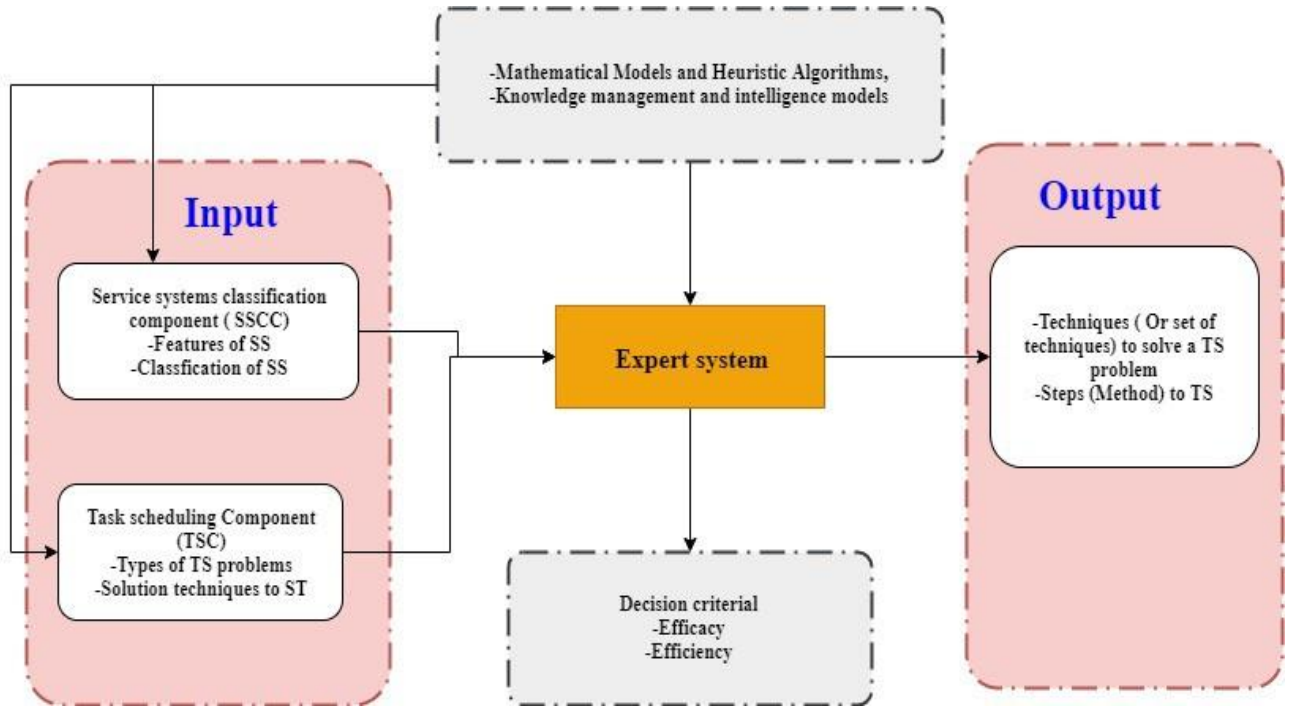

Figure 7: Knowledge base expert system: source: [40]

6. The AI in the context of Workforce management

Artificial intelligence drive indicators are boundary-less holistic work optimization, innovative across every function. AI social robotics is not like the bolted classic robotics. This social robotics can fly like drones or swim and can walk like anthropoid robots or swarm robots that roll on wheels[24]. AI will not perform its duty without an excellent package of information architecture. Artificial intelligence performs annual appraisal and has the power to enhance employee hired without being interviewed by a person.

Moreover, the algorithm predicts who is likely to leave the company soon [1]. Processing absence leaves, seek leave. It uses cognitive suggestions on whether to increase the salary to make new recruitment based on Staffing shortage. The shrinkage of life of skills and the growing of more advanced reskilling is sparking .many organizations to rethink the risk associated with full-time employment to reduce the risk of obsolescence [24]. Figure 8 depicts the potential area where AI can work better to increase the efficient performance of contingent workforce management.

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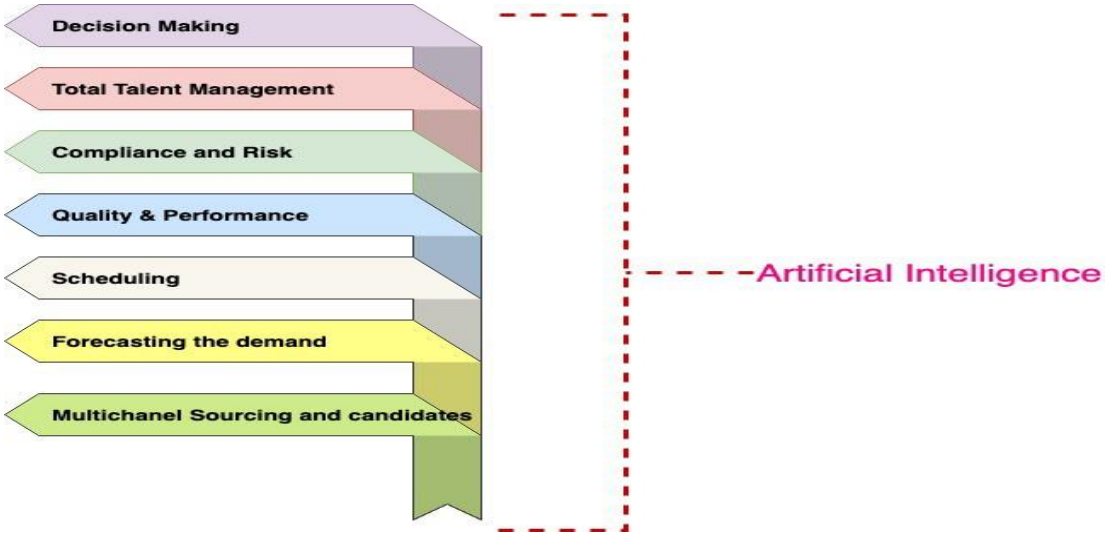

Figure 8: Artificial intelligence in CWM

7. How Artificial intelligence process data at the background

Considering figure 9, AI process data inputs in terms of video, text, speech and image form. Collecting and processing data involve data preparation which is collected through sensor signals, classifying, combining, learning and predicting possible future outcomes. Furthermore, it involves training the model, applying the model and capturing the feedbacks and interacting with people or with the environment in general. On top of that AI has the capability of manipulating objects in their environment and visual, spatial or acoustic analysis it also has power in facial recognition, image recognition or the recognition and classification of emotions[26]. The output of the information can be collected through appliances (Tablets, handsets, other computer appliances). The outputs can be forecasting, budgeting, staffing scheduling, time and attendance, employee performance management and compliance. All the information can be stored and retrieved through cloud servers which involve connectivity through the internet.

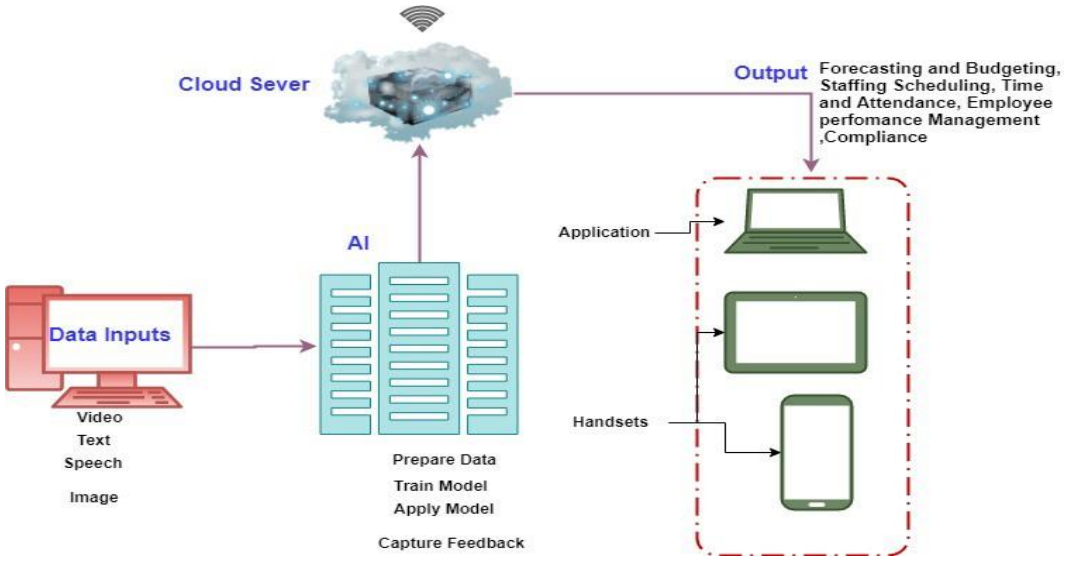

Figure 9: How AI process data in the background.

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Artificial intelligence cloud helps HR drive better business outcomes through insights and predictions, automation of routine tasks and guidance and suggestions. The argument of Artificial intelligence and Machine learning institute the contingent workforce management, it balances traditional and new technologies, and it optimizes how work performed.

8. How to engage AI in Contingent Workforce Management

In order to innovation, artificial intelligence to become a reality, there must be a transformation of thinking, accepting positive organizational change, utilization of technology, openness to new technology. The argument of artificial intelligence and machine learning institute the contingence workforce management, it balances traditional and new technologies, and it optimizes how work manipulated. To gain control of contingent workforce management is to get all the data needed in one place (agree with what you want to measure and bring it all together). Ask risks and process (review the process, identify where most significant risk is and efficiencies), Share best practice (Show success between areas, replicate and automate the process.

AI is hiring a significant impact on the workforce management industry by fostering a more predictive hiring environment. It is affecting how we are delivering services today and how we are investing in the development of our road map. For instance, we robotically change every CV into a searchable applicant record that can influence semantic examination technology to more successfully match the meaning of the applicant content with the intent of the work demand. That means applicant matching can comprise both fact-based necessities such as years of involvement and educations, as well as softer characteristics as cultural fit. AI can define talent pools using ranking algorithms to prioritize candidates based on requisition match and suitability. The human-based review can be focused on the most likely candidate to meet client expectations and cutting down on their review time and alternatively, the time to fill. Our clients, including our most extensive, global partners, are leveraging this technology daily. The investment in prescriptive technology and workforce to forestall our client acquisition needs and recommend on the right applicant and applicant type (Contingent Vs Permanent employees) at the correct time and the accurate cost. Capitalizing in novelty that simplifies and speeds up the acquisition process is critical for

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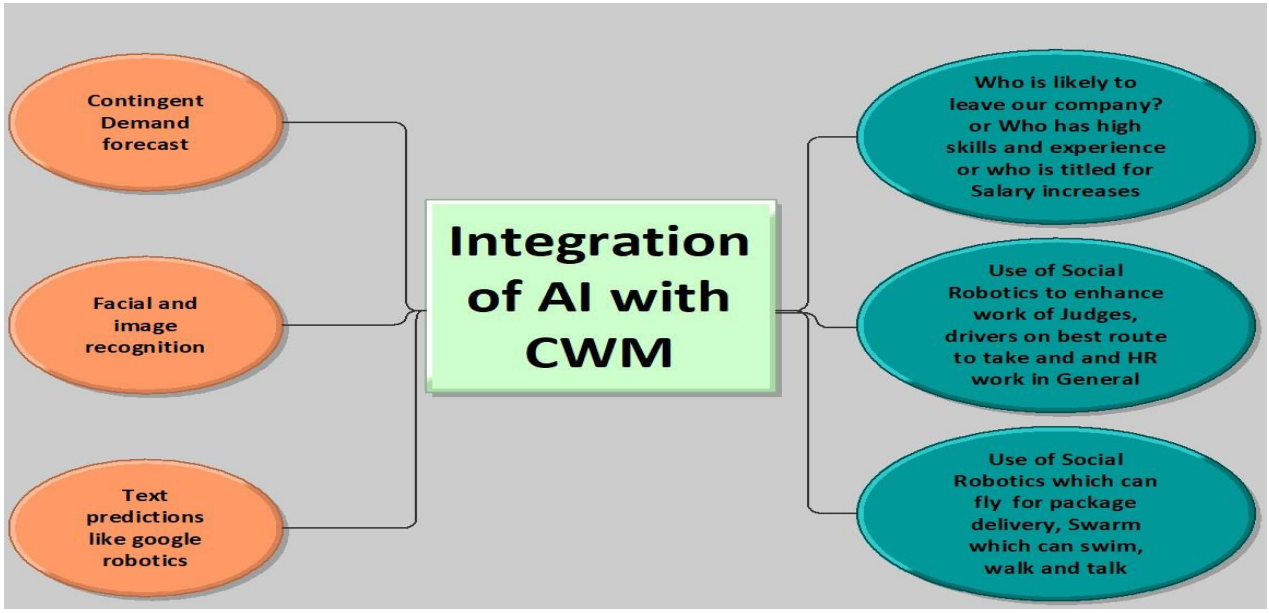

Figure 10: Synchronization of AI with CWM

wining, in today's competitive talent environment. AI capabilities allow the team to make hiring decisions faster. However, it also enables HR and procurement managers to focus on more creative and strategic planning. The aim is to foster efficient operational processes, employee retention, and a more robust bottom line. Software for integrating skills and experience, availability, criminal records, knowledge, and reliability of the contingency workforce has to keep in place [25]

Looking at the schematic diagram in figure 11, which shows the opportunity of artificial intelligence tools and areas they can work to improve the management of the contingent workforce. First of all, the user data inputs manipulated by the use of robotic process automation, as illustrated in figure 10. All data which are received also compared with trained data/instructions which are stored into the knowledge database. Then the pieces of information about transactions, predictive analysis, and deep learning can be performed by machine learning tools. Forecasting, staffing, vacations, and leave planning performed by support vector machine, which is part of supervised machine learning. Selecting the best employee or analyzing employee performance can be done by a genetic algorithm while dealing with compliance, time and attendance, payroll and benefits. The fuzzy expert system performs all the administration work. Its data must be passed to the input and KPI data analyzer to deliver output for decision making to be considered by top management.

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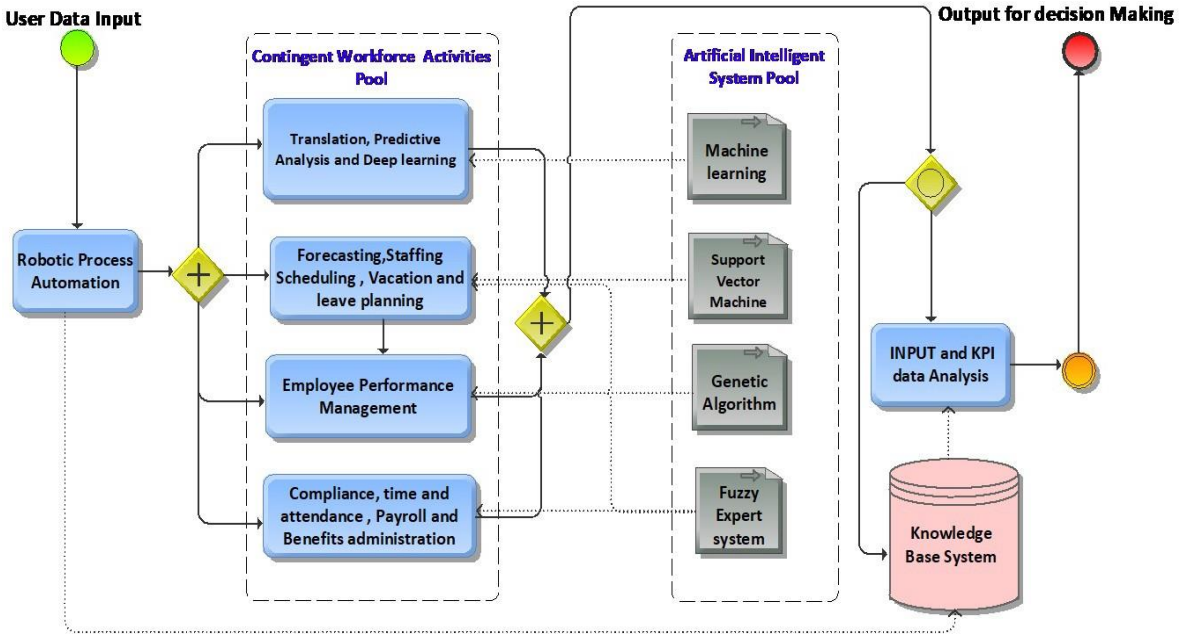

Figure 11: How AI work together with CWM.

9. Limitations and preparing for tomorrow, today

There will be more focus on how to include people who fit together well personality-wise as well as skill-wise [27].CWM needs to leverage continuously monitored for dinging regulations for different geographies, work type and roles. Enduring to invest in AI is an intermediate step for acquisition administrators to enable an improved level of control robotics and visibility in the contingent workforce management marketplace. While still measuring and developing technology by many. Increased combination of AI into current technologies is poised to expose a wealth of opportunities for corporations. By analysis, data groups and performing automated workers in behind the scene.AI aptitude to enable quicker decision making and free up valued resources for the investors.

10. Conclusion

The research paper focused on the application of innovation and artificial intelligence in workforce management, and the aim was to develop the conceptual application of innovation and artificial intelligence in contingent workforce management. The concept has been configured after a review of various kinds of literature (Journal papers, scientific articles, peer review papers, and books). The conceptual framework as per the figure 5 shows how we can make use of robotic automation in connections to other artificial intelligence tools to enhance the engagement of the contingent workforce. Shortly, all sorts of operational contingent management workforce will be replaced by Artificial social intelligence. Many organizations will need highly skilled and very few people to work with robotics and other Artificial intelligence. The conceptual framework has to be converted to reality, and prior tasks to be carried out before executing the developed concept are as shown in figure 12.

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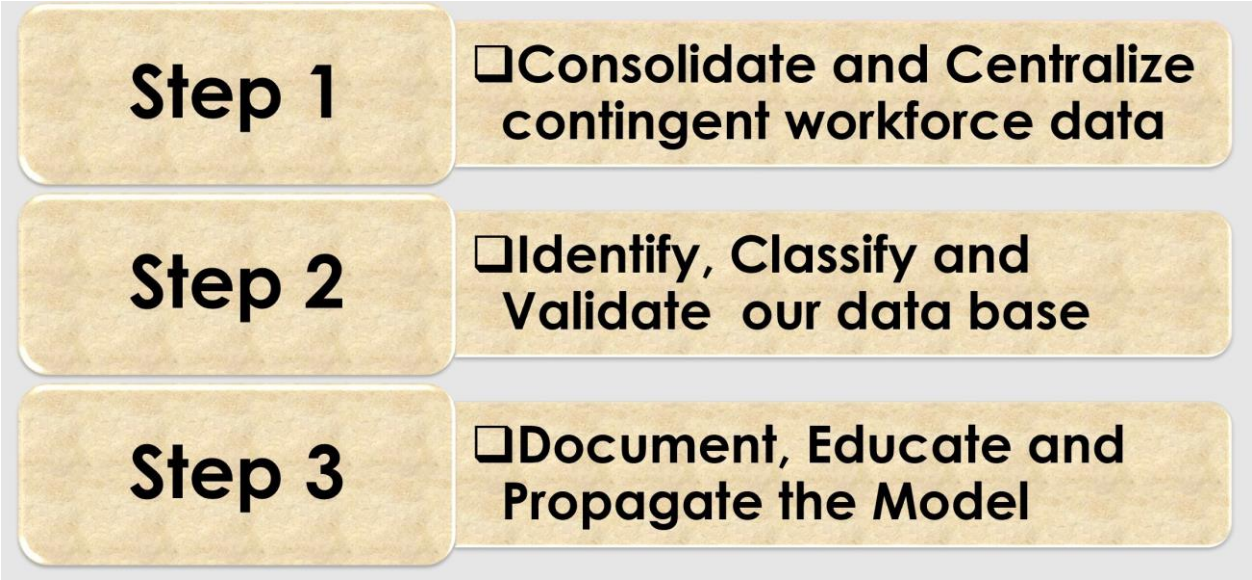

Figure 12: Steps need to be taken before further research.

11. References

[1] Lisbeth Claus, "HR disruption—*Time already to reinvent talent management Business Research Quarterly,* Volume 22, Issue 3, 2019, Pages 207-215, ISSN 2340-9436,

[2] D.G. Collings, G.T. Wood, P.M. Caligiuri (Eds.), *The Routledge Companion to International Human Resource Management, Routledge* (2014)

[3] Karin A. King, Vlad Vaiman, *Enabling effective talent management through a macro-contingent approach:* A framework for research and practice, BRQ Business Research Quarterly, Volume 22, Issue 3, 2019, Pages 194-206, ISSN 2340-9436,

[4] http://searchhrssoftware.techtarget.com (07/11/2018 at 4:27 pm) http://dictionary.cambridge.org

[5] MENYHÁRT József: Basics of maintenance engineering, note, 2018, University of Debrecen, Faculty of Mechanical Engineering

[6] Bing –Yuan Cao: *Optimal Model and Methods with Fuzzy Qualities*. (BIN No. 16390157)

[7] Prof. Br. Bela Lantos: *Fuzzy Systems and Genetic Algorithms*: 2002, Budapest (ISBN963420 70650.

[8] Mallon, Mary, and Joanne Duberley. "*Managers and professionals in the contingent workforce."* Human Resource Management Journal 10.1 (2000): 33.

[9] Marler, J. H., Barringer, M. W., & Milkovich, G. T. (2002). *Boundaryless and traditional content-gent employees: Worlds apart.* Journal of Organizational Behavior, 23, 425–453.

DOI: 10.21791/IJEMS.2020.1.47

[10] Deborah J. Schofield, Susan L. Fletcher. *The physiotherapy workforce is ageing, becoming more masculinized, and is working longer hours*: a demographic study, Australian Journal of Physiotherapy, Volume 53, Issue 2,2007, Pages 121-126, ISSN 0004-9514

[11] Messersmith, J. G., Patel, P. C., & Crawford, C. (2018*). Bang for the buck: Understanding employee benefit allocations and new venture survival*. International Small Business Journal, 104–125. https://doi.org/10.1177/0266242617717595

[12] Allan, Peter. "*The contingent workforce: challenges and new directions*." American Business Review 20.2 (2002): 103.

[13] Redpath, L., Hurst, D., & Devine, K. (2007). *Contingent knowledge worker challenges. Human Resource Planning*, 30(3), 33-39.

[14] Redpath, Lindsay, Deborah Hurst, and Kay Devine. "*Contingent knowledge worker challenges." Human Resource Planning* 30.3 (2007): 33-39.

[15] Borenstein, Jason. "*Robots and the changing workforce*." AI & Society 26.1 (2011): 87-93.

[16] Popovici, Stefan AD, and Sharon Kerr. "*Exploring the impact of artificial intelligence on teaching and learning in higher education."* Research and Practice in Technology Enhanced Learning 12.1 (2017): 22.

[17] Warnaar, Dirk B., et al. "*The aggregative contingent estimation system: Selecting, rewarding, and training experts in the wisdom of crowds approach to forecasting."* 2012 AAAI Spring Symposium Series. 2012.

[18] Richter, Yossi, et al. "Optimatch: *Applying constraint programming to workforce management of highly-skilled employees."* 2007 IEEE International Conference on Service Operations and Logistics, and Informatics. IEEE, 2007.

[19] Agrawal, Ajay, Joshua S. Gans, and Avi Goldfarb. "*Artificial intelligence: the ambiguous labour market impact of automating prediction."* Journal of Economic Perspectives 33.2 (2019): 31-50.

[20] Zarkadakis, George, Ravin Jesuthasan, and Tracey Malcolm. *"The three ways work can be automated."* Harvard Business Review.[online]. Available at: https://hbr. org/2016/10/the- 3- ways-work-can-be automated (2016).

[21] Frauenheim, E. (2010), "Special report: *HR technology", Human Resource Management International* Digest, Vol. 18 No. 6. https://doi.org/10.1108/hrmid.2010.04418fad.009

[22] Steinwendner, Patrick. *"Artificial Intelligence: Change in Business Models, Workforce and Legal Aspects."* (2018).

[23] Altman, Roy. "*Managing a Human/Robotic Workforce–It is Closer than You Think!".* (2017). Google Scholar.

DOI: 10.21791/IJEMS.2020.1.47

[24] Eduard Radaceanu. *Artificial Intelligence & Robots for Performance Management – Some Methodic Aspects*.Ifac Proceedings Volumes, Volume 40, Issue 18,2007, Pages 319-324,ISSN 1474-6670, ISBN 9783902661319.

[25] Leonid B Sheremetov, Miguel Contreras, Cesar Valencia, "*Intelligent multi-agent support for the contingency management system, Expert Systems with Applications*", Volume 26, Issue 1,2004, Pages 57-71, ISSN 0957-4174,

[26] Abdelkader AD. *A cooperative intelligent decision support system for contingency management.* Journal of Computer Science. 2006 Oct;2(10):758-64.

[27] https://blog.harbinger-systems.com/2018/08/*ai-in-contingent-workforce-management*/ (searched on Monday at 2.14 am, 14th of October,2019).

[28] Feras Al-Hawari, Hala Barham, "*A machine learning-based help desk system for IT service management",* Journal of King Saud University - Computer and Information Sciences, 2019, ISSN 1319-1578,

[29] Borenstein J. Robots and the changing workforce. AI & society. 2011 Feb 1;26(1):87-93.

[30] https://msatechnosoft.in/blog/tech-blogs/expert-systems-artificial-intelligence

[31] Wil MP van der Aalst, Martin Bichler, and Armin Heinzl. *Robotic Process Automation*, 2018.

[32] Leslie P. Willcocks, Mary Lacity, and Andrew Craig. *The IT function and robotic process automation. 2015.*

[33] Mathias Kirchmer. *Robotic process automation-pragmatic solution or dangerous illusion*. BTOES Insights, June 2017.

[34] Mary Lacity, Leslie P. Willcocks, and Andrew Craig. *Robotic process automation at Telefonica* o2. 2015.

[35] Simon Hall, Vitalie Schiopu, Jeroen van den Heuvel, and Adrien Jacquot. *Self- learning robotic process automation,* 2019.

[36] Subramaniyan Neelakandan, Ankit Tyagi, and Dhananjay Nagalkar. *Robotic process automa- tion for supply chain management operations*, 2019.

[37] Brad L. Petersen and George P. Rohith. *How robotic process automation and artificial intelligence will change outsourcing. Brussels*, Mayer Brown, 2017.

[38] Aleksandre Asatiani and Esko Penttinen. *Turning the robotic process automation into commercial success case opuscapita*. Journal of Information Technology Teaching Cases, 6(2):6774, 2016.

[39] Byun, H., Lee, SW. (2002) *Applications of Support Vector Machines for Pattern Recognition: A Survey. In: Lee SW., Verri A. (eds) Pattern Recognition with Support Vector Machines.* SVM 2002. Lecture Notes in Computer Science, vol 2388. Springer, Berlin, Heidelberg.

DOI: 10.21791/IJEMS.2020.1.47

[40] Edwyn Ramiro Lopez-Santana and German Andres Mendez Giraldo. *A knowledge-based expert system for scheduling in services systems. In Workshop on Engineering Applications, pages 212-224. Springer, 2016.*

[41] Derek Pearse and William C. Jones. *Expert system scheduler and scheduling method,* 1993.

[42] https://pythonmachinelearning.pro/classification-with-support-vector-machines/accessed on 01th January 2020.

[43] JW Schulte and B-D Becker. *Production scheduling using genetic algorithms,* pages 367/372. Information Control Problems in Manufacturing Technology 1992. Elsevier, 1993.

[44] Wannaporn Teekeng and Art Thammano. *A modified genetic algorithm for flexible job-shop scheduling problems,* 2012 2012. ID: 280203.

[45] Xinyue Liu, Liming Wang, Lin Kong, Fangyi Li, and Jianfeng Li. *A hybrid genetic algorithm for minimizing energy consumption in ow shops considering ultra-low idle state*, 2019 2019. ID: 282173.

[46] Fatima Benbouzid-Si Tayeb, Malika Bessedik, Mohamed Benbouzid, Hamza Cheurf, and Ammar Blizak. *Research on permutation ow-shop scheduling problem based on an improved genetic immune algorithm with vaccinated offspring*, 2017 2017. ID: 280203.

[47] Rui Zhang, Pei-Chann Chang, and Cheng Wu. *A hybrid genetic algorithm for the job shop scheduling problem with practical considerations for manufacturing costs*: Investigations motivated by vehicle production, September 2013 2013. ID: 271692.

[48] Bilgesu Ak and Erdem Koc. *A guide for genetic algorithm based on parallel machine scheduling and flexible job-shop scheduling*, 24 October 2012 2012. ID: 277811.

[49] Ameni Azzouz, Meriem Ennigrou, and Lamjed Ben Said. *A self-adaptive hybrid algorithm for solving a flexible job-shop problem with sequence-dependent setup time*, 2017 2017. ID: 280203.

[50] Benedikt Grosch, Timm Weitzel, Niklas Panten, and Eberhard Abele. *A metaheuristic for energy adaptive production scheduling with multiple energy carriers and its implementation in a real production system*, 2019 2019. ID: 282173.

[51] Arit Thammano and Wannaporn Teekeng. *A modified genetic algorithm with fuzzy roulette wheel selection for job-shop scheduling problems.* International Journal of General Systems, 44(4):499/518, 05/19 2015. DOI: 10.1080/03081079.2014.969252. URL https://doi.org/10.1080/03081079.2014.969252. DOI: 10.1080/030810