Postal Service Development Requires ICT and Big Data

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ABSTRACT

Postal systems around the world have well developed infrastructures and a historical link to local communities. The post office predates the telephone and internet as a standard form of communication. The expansion of the internet has shifted communication to the digital media. Email, SMS, Twitter and Facebook communication have replaced much of the traditional letter mail. However, the post office as an institution is much more than letter mail delivery. The community engagement, logistics operations, and infrastructure management components of the post office play a valuable role in community development and community service. To increase the role of the post office the use of information communication technology (ICT) must be expanded. In particular, the post office must leverage the extensive use big data and analytics to optimize operations and expand through innovation. This study examines work done in this direction and presents a strategy for further engagement. The methodology of framework development is used to extend the ICT driven research agenda developed in 2015 to a framework that addresses the big data analysis requirements and curriculum requirements to prepare practitioners in service industries such as the Post Office.

CCS Concepts

• **Information systems →Information Systems applications**
• **Applied computing →Enterprise computing and computing in postal services.**

Keywords

Big data; service optimization; ICT in postal services; curriculum development

1. INTRODUCTION

Big data has emerged as a result of the increase in storage capacity, computational speed and communication speed. This has led to the development of algorithms and hardware that take advantage of these technological advances. Following Moore's Law, storage capacity per unit cost continues to grow exponentially. This has led to complex fault tolerant storage systems capable of minimizing down time. The growing demand for information is a direct result of this reduced cost of storage. Organizations and institutions find themselves in a quandary to keep up with the information needed to stay on top of their business. Cloud computing and Grid computing came to solve the problem of the every growing need for more storage and computational power. Clouds and Grids became possible with the increased speed of digital communication. As the Internet increased in speed and connectivity, the semantic web and then web 2.0 became the process to bring more meaning and capability to sharing and communicating digitally. The sharing of information and knowledge, through Blogs, Wikis, YouTube and other video as well as audio lectures, continues to add to the wealth of knowledge and information publicly accessible. Commercial applications like Facebook, WhatsApp, and Twitter contribute the growth in data, information and knowledge. Twitter users have grown from 30 million in 2010 to over 300 million in 2015 [1]. The number of Facebook users grew from less than 50 million in 2008 to over 1.5 billion in 2015 [2]. As users add content on a daily basis, the dearth of knowledge and information at our fingertips will continue to grow exponentially. To deal with this situation we are tasked with: how to access what we need, how to know what is available and how to learn new knowledge from this massive, exponentially growing global library. This is the challenge of big data and associated analytics.

"The Internet of Things (IOT) is the name given to a network of smart devices and sensors that collect information and communicate autonomously with other devices, people, computers and big data systems. … it is likely that posts will establish their own 'Internet of Postal Things' (IoPT) – a network of autonomous sensors attached to different parts of the mail infrastructure, including mailboxes, delivery vans, sorting machines and individual mail pieces"[3]. The Post Office is one of many institutions that is taking advantage of IOT. This will contribute even more data and information to the global big data depository. The analysis of this IoPT data is vital to advancing postal operations.

Postal operation in developed countries, as well as developing countries, is a massive endeavor. The United States Post Office employed 617,254 workers (as of February 2015) and operated 211,264 vehicles in 2014. India has the largest Postal Network in the world with over 154,882 Post Offices (as on 31.03.2014) [43. These postal operations have been linked through the Universal Postal Union (UPU). The UPU was established in 1874 and currently has 192 member countries. The UPU "sets the rules for international mail exchanges and makes recommendations to stimulate growth in mail, parcel and financial services volumes and improve quality of service for customers"[5]. The UPU supports various multi-country and regional collaborations. SAPOA is the Southern Africa postal operators association, a UPU supported effort that brings together SADC country postal representatives in a range of collaborative efforts on a regular basis. Last year SAPOA hosted two workshops to bring together university researchers across SADC with an interest in research on postal operations. A SAPOA research council was established to coordinate postal research between SAPOA members and universities in SADC. The South African Post Office (SAPO) is the largest postal operation in SADC. With more than 2400 outlets and 5500 service points, SAPO has the largest reach of any organization in South Africa [6]. SAPO is positioned to play a leading role in advancing big data and analytics in postal operations. The research conducted in South Africa on big data, analytics and Internet of Postal Things can serve to assist in advancing postal operations across Southern Africa. This is an important responsibility of the SAPOA research council.

"From 1 January 2012 until 30 June 2013, more than 2.7 billion events were recorded through the POST*Net information technology infrastructure. The UPU and the international postal community could further leverage the billions of data points available." [7 p.178]. This indicates the potential for Post Offices across the world using big data.

"By integrating operational and information technologies across company processes, posts can improve their performance, reduce their costs, and optimize postal processes. For example, they could move toward real-time optimization of their sorting, transportation, and delivery processes. Finally, integrating IT and OT can help provide more effective and comprehensive dashboards for managers to make faster and more informed decisions." [8 p.6]

1.1 Previous Postal Research

A study of computational intelligence and computation science to advance innovation in postal operation was initiated in 2013 [9]. In the conclusion of this study eight key e-services were identified that should be addressed in the Post Office Information Systems strategy. The four e-post services identified were: public Internet at PO; postal electronic mailbox; online direct mail and hybrid mail (physical to electronic). The four e-government services identified were: digital identity; e-payment of pensions; management of e-medical files and electronic customs documents. This study advocated the extensive use of mathematical programming and other computational techniques to optimize postal service locations, resource allocation and facilitate scheduling of mail pickup, mail delivery and personnel assignments. The use of discrete simulation could assist in forecasting postal operations and aid decision makers at operational and top management levels.

More recent research builds on the 2013 work to look at community focused postal service development. The results of this investigation include a strategy for post office research engagement with universities. An ICT driven research agenda is presented that addresses: Data mining; Knowledge management; optimizing traditional postal services; Modeling and simulation of postal operations; innovations in e-post operations; innovations in e-finance; innovations in e-governance, and the use of ICT to enhance employee involvement and community engagement.

1.2 Inclusive Socio-Economic Development

The theme of the World Economic Forum in Davos, January 2016, was the Fourth Industrial Revolution. World economic leaders were presented with a global picture where the advances in digital technology would drastically increase productivity and reshape consumption at the expense of a massive number of jobs. This drastic shift is driven by computing developments that include: ubiquitous computing, the Internet of things (IoT), robotics, artificial intelligence and big data in decision-making [10]. Job creation is a priority in developing countries. Inclusive socio-economic development must be the approach in addressing new technology in general and the onslaught of interest in 'big data analytics' in particular. The South African Ministry of Telecommunications and Postal Services recognized this in addressing the GovTech SITA Summit in October 2015. Professor Mkhize points out that big data driven firms can potentially create thousands of new jobs because they are most likely to launch new innovative products and services. [11]

"Telecommunications infrastructures, modularized interfaces, bar codes and RFIDs enable a logistical revolution which allows capital to reach out to global labour and resource pools. This is the aspect of cybernetics that, rather than replacing labour, expands it globally, but at the lowest possible rate, and with maximum disposability in a savage labour arbitrage."[12] This reflects the negative consequences that can come with these advances of the 4th Industrial revolution.

"UPS, the delivery company [placed] sensors on vehicle parts to identify certain heat or vibrational patterns that in the past have been associated with failures in those parts. In this way, the company can predict a breakdown before it happens and replace the part when it is convenient, instead of on the side of the road." [10]. This is an example of how the IoT can be used to increase productivity.

2. METHODOLOGY

This study utilizes the framework development methodology implemented in an earlier study on postal service development [13]. This methodology draws on general system theory [15] and dialectical materialism [14]. Using general system theory, the postal environment is decomposed into a set of varied elements with unique relationships among the elements. The application of dialectical materialism views the postal situation as a plenum of forces in tension, where changes in the tension can be quantitative or qualitative. Quantitative changes are ongoing and generate patterns that are studied to forecast future situations. Periodically, qualitative changes occur. These are drastic changes that are indicative of innovations, significant system optimization or obsolescence of a system component. The methodology is applied to an examination of the postal system in South Africa. While the focus is on SAPO, this study can be extended to a global context considering SAPO's relationship to other members of the Universal Postal Union (UPU). This approach leads to the identification of factors that influence the development of the postal components. This methodology is applied through the lens of the Davos Global Economic Forum's argument for a 4th Industrial Revolution as well as the counter arguments to the Davos agenda.

3. INVESTIGATION AND RESULTS

3.1 Fourth Industrial Revolution

Klaus Schwab has been organizing the World Economic Forum (WEF) for the past 45 Years. This annual meeting held in Davos Switzerland hosts the global political and economic leaders. Each year, a theme is selected that addresses the driving forces or concerns of global economics. This year the theme was the Fourth Industrial Revolution. The organizers of the WEF venture that this 4th Industrial revolution will bring leaps in productivity in manufacturing and services. The increased role of capital and technology will come at the expense of jobs. Millions of manufacturing and service jobs will be eliminated. This industrial revolution is possible because of the technology advances in computing, telecommunications, information science, robotics, material science, genomics, and artificial intelligence. Schwab cautions "the great beneficiaries of the fourth industrial revolution are the providers of intellectual or physical capital – the innovators, the investors and the shareholders, which explains the rising gap in wealth between those who depend on their labour and those who own capital. It also accounts for the disillusionment among so many workers, convinced that their real income may not increase over their lifetime and that their children may not have a better life than theirs" [16]. The recognition that the 4th Industrial revolution will lead to further wealth disparity

and potential worker unrest is important. The recommendations of the WEF are designed to ease this tension, further stability and increase wealth and power of the wealthy. After all the WEF is set up to benefit them. The opposing perspective questions the validity of using technology advances to benefit the wealthy. The call for appropriate technology (AT) champions technology that empowers communities and workers. Socially relevant computing is a critical sector of AT [17]. The fact that the wealthy control the finances and factories needed to develop technology on a large scale is undeniable. What is challenged is their right to dictate the direction of technological development. If the technology of the 4th Industrial Revolution is inevitable, at least it should be used to benefit people. People should be given priority over profits. In public sectors such as the post office, it is possible to address this priority.

3.2 Postal components and elements

The traditional responsibility of the post office has been letter and parcel delivery. The scope of this responsibility has led to massive infrastructure. The Post Office has become responsible for facility and real estate management and has developed an expertise in logistics management. While these two responsibilities have emerged from the primary work of mail delivery, they have become a function that allows for innovative expansion of postal services. Post offices are engaged in commerce as well as financial functions. Both South Africa and Zimbabwe operate Post Office banks. These different functions are connected in different ways in different countries. In all cases the new multifunctional post office has become more complex with the increased use of technology. This leads to the generation of massive amounts of data and information on a daily basis. The challenges are: understanding the dynamic relationships between the different postal components, determining what data and information to monitor and how to best conduct analytics to gain new knowledge. This new knowledge must be used to improve postal operations through optimization of existing functions and innovation to deliver new functions.

3.3 Qualitative change and Innovation

Focus e-services were identified that would advance the South African Post Office [13]. The selection of these eight services is based on the best practices of the postal services with the highest international rating by the UPU [18]. The addition of these services would require a qualitative change in the operation of SAPO. These are new services that require new skills for postal personnel and new infrastructure. Table 1 below indicates the eight services identified.

Table 1. Focus e-service based on best practice

e-post services	e-government services
Public internet at PO	Digital Identity
Postal electronic mailbox	e-payment of pensions
Online direct mail	Management of e-medical files
Mail (physical to electronic)	Electronic customs documents

The contending forces at the SAPO are unskilled labor, technical workers, local management and national management. The current situation at the SAPO requires the contending components of the post office to break from their current relationships to make the changes needed to successfully implement new services. This is a difficult task. However, recognition of this distinction between qualitative change and quantitative change is the essential first step in making this leap. This leap is a fundamental component of most innovation.

The implementation of the Internet of postal things (IoPT) is a significant innovative change that represents such a qualitative leap. Issues from management policy to privacy will have to be addressed. The skills needed to implement the IoPT in a timely fashion must be acquired by the Post Office. The data and information generated from the IoPT will play a significant role in the broader collection and handling of postal big data. The analytics needed to turn this data and information into knowledge and business intelligence is the important step that will require computing and information science skills.

3.4 New skills needed

3.4.1 Strategic information systems management

The growth of Information technology and information systems in general, and big data and analytics in particular requires organizations, companies and government agencies to address information systems management at the highest strategic levels. Information systems cannot be relegated to the tactical or operational level of an organization. When the business plan is developed the information systems strategy must be a key component. This requires high-level management commitment to information systems and knowledge management. Organizations must bring on board the managers and technical experts trained in addressing information systems and technology at this strategic level.

3.4.2 Community relations and communications

Good communications and human relationship skills are needed to assure that technologies advanced as part of this 4th Industrial revolution address the needs of the community. As the Internet of postal things (IoPT) collects massive amounts of data it is important that the data collected and the analysis of this big data follow the interests and needs of the communities that the post office is designed to serve. In this process ICT must be used to enhance community engagement [19].

3.4.3 Technology development and transfer

Every organization, agency and industry must keep pace with the global advances in technology to stay relevant. The Post Office is no exception. Traditionally the post office has devoted a small percentage of resources to research and development and ICT. This has allowed newer players in the communications sector, both public and private to outpace the post office in embracing new technology. The post services must accelerate its technology development through technology transfer from industry and universities to existing and new postal operations.

3.4.4 Workforce development

The post office must employ additional technologists and train existing employees to meet the demands of the advances brought on by the 4th Industrial Revolution. The Internet of Postal Things (IoPT) is a critical aspect of this current industrial revolution and will have a transformative impact on the post office. The development and expansion of the IoPT requires skilled personnel to place and monitor the associated technology. To keep pace with competing industries, the post office workforce must foster an environment of continuously upgrading their technical skill set. Key on this list of skill sets to be acquired is expertise in big data analytics. To maintain relevance the post office will incorporate new technology. Old jobs will be replaced with new jobs requiring different levels of technical skills. To

make this transition employee centered, a strategic technology and information systems plan must be well integrated into the long-range business plan. This plan should emphasize employee training instead of employee retrenchment.

3.5 Skills and Big Data

Earlier research indicated that an ICT driven research agenda for postal services needs to address: data mining; knowledge management; optimization techniques; modeling and simulation; extending traditional postal services through innovative e-post operations and expanding into new e-finance and e-governance operations [13]. With the focus on the 4th Industrial revolution, this study highlights the first four aspects of this research agenda.

3.5.1 Data mining

Any effective data mining effort ought to start with a serious look at the data and information collection processes. As the post office embraces the IoPT, it has the opportunity to shape the data collection process such that it evolves to match the post office's adoption of technology and development of technical skills. The post office has employed statistical analysis in the past to both assessment and predictive purposes. Now that data sets have grown to the stage of big data, advanced analytics become necessary. The purpose of data mining is best illustrated in Figure 1 below, adapted from [20]. The post office performs data collection; then conducts data mining or analytics to create new knowledge or intelligence that will add to the business acumen.

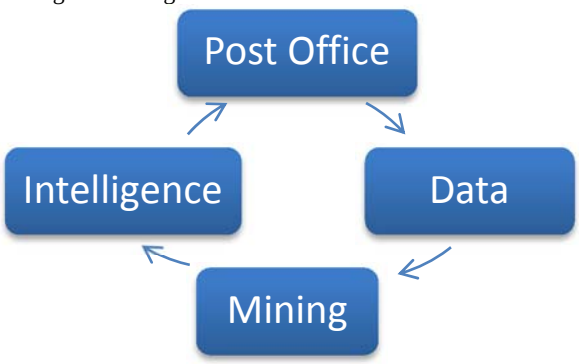

Figure 1. Business Intelligence and Data Mining Cycle

Data mining addresses four major problems: data clustering; data classification; association pattern mining or pattern recognition; and outlier analysis [21]. For years, Data Structures has been a fundamental core course in the computer science curriculum. Data Structures serves as a basis for understanding the data preprocessing phase and the various complex data types that have emerged as data mining has evolved. Advances in algorithm development are at the heart of data mining research. "Data mining comprises the core algorithms that enable one to gain fundamental insights and knowledge from massive data. It is an interdisciplinary field merging concepts from allied areas such as database systems, statistics, machine learning, and pattern recognition [22].

3.5.2 Knowledge management

The knowledge and intelligence gained from ongoing data mining of the IoPT and other sources of big data should be readily accessible to the various stakeholders in the postal operations. Knowledge management has taken on a significant role in most large operations and the post office is no exception. The SAPO has a Knowledge Management Director who reports directly to the Chief Operating Officer and Managing Director of Strategy. Knowledge management is concerned with identifying best practices across all postal operations and making this knowledge and business intelligence readily available to all stakeholders at the SAPO that can benefit from using this Knowledge Management System (KMS). The construction of an effective KMS is very difficult given the scope of the post office and the challenges it faces given its technology deficiencies. The Knowledge Management Director has initiated a KMS at SA Post Office Headquarters using Microsoft SharePoint. Best practices can be captured in a range of different knowledge representations from case studies, to scripts, guidelines, or rigid rule-based constructs. The study of knowledge representation as well as knowledge acquisition will increase in importance at the IoPT and other aspects of the 4th Industrial revolution continue to expand the realm of big data in postal operations globally.

3.5.3 Optimization techniques

Optimization techniques typically covered in the Operations Research discipline form the fundamental skills needed to study the allocation of postal resources [23, 24]. Linear programming, integer programming, non-linear programming, and dynamic programming are the standard mathematical programming techniques, that can be applied to examine post delivery routing, postal service point allocation, and a range of other real mail delivery problems. Graph theory, forecasting techniques, network analysis, queuing theory and stochastic processes [25] are other subject matter in operations research that would be useful in advancing optimization of postal practices. Location-Allocation modeling is a special application of integer programming. In the case of the SAPO, combining facility location and customer routing decisions, over the long term, can significantly reduce the total system cost [26]. The Chinese postman problem (CPP) is one of the most popular applications of Arc Routing. The CPP can be described as the task of finding a tour that visits each vertex of a graph once and only once and each edge on the graph at least once. Various versions of the CPP have been used by postal operations around the world to optimize the routes used for mail and parcel delivery. A recent study in South Africa looked at a variation called the min max k-vehicle windy rural postman problem (MM K-WRPP) to develop models of a multiple postmen system [27]. This is a skills set that is well established in postal operations in developed countries but is just coming into place in Post Office management operations in Africa.

3.5.4 Modeling and Simulation

Both discrete and continuous simulations have played a role in the study of postal operations for years. More recently agent-based modeling and simulation, 3D visual simulation and hybrid simulation are proving to be a valuable skill. At one point discrete simulation required costly computer facilities and high level programming skills. Advances in computing power, computer visualization and graphics, as well as fourth generation languages make it possible for complex simulation models to be developed by a wider range of practitioners and understood by an even wider audience. Tools like Arena, Stella, Vensim, Simeo, and AnyLogic are taught in a range of disciplines including management, industrial engineering, systems engineering, information systems and computer science. These skills bring a range of model building options to industries like the post office. System dynamics is a particular approach to system modeling using continuous simulation [28]. It allows the examination of the

dynamics of causality by modeling the key feedback processes of a system.

One set of models of particular interest to the post office, study the dynamics of supply chains [29]. The post office supply chain from mail collection (first mile) through sorting, transport, delivery, and reception (final mile) continues to be a subject of research. System dynamics provides the opportunity to present scenarios that study future dynamics and allow decision makers to examine the potential outcome of alternative courses of action. The most recent tools in system dynamics allow for visual representations of system models that go beyond simple two-dimensional graphs to complex system visualizations, story telling and micro-world representations. This opens a number of research avenues in terms of Human Computer Interaction (HCI). The skill set in HCI is useful in designing models that convey the dynamics of real world systems to management, stakeholders and a wider public audience.

4. DISCUSSION AND CONCLUSIONS

Previous research made recommendations to the post office and universities on how to collaborate on an ICT based research agenda [13]. These recommendations were addressed to postal operations and universities across Southern Africa (SADC). The response to these recommendations has led to the establishment of the SAPOA postal-university research council. This was initiated in July of 2015 as the result of a workshop where academics and postal service leadership were invited from SADC countries. The research council was tasked with addressing postal research needs beyond the ICT based research agenda. The workshop established six thematic areas to be addressed by the Research council, two broad crosscutting areas: the PO role and Research development, and four distinct areas: business opportunities; Trust; Delivery and Governance. Table 2 provides a brief explanation of the coverage.

Table 2. SAPOA Research Council Thematic areas

Role of Post Office – Universal Service Obligation, Connecting people and communities, mail and parcel delivery, logistics, Community enterprise hub, financial and government services.			
Business Opportunity: operational environment, diversification, unregulated and regulated services, skills development	**Trust:** perception, marketing, image, work ethic, and government expectation	**Delivery:** collection, sorting, tracking, transport, reception (last mile), and ICT utilization	**Governance:** public policy, legal framework (local and international), management philosophy, accountabilities, and responsibilities
Research – Existing research results, Ongoing research efforts, Embedding research in curriculum, Introducing new research topics, Research structures and Research methodologies			

When the chairperson of the Research council presented the structure to the general management of SAPOA at their annual meeting, a seventh thematic area was added – Transformation. This crosscutting theme is important because the future of the post office hinges on its ability to adopt transformational innovations. One conclusion from this study is that post offices in general and SAPO in particular are losing their competitive edge. Transformation is needed to regain this edge. All of our research must take into account the need for traditional postal operations to accept transformation in order to survive and grow the post office. The UN has recognized the importance of big data by initiating the Global Pulse initiative. Its indicated objective is the "harnessing of big data for development and humanitarian action" [30]. Over two years ago, the UPU decided to join this initiative recognizing that "the UPU has the biggest harmonized physical data that is real time in the world" [31, p 15]. In this instance, it is important that African governments and postal operators follow the lead of the UN and UPU and acknowledge the importance of big data and the IoPT.

4.1 Recommendations to SAPO and SAPOA

The 4th Industrial Revolution mandates that the post office focus on key technologies in order to thrive. These key technologies include: big data, the internet of postal things (IoPT), and various approaches to analytics including machine learning, artificial intelligence and information visualization. Industry leaders advise the post office to act now regarding the use of big data or risk being left behind [3]. Postal operations should follow the recommendations presented earlier [13] and coordinate the research conducted by their employees with the universities, particularly in the case of post office employees working on advanced degrees. Also the post office should involve university students in research internships and bring in university researchers as consultants to team with PO researchers. These are all approaches used by other industries such as Telecommunications to stay competitive. The fact that the SAPO has continued to support human capital development (including its graduate program), despite the difficult financial times, is a good indication of its commitment university relationships and research [32].

4.2 Recommendations to SADC governments

Globally post offices started as a service to citizens, organized and financially supported by the government. In recent years, many countries have decided to privatize government structures such as the post office. This restructuring in all cases has reduced the postal workforce. African governments must act to create jobs not eliminate jobs. The evidence presented at Davos [16] make a clear case that the technologies of the 4th Industrial revolution will be transformative. In order to maintain the relevance of the post office and expand its workforce the governments ought to invest in a strategic information system plan that allows for the capture and extensive utilization of big data. The South African government can do this by investing additional funding in the SAPO, but also by making big data and analytics a priority with the National Research Foundation (NRF). The NRF should be given a mandate to pursue the IoT in general and the IoPT in particular. One way of assisting this effort is for the governments of SADC to empower the newly created Postal Research council to escalate their research by providing the council with resources.

4.3 Recommendations to Universities

The university must recognize the potential for ongoing research in collaborating with the Post Office. As indicated by the structure of the Postal Research Council, the research is interdisciplinary and includes technical, social science and management fields. Legal frameworks are being researched by Law Faculties, while the IoPT is a serious concern of Engineering and ICT Faculties. Memorandums of Understanding (MOUs) including the Post Office, Universities, as well as the Ministry of Higher Education and the Ministry of Telecommunications and Post is a good starting point to indicate the seriousness of this effort.

4.3.1 Collaborative Research Agenda

The structure created by the SAPOA Research Council lays the groundwork for a comprehensive collaborative research agenda. As this agenda is given detail and resources, it is important to take into account the driving force of the 4th Industrial Revolution in making priorities on what research projects to pursue. This brings us back to the importance of an ICT-based research agenda to make the Post Offices across Southern Africa truly competitive [19]. The Post Office must develop an Information Systems Strategy (ISS) that invigorates all its current activities. This ISS must recommend innovative new activities that take advantage of 4th Industrial Revolution technologies. The expansion of the SAPOA Research Council should be open to all university and postal researchers across southern Africa. However, ICT-based research in general and big data related research in particular must be sought out. This is needed to guarantee that this research collaboration focuses on the technologies and support systems that will most effectively generate innovation in postal operations.

4.3.2 Big Data curriculum recommendations

The recommended big data curriculum closely matches the skills identified in section 3.5 above. These skills are not only needed for Post Office big data research but are the skills needed in any big data and analytics environment. This curriculum may be placed in Mathematics, Computer Science, Statistics, Information Systems, Operations Research or Engineering departments. The curriculum may reside in Faculties of Science, Engineering or Management or may be interdisciplinary. Table 3 indicates the recommended modules and tracks.

Table 3. Tracks and Modules for Big Data Curriculum

Computing Track	Engineering Track	Management Track
Core – data structures, algorithms, databases, Ethics of information	**Core** – data structures, algorithms, databases, Ethics of information	**Core** – data structures, algorithms, databases, Ethics of information
Specialty subjects Advanced algorithms: AI, machine learning	**Specialty subjects** Microprocessor, Sensors, Data communications	**Specialty subjects** IS strategies, human resource management
Operations research: LP, NLP, DP, IP, Stochastic Processes	Operations research: LP, NLP, DP, IP, Stochastic Processes	Operations research: LP, NLP, DP, IP, Stochastic Processes
Knowledge management: acquisition, representation, and assessment	Knowledge management: acquisition, representation, and assessment	Knowledge management: acquisition, representation, and assessment
Modeling, simulation and information visualization - including discrete, agent-based and system dynamics simulation	Modeling, simulation and information visualization - including discrete, agent-based and system dynamics simulation	Modeling, simulation and information visualization - including discrete, agent-based and system dynamics simulation

5. FUTURE WORK

The framework for big data curriculum, as well as the framework for ongoing post office research is just the starting point. The development of the SAPOA Research Council into a credible and productive research unit requires further engagement with postal operations management and government ministries. To improve the value of the work of the Research Council, the continuing work will focus on developing a knowledge management system that can capture post office research conducted not only by SAPOA members but also capture the best practices and research outputs from other UPU members.

The IoPT is in its infant stage. Research must assure that the direction of its development maintains an alignment with socially relevant computing and assures the privacy of postal workers and Post Office users.

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