The International Journal Of Engineering And Science (IJES)
|| Volume || 4 || Issue || 12 || Pages || PP -66-71|| 2015 ||
ISSN (e): 2319 – 1813 ISSN (p): 2319 – 1805

The Role of Artificial Intelligence and Expert Systems in the Implementation of Zimasset

Paul Simbarashe Mupfiga and Stewart Fohlo
Midlands State University, Zimbabwe

I. INTRODUCTION

Zimbabwe experienced a deteriorating economic and social environment since 2000 that was caused by illegal economic sanctions imposed by the Western countries. This resulted in a deep economic and social crisis characterized by a hyperinflationary environment, industrial capacity utilization of below 10% and an overall cumulative Gross Domestic Product (GDP) decline of 50% by 2008. To guide national development for the next five years, the Government has crafted a new economic blueprint known as the Zimbabwe Agenda for Sustainable Socio-Economic Transformation (Zim Asset).

II. DEFINITION OF KEY TERMS

Artificial Intelligence

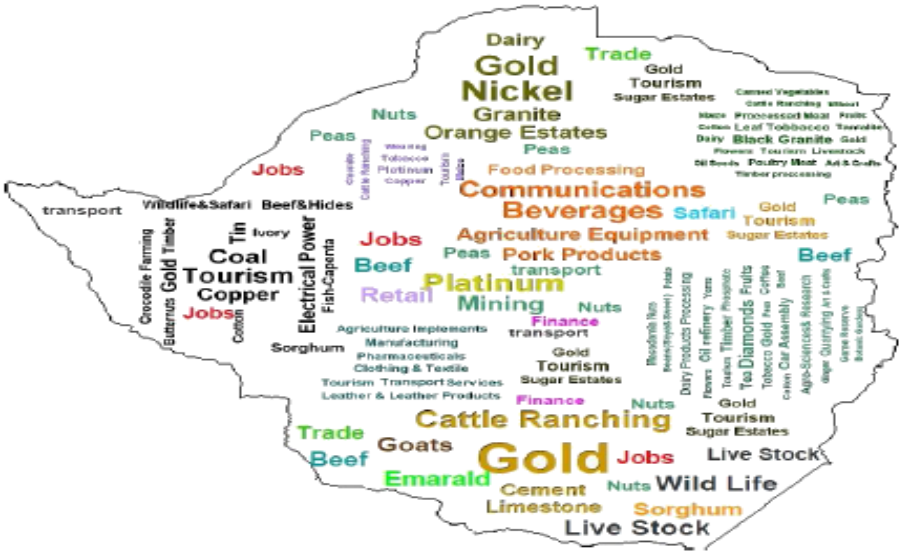
According to Russell & Norvig (2003) Artificial intelligence (AI) is the intelligence exhibited by machines or software, and the branch of computer science that develops machines and software with intelligence. Major AI researchers and textbooks define the field as "the study and design of intelligent agents", where an intelligent agent is a system that perceives its environment and takes actions that maximize its chances of success.

Expert System

McCarthy (2006) states that an expert system is a problem-solving computer program that achieves good performance in a specialized problem domain that is considered difficult and requires specialized knowledge and skill. For example, expert systems are used in diagnostic applications servicing both people and machinery. They also make financial planning decisions, configure computers, monitor real time systems, underwrite insurance policies, and perform many other services which previously required human expertise.

Zim Asset

ZimAsset is an abbreviation for Zimbabwe Agenda for Sustainable Socio-Economic Transformation. It is a plan formulated by the Government of Zimbabwe to achieve sustainable development and social equity anchored on indigenization, empowerment and employment creation which will be largely propelled by the judicious exploitation of the country's abundant human and natural resources (zim.gov.zw inc). Figure 1.1 Zimbabwe Map



The map shows the key areas in the country which shall be of great importance to the socio-economic transformation for Zimbabwe. With the aid of the map, the concepts of Artificial Intelligence and Expert Systems shall be incorporated for Zim-Asset to fully realise its benefits.

Ways in which the Zimbabwean Government can integrate the concepts of Artificial Intelligence and Expert Systems so as to fully realize the benefits of ZimAsset.

Artificial intelligence and expert systems play a crucial role in the production and manufacturing industry of any country's economy. The Government of Zimbabwe may also incorporate the concepts of artificial intelligence and expert systems in its plan to achieve a sustainable development and social equity anchored on indigenization, empowerment and employment creation which will be largely propelled by the judicious exploitation of the country's abundant human and natural resources (ZimAsset). This Results Based Agenda is built around four strategic clusters that will enable Zimbabwe to achieve economic growth and reposition the country as one of the strongest economies in the region and Africa. The four strategic clusters identified are:

1. Food Security and Nutrition
2. Social Services and Poverty Eradication
3. Infrastructure and Utilities
4. Value Addition and Beneficiation.

The concepts of artificial intelligence and expert systems shall be integrated to each of the four strategic clusters of the ZimAsset plan.

1. Food Security and Nutrition

The food industry as a whole in Zimbabwe has traditionally lagged behind other industries in adopting new technologies, and process automations. However, rapid advances in expert systems and artificial intelligence have heightened expectations of consumers and regulatory agencies for improved food quality and safety, forcing the food industry to consider automation of most of the manufacturing processes. For the Zim-Asset to attain a significant development, they is the need to integrate these "islands of automation" into an overall system of plant automation, from receiving raw materials to the transportation of finished goods. New technological tools such as computer vision, expert systems, artificial intelligence, computer integrated manufacturing, flexible manufacturing systems, systems engineering, have enabled integration of many batch operations into an overall manufacturing system design to provide on-line and continuous control capability.

People have grown crops and raised livestock in Zimbabwe and they have sought information from one another. What is the most effective planting strategy on steep slopes? Where can I buy the improved seed or feed this year? Who is paying the highest price at the market? How can I participate in the government's credit program? Producers rarely find it easy to obtain answers to such questions, even if similar ones arise season after season. Farmers in a village may have planted the "same" crop for centuries, but over time, weather patterns and soil conditions change and epidemics of pests and diseases come and go. Updated information allows the farmers to cope with and even benefit from these changes.

Through the use of artificial intelligence and expert systems, whether patterns can be forecasted hence contingence measures can be done to overcome bad or hazardous weather in crop and livestock rearing hence food security being attained. Neural networks are used for predicting weather conditions. Previous data is fed to a neural network which learns the pattern and uses that knowledge to predict weather patterns. Providing such knowledge can be challenging, however, because the highly localized nature of agriculture means that information must be tailored specifically to distinct conditions.

Zim-Asset is in the soil so first step is to take account of what the soil can give you in raw materials for industries. Put GIS land audit system in place and allocation of farms or mines done from that system. Then qualitative analysis data of the land is fed into the system that is soil sample data per square km, water network data (ground an underground) .Sector based performance management now comes into play that is agriculture is now crop initiative based on the system data for example soya beans: the government will have full details of a particular soil type and they best crop that crop that can be grown on that soil. This will enable the Ministry of finance to deduce the financial status health data and known wealth data. Government funds the crop and farmer is given target and a motivating margin hence agriculture performance based management system will be managing tillage, fumigation , seed, labour , time, transportation on the farmer's side which is Agritex.

In agriculture there is swarm intelligence which is an approach to, as well as application of AI, similar to a neural network. Here, programmers study how intelligence emerges in natural systems like swarms of bees even though on an individual level, a bee just follows simple rules. They study relationships in nature like the prey-predator relationships that give an insight into how intelligence emerges in a swarm or collection from simple

rules at an individual level. They develop intelligent systems by creating agent programs that mimic the behaviour of these natural systems. Technological change in agriculture plays a decisive role for meeting future demands for agricultural goods. However, up to now, agricultural sector models and models on land use change have used technological change as an exogenous input due to various information and data deficiencies. This paper provides a first attempt towards an endogenous implementation based on a measure of agricultural land use intensity. We relate this measure to empirical data on investments in technological change. Our estimated yield elasticity with respect to research investments is 0.29 and production costs per area increase linearly with an increasing yield level. Implemented in the global land use model MAgPIE ("Model of Agricultural Production and its Impact on the Environment") this approach provides estimates of future yield growth. As stated by the World Summit on Information Society (WSIS), E-Agriculture is an emerging field focusing on the enhancement of agricultural and rural development through improved information and communication processes. More specifically, e-Agriculture involves the conceptualization, design, development of expert systems, evaluation and application of innovative ways to use information and communication technologies in the rural domain, with a primary focus on agriculture. E-Agriculture is a relatively new term and we fully expect its scope to change and evolve as our understanding of the area it grows. By doing so, the food security and nutrition sector of the Zim-Asset strategy will help to pull Zimbabwe out of the mud.

Other areas were the concept of artificial intelligence and expert systems can incorporated to ensure food security and nutrition in the following ways:

- Data mining and pattern recognition in food processing
- Robotics for field operations with comprehensive multi-layer control
- Ontology-Based Mobile Communication in Agriculture
- Spatio-temporally Constrained Planning for Cooperative Vehicles in a Harvesting Scenario.
- iGreen – Intelligent tool for public-private knowledge management in Agriculture
- Detection of field structures for agricultural vehicle guidance.
- Bio-Inspired Sensor Data management for Modular Agricultural Machines.
- Mechatronic system for mechanical weed control.

The use of artificial intelligence and expert systems can help Zimbabwe through its socio-economic transformation in the food security and nutrition cluster of the Zim-Asset.

2. Social Services and poverty eradication.

Computer intelligence enabled public service delivery, if implemented effectively, can improve access to public services, increase efficiency, transparency and accountability of government and political processes and empower citizens by enabling them to participate in the decision-making processes of governments. The concepts of telecommunications, artificial intelligence and expert systems play a vital role as catalysts for sustainable economic development and growth. A World Bank study has shown that every 10% increase in broadband penetration boosts GDP by an average of 1.3% and every 10% increase in mobile teledensity results in a 0.7% increase in the Gross Domestic Product (GDP) of a nation (World Bank, 200).

Problems that hamper Zimbabwe's efficient service delivery commonly include inadequate targeting of the poor, supply-driven planning, elitist selection of programmes, an inadequate voice for the poor and their inability to reach the government and service providers. Data-coupling and data-mining techniques enable policy-makers to acquire a better insight into citizens' situations, which, in turn, facilitate better targeting of policy programmes and tailor-made services. Information collected for different purposes (tax, social security, population registration and so on) is combined and integrated through the use of artificial intelligence systems and expert systems. The starting point for service delivery thus becomes the citizens' needs and preferences, instead of the requirements of a bureaucratic organization. This recognition of different groups of stakeholders also enables public agencies to deliver services to citizens over channels and devices that are most appropriate for them.

Portals, information kiosks, call centres, mobile devices, conventional telephone and personal visits are common options available with citizens today. As societies become more democratic and awareness levels among citizens increase, public service delivery agencies now place an unprecedented emphasis on citizen-centric service delivery. An e-Government working in parallel with artificial intelligence, decision support systems and expert judgmental systems can be one of the strategies that can be used to achieve the goals to eradicate poverty in Zimbabwe.

In the social sector, some measure of progress was achieved on MDG 6 (Millennium Development Goal) on Combating HIV and AIDS, Malaria and Other Diseases; and MDG 2 on Achieving Universal Primary Education, among others. However, the health delivery system continues to be adversely affected by sporadic outbreaks of epidemics such as typhoid and dysentery, increased maternal mortality, shortage of funds to

procure essential drugs and equipment and to rehabilitate dilapidated infrastructure. Artificial Intelligence and expert systems can be integrated in this sector of the Zim-Assset so as to fully realize its benefits to the nation. Health care is about to be deeply impacted by technology which will make it more affordable and accessible, according to experts in the field of artificial intelligence. The industry is already in the midst of a technology upgrade, with regulations tied to the Affordable Care Act as well as still-high health costs leading hospitals to realize efficiencies and lower costs through improved IT. AI experts see more radical changes thanks to breakthroughs in artificial intelligence such as IBM Corp.'s Jeopardy-playing computer, Watson, now used in cancer research. These technologies can be implemented in Zimbabwe to help the health care sector. A medical clinic can use artificial intelligence systems to organize bed schedules, make a staff rotation, and provide medical information. Artificial neural networks are used as clinical decision support systems for medical diagnosis, such as in Concept Processing technology in EMR software. Other tasks in medicine that can potentially be performed by artificial intelligence include computer-aided interpretation of medical images. Such systems help scan digital images, for example from computed tomography, for typical appearances and to highlight conspicuous sections, such as possible diseases. A typical application is the detection of a tumour. Heart sound analysis can also be done through the use of artificial intelligence and expert systems.

There are several roles that are undertaken by artificial intelligence and expert systems in the education sector. Firstly, an expert system is a computer program that simulates the judgment and behaviour of a human or an organization that has expert knowledge and experience in particular field. Typically such a system contains a knowledge base containing accumulated experience and a set of rules for applying the knowledge base to each particular situation that is described to the program. The role of expert systems in university teaching and learning can be appreciated in programming languages which are aided through the World Wide Web, WWW. Their contributions may include:

- add or modify the commands' structure that will be taught
- generate different tutoring dialogs for the same command;
- generate different tutoring styles.

On the contrary, the students can access the system through WWW, select any language they want to learn as well as the style of presentation they prefer and they can exchange their experiences. A personal assistant agent for teachers (PAA-T), a personal assistant agent for students (PAA-S) with an adaptive interface, and tutoring agent (TA) has been built. The TA resides on the server side and communicates via HTTP and IIOP with both the PAA-T and PAA-S on the client's side. This structure allows customization of the PAA-T and PAA-S to the needs of the teachers and students, without putting extra burden on the server. In addition, this allows having many teacher agents attending to the needs of a single or multiple student agent(s). In Zimbabwe, education has remained a challenging area for Artificial Intelligence and Expert Systems. The importance of learning, however, is beyond question, particularly as this ability is one of the most important components of intelligent behaviour. An expert system may perform extensive and costly computations to solve a problem. Unlike a human being, however, if it is given the same or a similar problem a second time, it usually does not remember the solution. It performs the same sequence of computations again. This is true the second, third, fourth, and every time it solves that problem--hardly the behavior of an intelligent problem solver. The obvious solution to this problem is for programs to learn on their own, either from experience, analogy, examples, or by being "told" what to do.

Mechanical and engineering learning and teaching in universities has been made easier by expert systems. For examples the Automated Mathematician, designed to discover mathematical laws. Initially given the concepts and axioms of set theory, Automated Mathematician was able to induce such important mathematical concepts as cardinality, integer arithmetic, and many of the results of number theory. Automated Mathematician conjectured new theorems by modifying its current knowledge base and used heuristics to pursue the "best" of a number of possible alternative theorems. More recently, Cotton et al. (2000) designed a program that automatically invents "interesting" integer sequences.

3. Infrastructure and Utilities

Application of high technology is one of the most effective methods for improving productivity and ensuring safe working conditions in hazardous occupations like mining. The idea of totally automating the extraction process, although not new, was not believed to be practical. Through the integration of Artificial Intelligence, Expert Systems and Robotics automation of coal mines can be achieved with the use of mechanical haulage devices, conveyors and shearers on the coalface. Robotics and cybernetics have taken a leap combined with artificially intelligent expert systems. An entire manufacturing process is now totally automated, controlled and maintained by a computer system in car manufacture, machine tool production, computer chip production and almost every high-tech process. They carry out dangerous tasks like handling hazardous radioactive materials.

Robotic pilots carry out complex manoeuvring techniques of unmanned spacecrafts sent in space. Japan is the leading country in the world in terms of robotics research and use. (Buzzle.com Inc).

Mining industry has made significant contributions to the positive growth of the Zimbabwean economy. Zimbabwean government needs to approve the capital investment to install high throughput (or bulk) x-ray technology. This will represent another positive step in implementing and entrenching its diamond value management programmes which are focused on sustainably enhancing diamond recoveries. The mining sector continues to be a major foreign currency earner and has potential to become the pillar for economic growth through value addition and beneficiation. However, the sector continues to be constrained by energy and transport infrastructure challenges, depressed international mineral prices and shortage of utilities among other factors.

High throughput x-ray plants are the next significant advancement in diamond processing technology. These plants effectively concentrate and recover diamonds in one single, efficient, cost effective and secure step. This technology can also identify rare Type II diamonds, which are known to be present in Zimbabwe. The project will include the procurement and installation of one high throughput Bourevestnik (BV) sorter and one BV single particle sorter for the concentration and final sorting of diamond bearing ore at Marange-Chiyadzwa. Just like anything else, exploring for gold is being changed by technological advances. Some specific examples of technologies in gold exploration which can be used in Zimbabwe to enhance gold mining include: Satellite Imagery and gold exploration, remote sensing and mineral exploration, Gold grain morphology and the Indicator and pathfinder minerals and gold exploration.

4. Value Addition and Beneficiation

Zimbabwe is country that has in the past attracted a vast number of tourists who visit to pleasure themselves with the beauty of the country. Tourism can resuscitate the economic situation of Zimbabwe by implementing artificial intelligence and expert systems in hotel management. Internet bookings need to be facilitated and enable even advanced payments through online visa transaction. Tourists at all times are concerned about security. Artificial intelligence is implemented in automated online assistants that can be seen as avatars on web pages. It can avail for enterprises to reduce their operation and training cost. A major underlying technology to such systems is natural language processing. Similar techniques may be used in answering machines of call centres, such as speech recognition software to allow computers to handle first level of customer support, text mining and natural language processing to allow better customer handling, agent training by automatic mining of best practices from past interactions, support automation and many other technologies to improve agent productivity and customer satisfaction.

Many telecommunications companies worldwide make use of heuristic search in the management of their workforces, for example BT Group has deployed heuristic search in a scheduling application that provides the work schedules of 20,000 engineers. Therefore the concepts of Artificial Intelligence and Expert Systems can be applied in telecommunications for better and improved communication. The Air Operations Division (AOD) uses AI for the rule based expert systems. The AOD has use for artificial intelligence for surrogate operators for combat and training simulators, mission management aids, support systems for tactical decision making, and post processing of the simulator data into symbolic summaries. The use of artificial intelligence in simulators is proving to be very useful for the AOD. Airplane simulators are using artificial intelligence in order to process the data taken from simulated flights.

The system used by the AOD in order to measure performance was the Interactive Fault Diagnosis and Isolation System, or IFDIS. It is a rule based expert system put together by collecting information from TF-30 documents and the expert advice from mechanics that work on the TF-30. This system was designed to be used for the development of the TF-30 for the RAAF F-111C. The performance system was also used to replace specialized workers. The system allowed the regular workers to communicate with the system and avoid mistakes, miscalculations, or having to speak to one of the specialized workers. The AOD also uses artificial intelligence in speech recognition software. The air traffic controllers are giving directions to the artificial pilots and the AOD wants to the pilots to respond to the ATC's with simple responses. The programs that incorporate the speech software must be trained, which means they use neural networks. The program used, the Verbex 7000, is still a very early program that has plenty of room for improvement. The improvements are imperative because ATCs use very specific dialog and the software needs to be able to communicate correctly and promptly every time.

The Artificial Intelligence supported Design of Aircraft, or AIDA, is used to help designers in the process of creating conceptual designs of aircraft. This program allows the designers to focus more on the design itself and less on the design process. The software also allows the user to focus less on the software tools. The AIDA uses rule based systems to compute its data. This is a diagram of the arrangement of the AIDA modules. Although simple, the program is proving effective. On the other hand, companies in Zimbabwe should develop online and telephone customer services so as to improve their quality of service. Artificial intelligence is implemented in automated online assistants that can be seen as avatars on web pages. It can avail for enterprises to reduce their operation and training cost. A major underlying technology to such systems is natural language processing.

Similar techniques may be used in answering machines of call centres, such as speech recognition software to allow computers to handle first level of customer support, text mining and natural language processing to allow better customer handling, agent training by automatic mining of best practices from past interactions, support automation and many other technologies to improve agent productivity and customer satisfaction. In conclusion, artificial intelligent tools and expert systems can be used to measure the progress of the Zim-Asset Plan. The implementation of Zim-Asset will be underpinned and guided by the Results Based Management (RBM) System which and will be used as a basis for the macroeconomic budgetary framework by Treasury, commencing with the 2014 fiscal year.

References

[1] Russell, Stuart J.; Norvig, Peter (2003). Artificial Intelligence: A Modern Approach (2nd ed.). Upper Saddle River, New Jersey: Prentice Hall. ISBN 0-13-790395-2

[2] Kurzweil, Ray (2005). The Singularity is Near: When Humans Transcend Biology. New York: Viking. ISBN 978-0-670-03384-3

[3] National Research Council (1999). "Developments in Artificial Intelligence". Funding a Revolution: Government Support for Computing Research. National Academy Press. ISBN 0-309-06278-0. OCLC 246584055.

[4] Moghaddam, M. J., M. R. Soleymani, and M. A. Farsi. "Sequence planning for stamping operations in progressive dies." Journal of Intelligent Manufacturing(2013): 1-11.

[5] Scholkoff, R.J. (1990) Artificial Intelligence: An engineering Approach, Mc Graw Hill, New York.

[6] Bellman. (1978). An introduction to artificial intelligence: can computers think? Boyd & Fraser Pub. Co.

[7] Russell, S., & Norvig, P. (1995). Artificial Intelligence: A Modern Approach. New Jersey: Prentice Hall.

[8] Whitby, B. (2003). A beginner's guide: Artificial Intelligence. Oxford, England: Oneworld Publications.

[9] Tedesco, B. G. (1992), Neural Analysis: Artificial Intelligence Neural Networks Applied to Single Source and Geodemographic Data. Chicage, IL: Grey Associates.

[10] http://www.businessweek.com/archives/1992/b325470.arc.htm

[11] Hall, O. P. (2002). Artificial Intelligence Techniques Enhance Business Forecasts: Computer-Based Analysis Increases Accuracy. Graziado Business Review, 5(2). Retrieved from http://gbr.pepperdine.edu/2010/08/artificial-intelligence-techniques-enhance-business-forecasts/

[12] Neural Net Technology- Ready for Prime-Time. IEEE Expert, 7(6), 2-4.

[13] Woelfel, J. (1992). Artificial Neural Networks for Advertising and Marketing Research: A Current Assessment. University at Buffalo.

[14] Lin, B. (1995). Applications of Neural Network in Marketing Decision Making. Shrevport: Louisiana State University.

[15] World Bank. Information and Communications for Development 2009: Extending Reach and Increasing Impact. s.l. : World Bank, 2009.

[16] http://www.buzzle.com/articles/applications-of-artificial-intelligence.html