

Towards a Digitally Transformed Criminal Justice System: A South African case study

1st Nelisiwe Dlamini
Research and Innovation
State Information Technology Agency
(SITA)
Pretoria, South Africa
nelisiwe.dlamini@sita.co.za

2nd Lusani Mamushiane
Network Systems and Applications
Council for Scientific and Industrial
Research (CSIR)
Pretoria, South Africa
lmamushiane@csir.co.za

3rd Mpho Nkosi
Research and Innovation
State Information Technology Agency
(SITA)
Pretoria, South Africa
mphocaselina@gmail.com

4th Sabelo Dlamini
Research and Innovation
State Information Technology Agency
(SITA)
Pretoria, South Africa
sabelo.dlamini@outlook.com

5th Tumelo Ramaboka
Research and Innovation
State Information Technology Agency
(SITA)
Pretoria, South Africa
tumelo.ramaboka@sita.co.za

Abstract—The criminal justice system is a critical component of the South African government and its developmental and operational activities must be seamless to ensure timely delivery of justice to those who committed crimes. This study provides a glimpse into the current initiatives by the South African government towards a digitally transformed criminal justice system and conducts a gap analysis on these implementations, as well as highlights improvement opportunities. The study also proposes some of the technological paradigms (such as blockchain, 3D printing, digital twins, artificial intelligence and 5G) which demonstrate great potential to transform the South African criminal justice system. Last but not least, Estonia’s digital transformation initiatives to improve the criminal justice system are presented to benchmark the South African justice maturity level. From our analysis, it was discovered that South Africa has made significant strides towards modernizing its justice system. However, there is still room to modernize the justice system further by leveraging emerging technologies. Notably, these modernization efforts may require lengthy legislative processes, which is likely to delay utilization of the digital solutions by the justice cluster.

Keywords— *Criminal justice system, South Africa, Justice and Protection Services, JPS, Artificial Intelligence, Blockchain, 3D printing, Digital Twins*

I. INTRODUCTION

Over the last decade, South Africa’s crime rate has steadily increased, with a slight dip of 8.5% observed in 2020 during major national lockdowns which were put in place in response to the COVID-19 pandemic [1]. Even though a slight decline was observed during lockdowns, the rate of homicide increased by 8.7% [1]. The increase in crime levels means that the criminal justice system (which constitutes court systems, law enforcement agencies, prosecutors, legal representatives and corrections) is overburdened by an influx of criminal cases which must be processed. Thus, it is critical to integrate smart digital technologies into the criminal justice system to enhance operational efficiency, ease of administration, and seamless coordination between different functions. Moreover, technology integration into the criminal justice system means better prospects of successful investigations and prosecutions and minimizes wrongful convictions.

This paper unpacks some of the major initiatives by the South African criminal justice system, locally known as the Justice and Protection Services (JPS), towards the digital

transformation of the justice system. The current gaps and improvement opportunities are also presented including the specific transformative technologies, namely blockchain, 3D printing, digital twins and artificial intelligence, that JPS can consider in its quest for a modernized justice system. The paper also briefly highlights some of the major initiatives by Estonia (which ranks among the most digitally transformed countries) towards digitally transforming its criminal justice system. To the best of our knowledge, there is a lack of publications in the literature that review current digital transformation initiatives and maturity levels of the South African justice cluster, and this study aims to close this gap.

The paper is organized as follows: Section 2 gives an overview of the structure of the South African criminal justice system and chain of events, Section 3 highlights South Africa’s initiatives towards a digitally transformed justice system and some shortcomings, Section 4 presents Estonia’s digitalization efforts of its justice system, Section 5 presents new digital trends that can be used to enhance the criminal justice system, and lastly, Section 6 concludes the paper and highlights future work.

II. SOUTH AFRICA’S CRIMINAL JUSTICE SYSTEM

A. Structure of South Africa’s Criminal Justice System

At the cabinet level, South Africa’s criminal justice system is organized into one of five government clusters called the Justice and Protection Services (JPS), formerly known as the Justice, Crime Prevention and Security cluster (before cluster reconfigurations). The JPS cluster constitutes a total of 7 core ministries, namely the Police Ministry (locally known as South African Police Services (SAPS)), State and Security Agency, Home Affairs, Justice and Constitutional Development, Office of the Chief Justice, Defence Ministry (which is the Department of Defence), and Correctional Services [33]. JPS ministries work in an integrated pattern to deliver on the cluster’s mandate of reducing crime, improving the efficiency of the criminal justice system, fighting corruption, improving border integrity, managing the population registration system and fighting against and preventing cyber-crimes.

At its core, JPS is about strengthening coordination between different ministries under its jurisdiction to streamline communication between said ministries to build safe, just, inclusive and resilient communities.

B. Criminal Justice Case flow

The criminal justice system constitutes four main events namely, (1) Initial entry into the system, (2) Prosecution and pretrial services, (3) Adjudication, (4) Sentencing and sanctions, and (5) Corrections. In South Africa, seven government departments, namely, Legal Aid South Africa, Department of Correctional Services (DCS), Department of Social Development (DSD), Department of Justice and Constitutional Development (DoJ&CD), Office of Chief Justice, National Prosecuting Authority (NPA), and SAPS, are involved in prosecution, adjudication, and sentencing, except for SAPS and DCS, who are involved during initial entry in the system and corrections, respectively. Fig. 1 gives a simplified view of the case flow through the criminal justice system.

1) *Entry into the system*: The trigger point of the criminal justice system is the reporting of a criminal offense by dialling 10111 or going to the nearest police station to report the crime. After a crime is reported, the police open a docket and an investigation into the crime commences, evidence is secured, and the accused is apprehended.

2) *Prosecution and pretrial services*: The docket is then submitted to the prosecution office which (in consultation with the grand jury) decides whether or not to prosecute the accused. If the verdict is to file a charge, the accused is taken before the judge for an initial appearance, who decides whether or not there is probable cause to detain the accused. At this stage, the accused is either detained or released on bail, own recognizance or supervision, while waiting for trial. In many jurisdictions, an initial appearance is followed by a preliminary hearing to determine if there is reasonable ground to believe that the accused has committed the crime they are accused of. If the judge does not find probable cause, the charge is dismissed. However, if the prosecution case is strong and sufficient evidence is presented, the case is bound over to a grand jury, which determines if there is probable cause for the charges. If enough evidence is presented, the grand jury submits an indictment to the court which schedules an arraignment for the accused. At the arraignment, the accused is asked to enter a plea to the charges.

3) *Adjudication*: If the accused pleads guilty, the case does not proceed to trial and the accused is sentenced during the arraignment proceedings or at a later date determined by the judge. If the accused pleads not guilty or guilty by reason of insanity, the case is scheduled for a trial. At the trial, the lawyers (both prosecutors and defense) present their case and all their evidence to the court.

4) *Sentencing and sanctions*: If the trial is decided by a judge, the judge decides if the accused is guilty or innocent. The guilty verdict must be given beyond reasonable doubt. The verdict can be decided by the judge independently or by a jury for capital offenses. If the accused is found guilty, the judge can order probation officers to conduct a presentencing investigation which is used to determine if there are extenuating circumstances which should influence the severity or leniency of a criminal sentence. After a conviction and presentencing investigation, the sentence is imposed and

the accused is incarcerated. Other sentencing choices are available to the judge, such as the death penalty, probation, restitution, community service or boot camps.

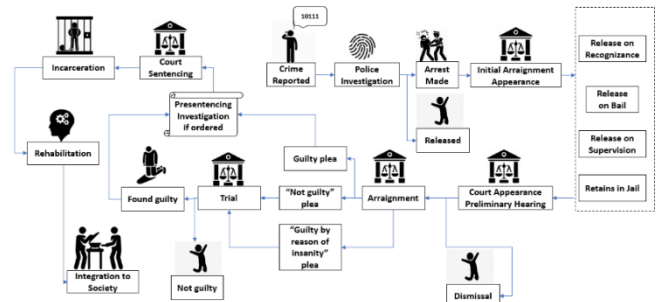


Fig. 1: Criminal justice chain of events

5) *Corrections*: Offenders sentenced to incarceration serve their sentence at either a local jail or a maximum-security prison. A prisoner may be eligible for parole after serving some of his/her sentence. If released by parole, the releasee will be under supervision by a parole officer for the remainder of their sentence. For successful integration into society, prisoners are encouraged to attend social reintegration programs, in-prison education, and vocational training.

III. CURRENT INITIATIVES BY THE SOUTH AFRICAN JUSTICE SYSTEM

A. The Integrated Criminal Justice System

The Integrated Criminal Justice System (ICJS) is an initiative by the JPS cluster designed to modernize and digitise the criminal justice system to enhance the operational efficiency and effectiveness of the justice system. This section presents some of the major initiatives under the ICJS and highlights some of the strengths and shortcomings of these initiatives.

1) *Person Integration*: The person integration project [2] constitutes initiatives for robust and secure identification, verification, authentication, and tracking of persons in the criminal justice system. Person tracking across the criminal justice system provides all authorised stakeholders of the justice cluster with up-to-date information regarding the location (in rehabilitation, incarcerated, released on bail and awaiting trial, acquitted, in parole, etc.), case status (investigation, pre-trial, trial, sentencing, etc.), case history, case handlers and criminal records of persons of interest.

JPS is also currently developing a Person Identification and Verification Application (PIVA) for secure identification of individuals by retrofitting multi-modal automated biometric identification and registration systems to their platforms, which use a combination of person identifying characteristics such as a fingerprint, palmprint, facial and iris scanning, voice recognition, handwriting, and ear height. The use of multi-modal biometrics increases the scope and variety of input of identifying characteristics which minimises identity fraud and enhances identification accuracy. With PIVA, individuals are verified against the Department of Home Affairs National Identification System (HANIS) [2], which constitutes the identity and status information of all individuals within the borders of South Africa. PIVA has

been successfully implemented by SAPS to verify the identity of detainees during the admission process and to provide verification services for SAPS operations at several airports. Another beneficiary of PIVA is the South African Social Security Agency (SASSA), which has integrated PIVA into its enrolment systems to combat identity fraud, which is quite prevalent in this vertical. PIVA is chiefly enabled by artificial intelligence (AI) technologies, such as natural language processing (NLP) [3], deep learning, and machine learning. An important requirement during biometric identification and verification is the high reliability of the AI algorithm as well as the security and reliability of the telecommunication link to the data centre(s) used to host the Home Affairs databases.

2) *Integrated Case Docket Management System*: JPS has made significant strides towards modernizing its case management by integrating an electronic docket (e-docket) management system to ensure seamless case information exchange between SAPS, NPA and DoJ&CD. The e-docket management system currently has a footprint in about 509 courts and 982 of 1146 police stations in South Africa. The system was designed to improve operational efficiency and to prevent dockets from being stolen, destroyed or manipulated [4]. Although widely deployed, the uptake of the e-docket management system, particularly by police stations, is rather slow [5]. To further enhance the security of the e-docket management system, JPS should consider integrating emerging technological trends such as blockchain [6] to fully tamper-proof the e-docket system. Blockchain is the technology behind Bitcoins and other crypto currencies. It is a distributed network of servers, where information is securely replicated on all participating computers using cryptography. The main advantage of this technology is that it does not have central management authority, meaning that changes to the blockchain can only be consensually implemented by blockchain participants, making this technology tamper-proof.

3) *Audio-Visual Remand (AVR)*: JPS has made significant investments towards courtroom modernization by integrating audio-visual technologies into their courtrooms and correctional facilities, which enable court proceedings, including witness testifying and language interpreting to be conducted virtually [7]. Using Audio Visual Remand (AVR), detainees at correctional facilities are tried virtually via a live video conference link to the corresponding courts handling their cases. This revolutionary system is both time-efficient and cost-efficient as it eliminates the logistics involved in transporting detainees to court. Additionally, the system also minimizes the possibility of escapes which typically occurs during transit from the correctional centre to the courthouse and vice versa. AVR has been very effective in curbing the spread of COVID-19 and in making sure that all court hearings and trials occur as scheduled, especially during major national lockdowns which restricted movement and physical meetings [8].

The main beneficiaries of this system are magistrates, prosecutors, attorneys, and lawyers, who can communicate with the inmates from the correctional services centres. Unfortunately, the AVR platform has only been rolled out at

a few court complexes and correctional facilities. To date, there are only 46 AVR sites operational across the country [9]. An important requirement towards an effective AVR system is a robust telecommunication infrastructure optimised to provide very high bandwidth and ultra-low latency, to ensure ultra-high-definition live video conferencing during virtual court proceedings. Video quality and real-time audio and video transmissions are critical during court proceedings to capture the accurate witness' and defendant's accounts, and to detect deception and sincerity.

A common major challenge reported by most courts (especially those located in rural areas) is poor network connectivity [8], which causes audio stuttering and video buffering. 5G promises to cost-effectively offer capabilities such as ultra-low latency and high-bandwidth communications, capitalizing on advanced technologies which include, but are not limited to, massive MIMO (multiple-input multiple-output) communications [10], New Radio Frequencies [11], and Mobile Edge Computing [12], for the last-mile infrastructure, and Software Defined Wide Area Networks (SDWAN) [13] and Network Function Virtualization (NFV) [14], for the core networks and data centre networks. It would thus be prudent for the government to start exploring optimal ways to integrate these new technologies into the telecommunication infrastructure to cost-effectively support bandwidth-hungry applications such as AVR.

4) *The Paperless Estates Administration System (PEAS)*: DoJ&CD has made significant progress towards the implementation of its paperless working environment initiative by successfully rolling out the Paperless Estates Administration System (PEAS) at about 15 Master Offices [15] and 280 magistrates' service points across South Africa. The service points are linked to the master offices, which oversee the appointment process to ensure that all South Africans receive the same quality of master's services, without travelling long distances to the 15 Master's Offices [16].

PEAS is used by the Master's Office to capture the deceased's estate information and to manage case workflows. The main objective behind the development of PEAS is to improve service delivery and time management by the Master's Office as well as to strengthen document security and retention and generate an automatic audit trail of all actions performed on the system [17]. The main drawback of PEAS is that the original documents are received by the Estate Controller as hard copies from the applicants and forwarded to what is called a "Scanner Clerk" who scans the documents to generate electronic copies. As a result, the system is not as environmentally friendly and calls for further digitization efforts. Moreover, there are stringent confidentiality and security requirements as it pertains to estate documents. Blockchain is a promising solution which could be leveraged to create distributed ledgers of tamper-proof estate documents.

5) *The Court Recording Technology (CRT)*: JPS has successfully implemented and operationalized a digital audio recording technology in over 1900 courts in the country. This technology is used to record court proceedings (such as trial,

or pre-trial hearings) for review and playback during court sessions and to address future transcription needs [2]. The court recordings are automatically sent via a secure link to local and national servers for safekeeping. The drawback of CRT is that it still requires manual transcription efforts, which is a time-consuming exercise. Moreover, the lack of automatic transcription capabilities makes CRT very costly in terms of internet bandwidth. This is because to access transcripts, the attorney, litigant, journalist or member of the public, has to apply to the clerk of the court for a copy of the transcript for a specific trial or court hearing. The clerk of the court then has to locate the recording and send the downloaded files to transcribers for speech-to-text conversion. As a result, the processing times of the transcripts are very extensive, depending on the length of the recordings and the backlog of applications for transcripts. According to transcribers, the processing time ranges between six weeks to two months for an average transcription, excluding the time it takes to courier the transcripts back to the court [18].

The transcripts delivery format is still paper-based requiring the applicant to physically collect the transcripts from the court which is both time-consuming and costs money. There is an opportunity to integrate automatic transcription capabilities into CRT leveraging AI and NLP. Such technologies have already been tried and tested in various court settings and have demonstrated great accuracy and efficiency. For instance, the CourtSide [19] software application can create verbatim transcripts in just a matter of seconds for audio recordings and minutes for video recordings. Another industry contender is CourtAudio [20], which is capable of delivering automated transcription in almost real-time. For video recordings, biometric recognition (such as facial recognition) is used to ensure accurate identification of various speakers during the proceedings [21]. Moreover, instead of archiving the entire audio or video recording in data centres, edge computing can be implemented for automatic transcription at the edge of the network (closer to where the recording was made) which will ensure better utilization of the broadband infrastructure and ensure cost savings on storage services. In other words, instead of storing audio and video recordings both of which require more storage resources, only the transcribed files are stored which require less storage capacity.

6) *MojaPay*: During the 2016/17 financial year, DoJ&CD successfully rolled out a financial management system called *MojaPay*, intended to address the accounting and service delivery challenges, and inadequate management and administration of third-party funds (such as child maintenance funds and deceased estates) [12]. Unfortunately, the system recently suffered a ransomware attack which denied access to all services making it impossible to pay maintenance and estate beneficiaries. This incident shone a painful spotlight on the cybersecurity maturity of government IT systems. There is an opportunity to further enhance the security posture of government IT systems by staying abreast of increasingly sophisticated cyberattacks and proactively innovating antidotes to these potential attacks. AI (machine learning and deep learning) and blockchain present a vast

transformative potential to improve cybersecurity in government IT systems by enabling automatic cyberdefense [19, 22].

IV. ESTONIA'S DIGITAL TRANSFORMATION FOR THE CRIMINAL JUSTICE SYSTEM

Estonia has developed a single central database architecture called E-File that integrates different information database systems (such as the police information system, court information system, jail's information system, and criminal case management registers) of the criminal justice system, to enable parties of the legal proceedings (victims, witnesses) and their representatives to electronically submit their cases and related documents and to observe the progress of their cases online [23]. E-File enables different departments within the criminal justice system to digitally exchange criminal case information and procedural acts, and to manage the progress of cases across the justice system, making it easier to digitally monitor the performance of different departments and to identify bottlenecks for accountability purposes. Moreover, E-File is equipped with a zero-touch case allocation module, which allocates a case to a judge based on their capacity and specialist knowledge to ensure a more balanced distribution of caseload for optimal utilization of human resources. Blockchain is integrated into this database to enhance resiliency, transparency, and security.

Despite all these digitization efforts, the court hearings and all other parts of the criminal justice system of Estonia still use paper documents. This is because, in Estonia, paper documents are legally considered to be the original documents and electronic documents are considered null and void during formal proceedings. The electronic documents are only accepted during the online case filing. Estonia has also invested extensively in cutting-edge audio-visual technologies and speech recognition technology capitalizing on AI to streamline the transcription processes at different stages of the criminal justice chain of events [24]. In this study, Estonia was chosen as the benchmark due to its reputation for growth and success in leading digital transformation initiatives, which is largely attributed to the government's political willingness to offer more convenient public services. The government has taken necessary steps, such as implementing innovative policies, making changes to policies and laws, introducing the required regulations and making investments to drive and expedite digital transformation [32]. This highlights the possibilities of the extent of digital transformation South Africa can achieve if a proactive approach is taken by the government by spearheading these efforts.

V. OTHER OPPORTUNITIES BASED ON CURRENT DIGITAL TRENDS

This section highlights the current technological trends with a vast transformative potential for the criminal justice system. These technologies include blockchain, 3D printing, digital twins, artificial intelligence, 5G, robotic process automation, and augmented and virtual reality. Other governments have been successful in integrating these technologies into their criminal justice system.

A. *Blockchain*

Blockchain has already entered judicial structures as a tool for the management and storage of sensitive legal documents (dockets, sex offender registries, evidence documents, land registries, civil registries, criminal records, etc.), to provide

operational efficiency (through automated workflows) and document security, while increasing accountability and transparency [25, 26]. China has successfully integrated blockchain into its community correction programs for real-time location tracking of parolees and sex offenders [27]. Another application of blockchain is to tamper-proof videos taken by police body cameras, which usually provide crucial evidence of alleged police misconduct [28].

B. 3D Printing

3D printing, also known as additive manufacturing, is the construction of 3D objects from a digital file or computer-aided design (CAD). This technology is superior to traditional casting methods because of its great accuracy and speed of construction. With 3D printing, objects can be scaled up to make small features more visible, or conversely, scaled down to make the object more portable. In the context of the criminal justice system, 3D printing has been widely adopted to recreate detailed models of crime scenes, fingerprints, facial reconstruction and weapon reconstruction. For instance, Hong Kong law enforcement is using 3D printing to make crime scene models, which helps them understand the crime and build stronger cases. Law enforcement agencies in Ohio and New York have been successfully using 3D printing to solve cold cases (some of which are a decade old) and preservation of evidence, by using facial reconstruction on top of 3D models of badly decomposed skeletal remains [29, 30]. The remains are considered evidence, and thus, forensic artists cannot build on top of them, making 3D printing the ideal alternative.

C. Digital Twins

Digital twins are the next big thing in the fourth industrial revolution for the development of new products and services. This technology uses real-time data collected from IoT sensors, along with AI and software analytics, to create a digital copy of an asset (such as a process, product or service) to optimize the performance of the asset before real deployment. Digital twins have traditionally been used to optimize manufacturing processes. However, this technology has started to extend beyond the factory floor and is penetrating other industry verticals such as healthcare, construction and justice and protection services. Some of the use cases of digital twins in justice include creating forensic digital twins [31], which essentially is the simulated replica of crime scenes used to test theories and hypotheses with changing environmental factors. This ultimately improves crime investigations and prosecution. Another benefit of forensic digital twins is that it helps with the digital preservation of crime scenes for as long as a case remains relevant. Digital twins are also gaining traction in public safety where data models are used to create live digital blueprints of cities to achieve real-time visibility of cities which enables better response to emergencies.

VI. CONCLUSION

This paper highlights the current activities of South Africa's Justice and Protection Services (JPS) cluster towards a digitally transformed criminal justice system and provides visibility of what is happening in the cluster. It also closes the gap where a lack of publications in the literature that review current digital transformation initiatives and maturity levels of the South African justice cluster, was identified. The paper also presents current technological trends (such as 3D printing, digital twins, artificial intelligence, and blockchain)

that have transformative potential for the justice system. From our review, the JPS cluster has made significant strides towards modernizing the justice system to tackle the most time-consuming and menial tasks and has found solutions to replace these with automated systems. Most of the transformation efforts by the cluster are towards a paperless integrated criminal justice system to improve operational efficiency and the quality of justice services provided to the citizens. However, there is still room to improve the current initiatives through the adoption of intelligent technologies. For instance, the e-docket and estate administration system can potentially benefit from blockchain technology for security enhancement, while the court recording system and MojaPay can be improved by integrating AI and NLP for automatic transcription and security respectively, lastly, the audio-visual remand needs a robust telecommunication infrastructure, which can potentially be achieved using 5G and SDWAN technologies.

The paper also highlights some of the major initiatives by Estonia towards the digital transformation of its justice system. The country has made significant investments in the digitisation of its criminal justice system through the implementation of the E-File system. Unfortunately, the adoption of this system is quite limited due to stringent legislation which requires paper-based court proceedings. It is important to note that changes to the existing criminal justice system may require lengthy legislative procedures, which warrants a thorough and targeted analysis of the legislative implications of adopting each of these digital technologies and an in-depth and detailed study of each of these technologies. This paper is a first step towards such an analysis.

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