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Interoperability Maturity Models for Consideration When Using School Management Systems in South Africa: A Scoping Review

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***Abstract*—**The main purpose and focus of this paper are to determine the Interoperability Maturity Models to consider when using School Management Systems (SMS). The importance of this is to inform and help schools with knowing which Interoperability Maturity Model is best suited for their SMS. To address the purpose, this paper will apply a scoping review to ensure that all aspects are provided. The scoping review will include papers written from 2012-2019 and a comparison of the different types of Interoperability Maturity Models will be discussed in detail, which includes the background information, the levels of interoperability, and area for consideration in each Maturity Model. The literature was obtained from the following databases: IEEE Xplore and Scopus, the following search engines were used: Harzings, and Google Scholar. The topic of the paper was used as a search term for the literature and the term 'Interoperability Maturity Models' was used as a keyword. The data were analyzed in terms of the definition of Interoperability, Interoperability Maturity Models, and levels of interoperability. The results provide a table that shows the focus area of concern for each Maturity Model (based on the scoping review where only 24 papers were found to be best suited for the paper out of 740 publications initially identified in the field). This resulted in the most discussed Interoperability Maturity Model for consideration (Information Systems Interoperability Maturity Model (ISIMM) and Organizational Interoperability Maturity Model for C2 (OIM)).

***Keywords*—**Interoperability, Interoperability Maturity Model, School Management System, scoping review.

I. Introduction and Background

IT is important for systems in an organization to communicate and share information to ensure efficiency and effectiveness of the overall operation of the organization, Interoperability allows system communication.

Interoperability is defined globally as "the ability of two or more systems components to exchange information or to and use the information that has been exchanged" [1]. There are server risks that can occur in an organization that lacks interoperability as its vital to be able to connect through the use of technology [2]. Relevant articles from 1980 to 2019 identified Interoperability Maturity Models through a search which is in no particular order: Government Interoperability Maturity Matrix Model, ISIMM, Enterprise Interoperability Maturity Model, Levels of Information Systems Interoperability Model (LISI), and OIM. Interoperability is evaluated by the use of these models. Maturity Model (MM), is simply a set of patterns, indicators, attributes, or characteristics that represent the achievement and progression in a specific disciple or domain [3]. MM gives means to assess and benchmark and the progression of characteristics that are set against that benchmark [4]. An organization or industry is allowed to have its methods, processes, and practices assessed against clear artifacts set to institute a benchmark. There is often a representation of best practices and standards of practices from these artifacts [3].

The evaluation of higher education institutions (HEI) in numerous dimensions, such as e/m-learning, process management, pedagogical strategies, ICT, online courses, management, course curricula, and course/HEI accreditation has always used MM in the education sector [5]. When there is a variety of challenges, MM is always available to respond to those challenges [5].

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II. School Management Systems

SMS can benefit a lot from interoperability, SMS is a huge database system that is utilized for the management of the everyday work of schools, it can be set up in a manner that addresses the needs of any school [6]. Teachers can perform various functions on the system such as: capturing marks, lesson plans, notes for the class, complete marks for learners, track student's attendance, and retrieve reports that are detailed as well as communicate with colleagues through the use of emails [7]. Students can test results and assignments and view the academic transcripts [7]. SMS help overcome boring paperwork in schools. It reduces the workload, increases efficiency in school management, and saves time. Administrative staff can add or remove teachers and students from the database via this application and they also can register themselves [6].

A. Disadvantages of SMS

Although SMS has many benefits for schools, it also comes with disadvantages as follows:

- Most schools use a free version of SMS which often lacks in numeral features such as discipline, custom reports, registration, and inventory [8].
- Some are narrowed by space capacity, the number of students, and storage which can be managed [8].
- The majority of these systems are not linked to the Department of Basic Education (DoE) which makes it hard to submit data to the DoE [9].
- The SMS are also not linked to one another which mean that schools are also not sharing information among

themselves, each school works in their silos, and this necessitates the need for interoperability and an investigation into Interoperability MM which can guide schools of how to solve problems they encounter with their SMS.

- SMS are often installed on one standalone computer which limits access [9]. This places substantial tension and stress on the administrator who is working alone and is the only resource available during peak demand times such as the end of the term when schools are required to process learner reports, which mostly leads to annoying delays [9].
- Teachers have a small amount of access to the system for an easy piece of work like capturing marks and mostly consume teaching time by manually validating marks in on paper that are never-ending [9].
- Some SMS have an infrastructural deficiency as it is normally installed on a stand-alone PC with limited/no access to the internet specifically for schools located in rural areas. One might also find that an SMS has a lack of not only maintenance and data security measures, but also of specific and inadequate availability of relevant software.
- Another disadvantage is the non-availability of skilled ICT personnel as users are often not trained to utilize the system effectively.

The South African School Administration Management System (SA-SAMS) was introduced by the DoE in 2005, to improve data management at the school level and permit data to be uploaded on provincial database [10], [11] . In 2008, SA-SAMS was made available at no cost to all schools in South Africa after being tested in several schools to ensure that data from schools will be submitted to the departments in the correct format [11]. When schools submit data to DoE, they normally face a difficult and tiring process due to the fact the SA-SAMS is not linked to the systems at the DoE. The data requested by the DoE are extracted from SA-SAMS by schools and copied into a memory stick or CD and physically sent to the DoE, the DoE then has to manually upload the data on their database which causes major delays when it comes to releasing the statistics of the schools [12]. Interoperability ensures that systems can work together with other systems without the significant effort required from the user [13], the information will be exchanged continuously without requiring schools to physically send data to the DoE. Although SA-SAMS was made compulsory in all schools in 2008, It is not a must for schools to use it, However, the legal requirements of creating data in SA-SAMS format must be met by all schools that are not using SA-SAMS. To reduce duplicating work, each SMS used by schools should easily integrate with SA-SAMS [14], [15]. There is also a need for SMS to integrate with the systems at the DoE which is a need that interoperability can solve.

B. Educational Benefits of Interoperability

For an education system to be successful, its Information Systems must be effective in its ability to provide support for classifying, storing, sharing, and using information [16]. It is important to evaluate the level of interoperability in SMS to determine how interoperability can best benefit SMS and ultimately improve it by addressing the disadvantages of SMS as listed above. A combination of ISIMM and OIM will be used to assess the level of interoperability. Similarly, interoperability has educational benefits which can be used to improve SMS such as [17], [18]:

- The burden on school staff to enter data is reduced: Staff members enter information about a new student into the systems repeatedly to assign the student to classes, free or reduced meals, and bus routes, access to the library, student number, and academic record and so on. Interoperability systems allow for data to be captured only once and then shared when required with the entire school, DoE, and the district.
- Quality of data is improved: A risk of error is normally caused by manually entering data into a system; risks also arise when there is a manual migration of data from one system to another. Interoperability systems ensure that data exchanges are automated significantly to decimally reduce the chances of error. A data driven decision based on timely and accurate information where timely action flows can also result in good decisions
- SMS offer adaptability because when interoperability is combined with a modular approach; both IT architecture and educational practices can arise, it is less disruptive, cheaper, and faster to change things as needed.
- There are innovation and market growth.
- Data are shared effectively across systems.

The following was outlined by the U.S. Department of Education and National School Interoperability Program as the benefits of interoperability for school systems [19]:

1. More information and data are made available to the public.
2. Chances of error are reduced.
3. Multiple providers integrate services and products to create a seamless user experience.
4. Transparency will be forested more in a larger educational community.
5. A variety of devices can be used to access the same service.
6. Collaboration can be enhanced with non-profit and private entities, the public, and other federal and non-federal agencies.
7. Access to teaching tools and learning resources is significantly improved.
8. Reporting, online assessment, and performance monitoring improve the data quality as was mentioned above as educational data are transferred securely and reliably and administrative and academic data can be exchanged between databases and software applications to assess performance and maintain administrative reporting;
9. The main parts of the educational systems which are teachers, administrators, and students needs to follow standards for expressing digital content and school data,

to maintain this kind of activity [16].

From the listed educational benefits of interoperability, a clear picture of how Interoperability MM can potentially solve the problems encountered by schools in their SMS is observed. The majority of the disadvantages of SMS are addressed by the listed educational benefits of interoperability.

C. Challenges of Interoperability

The Industry Advisory Council outlines several challenges that are faced to achieve interoperability and information sharing that can affect SMS. They are [19]:

- Organizational: The most difficult challenge is to achieve a meaningful consensus. It is hard to achieve an agreement on syntax and semantics.
- Architectural: There is no alignment of the enterprise architecture agencies and there is no defined process alignment.
- Technical: There is no infrastructure put in place to support interoperability at the component or service data level.

By keeping these benefits and challenges of interoperability in mind a scoping review will be done to determine the best-fit interoperability MM for SMS.

III. Methodology

In general terms, a research study led by a team of researchers with specialized skills is well known as systematic review [20]. This team identifies and obtains international evidence relevant to some of the questions and results of the research used to inform practice [20]. A systematic review was used for this paper, to follow a process that is predefined and organized which has accurate methods for meaningful and reliable results to end-users [20]. To address the research question, a scoping literature review was conducted to determine which Interoperability MM to consider when using SMS in SA. Reference [21] shows that scoping review is a model of information necessary to solve a search query. Along with scoping scans, key concepts are prepared, these schemes are sought and the lines are sorted in place by deliberately looking, selecting, and including schemes, knowledge, and available income [22]. Reference [23] suggests that a scoping literature review should ensure that: the benefit of pursuing a systematic review is identified and clearly articulated; the nature of the exploration action or activity, range, and the degree is examined; research chasms in the current literature are identified, and there is a summary and disperse of results from research. A scoping review was applied, as a result of following these views, to take into account the degree, nature, and range of research activities with regards to the notions of Interoperability MM [22]. Relevant publications which had not been listed in the databases but were highly cited were obtained using software such as Perish or Harzing's Publish. Important papers and records on Interoperability MM were searched by using the following databases: IEEE Xplore, ScienceDirect, ACM digital library, and Scopus. A manual search was led using the Google web search tool to get other applicable publications, the inquiry time frame was from 2011 to 2019, and the search was directed in April 2019.

The search criteria included search terms: 'SMS' AND Interoperability MM' within the context of SMS. Of the 740 papers retrieved, only 24 covered Interoperability MM, levels of interoperability, and background information which were relevant and were included. Most of the papers focused on Interoperability MM which are Enterprise Interoperability Maturity Model (EIMM), ISIMM, OIM, Information LISI, and Government interoperability maturity matrix (GIMM), while others provided the Educational benefits and challenges of interoperability. The screening process identified 59 eligible remaining records and 35 papers were excluded from the 59 papers which are eligible as 25 papers only stated the name of the MM but did not go in-depth, and 10 were not an original study. To address the question in this paper: Which Interoperability MM should be considered when using SMS in South Africa?, a scoping review was done and findings are provided below.

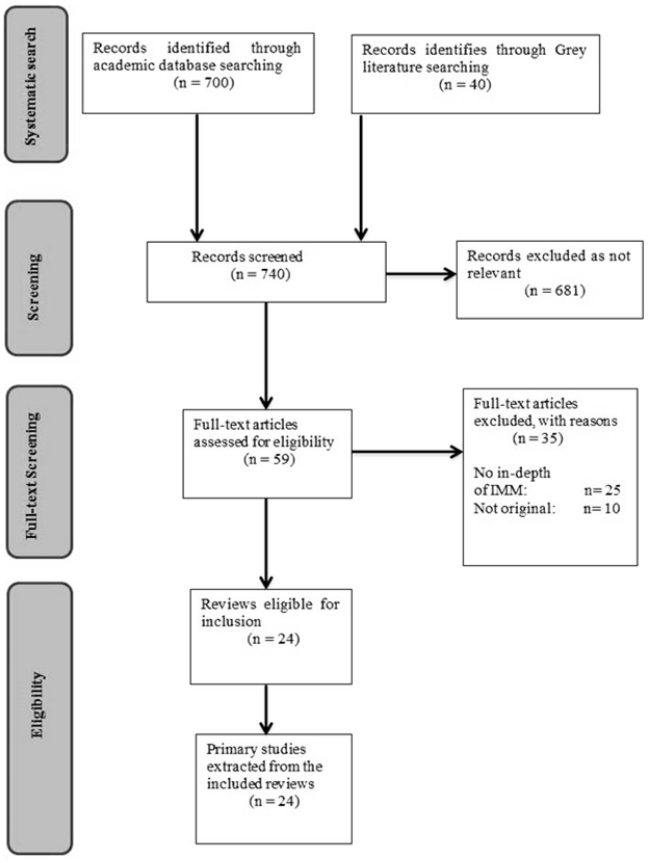

Fig. 1 Scoping Review-Prisma

IV. Scoping Review Results of Interoperability MM

A. Scoping the Interoperability MM

This section of the paper indicates the findings of the scoping review discovered on the search items to establish the Interoperability MM that need to be taken into consideration when using SMS in SA. The approach will be to list all the Interoperability MM which exist according to literature and

discuss them in more detail. The following were found:

B. LISI Model

The US Department of Defense C4ISR Working Group developed the LISI model in 1998. LISI is a model that provides an analysis of the structure of information interoperability [24], [25]. In other words, it is a process of interpreting, measuring, and evaluating the impact that systems and organizations need [26]. Improving the coherence of problems in the system is a key goal of the LISI model [13], [25]. Five interoperability levels are ranging from 0 to 4 which include: Isolated, Connected, Functional, Domain, and Enterprise which exist in a certain environment [24]. A representation of the levels of the LISI model has been given in Fig. 2 [27]. These levels are displayed in rows, and four columns, which shows that the attributes of the LISI Reference Model contain Procedures, Applications, Infrastructure, and Data (PAID) [13]. Consequently, in the LISI, interoperability aspects are categorized into four unified attributes [24], [27].

<table>
<tr><th colspan="3" rowspan="2">LEVEL
(Environment)</th><th colspan="4">Interoperability Attributes</th></tr>
<tr><th>Procedures</th><th>Applications</th><th>Infrastructure</th><th>Data</th></tr>
<tr><td rowspan="3">Enterprise Level (Universal)</td><td rowspan="3">4</td><td>c</td><td>Multi-National Enterprises</td><td rowspan="2">Interactive (cross applications)</td><td rowspan="3">Multi-Dimentional Topologies</td><td rowspan="2">Cross-Enterprise Models</td></tr>
<tr><td>b</td><td>Cross Government Enterprise</td></tr>
<tr><td>a</td><td>DoD Enterprise</td><td>Full Object Cut & Paste</td><td>Enterprise Model</td></tr>
<tr><td rowspan="3">Domain Level (Integrated)</td><td rowspan="3">3</td><td>c</td><td rowspan="3">Domain Service/ Agency Doctrine, Procedures, Training, etc.</td><td>Shared Data (Situation Displays Direct DB Exchanges)</td><td rowspan="3">WAN</td><td>DBMS</td></tr>
<tr><td>b</td><td>Group Collaboration (While Boards, VTC)</td><td rowspan="2">Domain Models</td></tr>
<tr><td>a</td><td>Full Text Cut & Paste</td></tr>
<tr><td rowspan="3">Functional Level (Distributed)</td><td rowspan="3">2</td><td>c</td><td rowspan="3">Common Operating Environment (Dll-COE Level 5) Compliance</td><td>Web Browser</td><td rowspan="2">LAN</td><td rowspan="3">Program Models & Advanced Data Formats</td></tr>
<tr><td>b</td><td>Basic Operations (Documents, Maps, Briefings, Pictures, Spreadsheets, Data)</td></tr>
<tr><td>a</td><td>Program Standard Procedures, Training etc.</td><td>Adv, Messaging (Parsers, E-mail+)</td><td>Network</td></tr>
<tr><td rowspan="4">Connected Level (Peer-to-Peer)</td><td rowspan="4">1</td><td>d</td><td rowspan="2">Standards Complaint (JTA IEEE)</td><td>Basic Messaging (Plain Text, E-mail w/oattachments)</td><td rowspan="3">Two Way</td><td rowspan="3">Basic Data Formats</td></tr>
<tr><td>c</td><td>Data File Transfer</td></tr>
<tr><td>b</td><td>Security Profile</td><td>Simple interaction (Text Chatter, Voice, Fax, Remote, Access, Telemetry)</td></tr>
<tr><td>a</td><td colspan="2"></td><td>One Way</td></tr>
<tr><td rowspan="5">Isolated Level (Manual)</td><td rowspan="5">0</td><td>d</td><td colspan="2">Media Exchange Procedures</td><td rowspan="5">N/A</td><td>Removable Media</td><td>Media formats</td></tr>
<tr><td>c</td><td rowspan="3">Manual Access Control</td><td>NATO Level 3</td><td rowspan="3">Manual Re-entry</td><td rowspan="3">Private Data</td></tr>
<tr><td>b</td><td>NATO Level 2</td></tr>
<tr><td>a</td><td>NATO Level 3</td></tr>
<tr><td colspan="2"></td><td colspan="2"></td></tr>
<tr><td colspan="3">0</td><td colspan="4">NO KNOWN INTEROPERABILITY</td></tr>
</table>

Fig. 2 The LISI Model [13], [26].

- Level 0 – Isolated interoperability manual environment: this level includes isolated or standalone systems, a direct connection is not permitted within these systems and they have a manual interface, data are manually extracted and integrated between multiple systems [24], [27].
- Level 1 – Connected interoperability in a peer-to-peer environment that involves the the homogeneous shared data types. Interoperability can only be achieved through the electronic connection among systems which has the easiest way to electronically exchange data [24], [25].
- Level 2 – Functional interoperability distributed environment: systems are located locally that allow the transmission of data through the system. At this stage, there is good media coverage, and models of parallel documentation are introduced with the system [24], [27].
- Level 3 – Domain-based interoperability integrated environment: there is a wide area network (WAN) that connects systems which can be used by many users. The exchange of information is conducted by independent applications using data models that have been agreed-upon [25].
- Level 4 – Enterprise-based interoperability universal environment: a variety of users can access difficult data at the same time, which can be accessed by multiple users simultaneously, and worldwide information space can be used by systems in numerous domains [25], [27].

Within a level, more aspects that impact the capability of systems to interoperate are identified by LISI. These factors are made up of four attributes: PAID.

- Procedure attributes: these attributes address the policies and procedures, doctrine, and architecture guidance and standards that permit systems to exchange information [13], [24], [27].
- Application attributes: the guidance of the architecture as well as the step by step processes, standards, rules, and regulations that empower the exchange of information among systems are addressed by this attribute [13].
- Infrastructure attributes: these attributes support the creation and connection between systems. Environments that enable the communication are services of the system, the network, and the hardware [13], [24].
- Data attribute syntax and semantics data format of information processes are the main focus of this attribute and content formats as well as protocols that enable data as well as information to be interchanged [13], [24].

The value of using the LISI Model is that the results will be expressed in the interoperability metric form [13], [24]. With this model, an essential evaluation detail required for determining interoperability matric and profile will be provided [13].

C. OIM

The Australian Defense Science and Technology Organisation developed the Organisational Interoperability Maturity Model (OIM) in 1998 to evaluate the capability of organizations to interoperate [28], [29]. To also assess the non-technical, or human-activity, characteristics of one organization's capability to interoperate with another [26]. The LISI model is extended into the further intellectual layers of knowledge and control support. Fig. 3 illustrates the organizational interoperability MM in detail [13], [25]. OIM has levels (independent, cooperative, collaborative, combined, and unified) similar to LISI and four organizational interoperability attributes (preparation, understanding,

command style, and ethos) [13], [28].

	Preparedness	Understanding	Command Style	Ethos
Level 4 Unified	Complete normal day-to-day working	Shared	Homogeneous	Uniform
Level 3 Combined	Detailed doctrine and experience in using it	Shared comms and shared knowledge	One chain of command and interaction with home org	Shared ethos but with influence from home org
Level 2 Collaborative	General doctrine in place and some experience	Shared comms and shared knowledge about specific topics	Separate reporting lines of responsibility overlaid with a single command chain	Shared purpose; goals, value system significantly influenced by home org
Level 1 Ad hoc	General guidelines	Electronic comms and shared information	Separate reporting lines of responsibility	Shared purpose
Level 0 Independent	No preparedness	Communication via phone etc	No interaction	Limited shared purpose

Fig. 3 OIM [29], [30]

Five levels of organizational maturity are defined which describe the ability to interoperate [26]. These levels were suggested to talk to the needs of the levels of conceptual interoperability that extend across technical models like LISI. Interoperability is considered a conceptual problem rather than a technical problem [13], [27]:

- Level 0 – independent: This level describes the impact of independent organizations. It includes organizations that have no interaction or anything but personal contact. Organizations that need to interact without goals and objectives are at this level [13], [24].
- Level 1 – ad hoc: In this level, a minimal organizational framework is put in place to support ad hoc arrangements. There are guidelines put in place to explain how interoperability will be implemented [13], [24].
- Level 2 – collaborative: There are frameworks and common goals that are put in place to support interoperability. The everyday roles and responsibilities of the organizations are assigned and recorded [13], [24].
- Level 3 – integrated: There is the same level of understanding and preparedness to interoperate as well as common goals and value systems, at this level [13], [24].
- Level 4 – unified: This level is normally considered ideal as organizations share value systems, goals, command style, and knowledge bases across the system [13].

The four enabling attributes for organizational interoperability are:

- Preparedness: This attribute ensures that the organization is prepared to interoperate by offering training, experience, and doctrine [13], [27].
- Understanding: This attribute measures the level of understanding by looking at the knowledge base, sharing of information, and communication in the organization [27].
- Command style: These attributes look at how decisions are made in the organizations, the assignment of responsibilities and roles, and the management style of the organization.
- Ethos: This focuses on the trust level, value system, goals, culture as well as the goals of the organization, the value systems, and the culture of the organization [13], [24].

D.EIMM

EIMM is explained by the European Commission through the Advanced Technologies for interoperability of Heterogeneous Enterprise Networks and their Applications Integrated Project (ATHENA IP). A set of areas of concern and maturity levels are explained where every area of concern is explained by goals and objectives [31]. Every indicator is needed to achieve a specific maturity level [31].

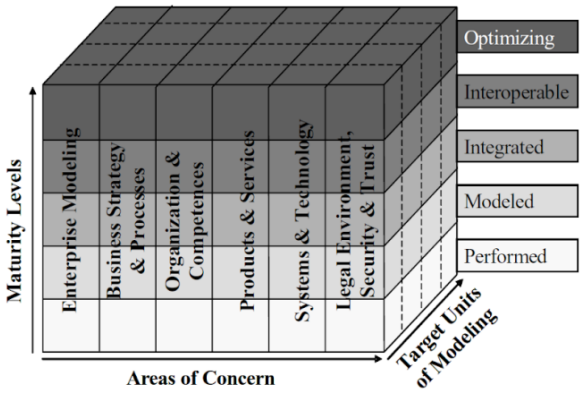

Fig. 4 EIMM [31]

- Enterprise Modeling: improvements, applications, constructions, and specification of the enterprise models are the area of concern which are covered [25], [28].
- Business Strategy and Processes: This area of concern identifies processes, business strategy, and ensures their alignment, specification, execution, and improvements [31].
- Organization and Competencies: Specifications, enactment, identification of the organizational structure, and improvements which include the knowledge and skills of players identified are covered in this area of concern [24].
- Systems and Technology: Design, operation, identification of enterprise systems, improvement, maintenance, and acquisition/construction are covered by this area of concern [30].
- Legal Environment, Security, and Trust: This area of concern covers trust and security requirements, legal identification due to the Interoperability Framework (EIF) to collaborate with external entities and the establishment of solutions that will manage key aspects for interoperability [24], [27].

The five maturity levels of the EIMM are:

- Performed: This level handles enterprise modeling and collaboration, however, collaboration is completed

between ad-hoc organizations and external entities which include suppliers, customers, and administration even though there is no well thought out relationships [24], [30].

- Modeled: This level handles collaboration as well as enterprise modeling all the time and this technique work very well at this level [24], [27].
- Integrated: There is a formal documentation process of enterprise modeling which is used all the time in this level [24], [27].
- Interoperable: In this level, the enterprise model supports the ability to adapt to change, external entities, and dynamic interoperability [24], [27].
- Optimizing: Organisations are allowed to flexibly and responsively react and adapt to change in an agile manner [30].

E. GIMM Model

The model contains a system of governance and self-assessment that can be used to measure current governance situations that need to be addressed with government-e-government interference as well as the steps required to improve their performance as well as the use of jobs and services provided to the public and the industry [24]. Three types of interoperability are extended by this model in the European context, which aims to identify numerous Interoperability Attributes that need to be taken into consideration with the intent to evaluate every organizational position in e-Government interoperability. GIMM consists of a set of levels as illustrated in Fig. 5 which links to diverse interoperability levels for a set of interoperability attributes (IA) [24]. Fig. 5 below shows Government Interoperability Maturity Levels

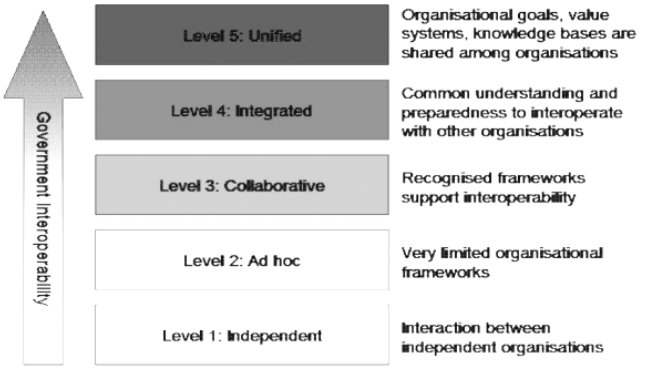

Fig. 5 Government Interoperability Maturity Levels [25]

The five levels of maturity are:

- Level 1 – Independent: The communication of self-regulating organizations are explained in this level [13], [24].
- Level 2 - Ad hoc: Few organizational frameworks are included in this level which supports ad hoc arrangements [13], [24].
- Level 3 – Collaborative: Some affirmations have been put in place to encourage interaction. There are also synergies and roles and responsibilities assigned to the staff of the organization [24].
- Level 4 – Integrated: There are mutual understanding and planning of interactions with other organizations, implementation of benefits, and goals [24].
- Level 5 – Unified: knowledge bases, organizational goals, command structure/style, and value systems are shared between organizations in this level [24]

F. ISIMM

A more practical ISIMM was developed to assess the degree of interoperability among Information Systems, with the intension meeting the set objectives. The ISIMM was derived from the theories of LISI and GIMM and its main focus is technical aspects of interoperability that are detailed and that permit the sharing and exchange of data inside the information system environment [31]. The degree and levels of interoperability that an organization will progress through are represented in Fig. 6. These levels offer a systematic and structured method for evaluating and quantifying Information Systems' interoperability maturity. ISIMM also gives ways to obtain an in-depth understanding of Information Systems, and interoperability that will be helpful with promoting and establishing an interoperable systems environment within government [31].

Fig. 6 ISIMM [13], [25]

Technical interoperability of information systems is the main focus of ISIMM, specifically in the following areas:

- Data Interoperability: This introduces the ability of various software from different systems to understand the meaning and content of data obtained from different data formats through the use of different data, patterns, and grids [31], [32].
- Software Interoperability: This is when various software that differ from one another, used by different organizations, can work collectively in data sharing and exchanging information through fixing their differences [31], [32].
- Communication Interoperability: This means that systems can communicate and connect through common protocols [31], [32].
- Physical Interoperability: This is when computers are not the same in terms of hardware, peripherals, and network devices but they can work together in a connected way [31], [32].

Fig. 6 displays the maturity interoperability computing environment levels which are defined as follows:

- Level 1 – Manual: there is no connection of Information Systems and the sharing of data among these systems and data sharing can only be done manually [31], [32].
- Level 2 – Ad-Hoc: The simplest form of data sharing for non-standardized data is done through the easiest electronic form with other organizations. There is a separation of applications and databases and there is no data that is shared among organizations [31], [32].
- Level 3 – Collaborative: There is a broader connection to legacy systems that are facilitated, the simplest collaboration occurs at a program level among self-governing applications in a distributed manner. Least shared functions exist, there are separate applications and databases and data are not shared [31], [32].
- Level 4 – Integrated: There are data that are shared to a certain extent in the integrated stage. There is also a higher level of collaboration and services or systems integration being implemented between organizations [31], [32].
- Level 5- Unified: Complete data are shared at this level; organizations can talk to one another and exchange information. The information is also interpreted the same way between these organizations and the systems are fully interoperable [31], [32].

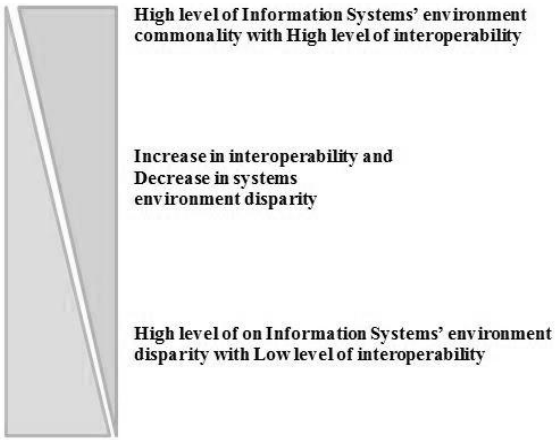

Fig. 7 Information systems' interoperability maturity transition [32], [33]

Fig. 7 shows the progress of an environment that is interoperable from a high dissimilar Information Systems environment to a high shared integrated and shared Information Systems environment [31], [32].

V. Experiments and Results

Table I summaries the focus area of each Interoperability MM identified during the scoping review.

As per Table I, the LISI provides a way to address system-to-system interactions to communicate, the key to a relationship [36]. The Organizational Interoperability Maturity Model (OIMM) does not focus on technical, semi-functional, or synthetic functions, but focuses on the industry and area of concern [36]. EIMM focuses on the enterprise, GIMM Model focuses on the Administrations concerning e-Government interoperability, and ISIMM focuses on the technical aspects of information systems interoperability. This table provides a holistic view of identifying which model to consider for SMS.

TABLE I
Focus Area of Interoperability MM

MM	Focus Area	Authors
LISI	Technological (Information Technology Interoperability), Technical	[13], [24]-[27], [33]-[37]
OIM	Organizational	[13], [26]-[30], [33]-[35], [37]-[39]
EIMM	Business Strategy and Processes, Organization and Competences, Systems and Technology, Legal Environment, Security and Trust, and Enterprise Modeling	[26], [28], [29], [31], [33], [34]-[37], [39]-[41]
GIMM model	Administrations concerning e-Government interoperability, Organizational interoperability, Semantic interoperability, and Technical interoperability	[25], [26], [28], [29], [31], [32], [34], [38]-[41]
ISIMM	Technical aspects of information systems interoperability	[31]-[33], [35], [40], [41],

The Interoperability MM to consider when using SMS in SA are ISIMM and OIM because ISIMM evaluates the degree of interoperability among information systems, this is vital as it will provide a clear view of interoperability in the SMS. ISIMM also focuses on very detailed information that allows data to be exchanged and shared in the information environment; this is a very important aspect to have as the purpose of interoperability is information exchange. There will be a deeper understanding of the information system with this MM which is vital for SMS. OIM extends the LISI model and focusses on the ability of organizations to interoperate with one another. This model examines how non-professional or human-related activities and organizations can interact with others. These two models complement each other in so many ways and are both developed as an extension from the LISI model. It is very important to understand the degree of interoperability in the SMS so it can be improved and relatively important to also assess how users will interact with the system and these two chosen models provide that holistic view, from system to organization adaptation.

The LISI Model is not considered in this regard because it is more similar to the ISIMM in that it measures the level of interoperability between systems and it is also an extension of both ISMM and OIM model. GIMM can be used later on when interoperability has been positioned in SMS to conduct a self-evaluation that asses the present position of the administrations regarding e-government interoperability and the steps required for bettering their positioning in respect to system implementation. This model can be considered for future purposes. EIMM is not considered because it is a high-level MM that focuses on the enterprise.

VI. Conclusion

The literature review and results of the scoping review have provided a holistic view of each Interoperability MM along with its focus area in order to indicate the benefits of the educational system that can be obtained by implementing

interoperability in SMS, and thus the majority of the problems encountered by the schools will be decreased decimally. Many of the SMS used by Private schools in SA have not been customized to fit the requirements of the needs of DoE and therefore need to be interoperable with the DoE SMS called SA-SAMS. Schools, in general, should consider using one or a combination of these MM because they will streamline information at the national, district, and school levels.

OIM will be used to assess the ability of the school's SMS to interoperate with other schools SMS; it will also assess the system interaction at the human level. This assessment will provide information on staff training to use SMS, those most affected by SMS, frequency of utilizing SMS, the level of understanding and knowledge that the staff has with the system, staff members in need of more training, staff members who are advanced in using SMS and measures to improve the user experience and knowledge about SMS. This information will provide a guideline for the school to see how they effectively interact with SMS and what can be done to better utilize the system. The main focus of OIM is to check how prepared the school is to utilize SMS and the level of understanding of SMS, most importantly to assess if there is any interaction with other systems specifically SA-SAMS and DoE systems, it will also provide a step by step guideline from level 0 to level 4 which will gradually help schools on how to improve their SMS. The essence of ISMM will be to analyze the interaction of data, a better knowledge that can enable the disclosure and exchange of information in the information environment. This model covers the technical aspect of SMS which OIM fails to do cover hence a combination of these two models is vital for the schools. ISIMM will look at SMS technicality and provide information such as; Is the SMS of the school on the same level as other SMS's?, what are the current features of SMS, are they up to standard?, what features needs to be updated?, and how can SMS be improved to meet competitive advantage? The main focus of these models is to then take up all this information and show schools at each level how interoperability can benefit SMS; it will show at each level how SMS can progress into the ultimate level of interoperability.

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