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A Metrics Model for Assessing Incident Command System: A Case of a South African Municipality

Asithandile Johnnie [1] and Tiko Iyamu [1]

[1] Cape Peninsula University of Technology, South Africa
IYAMUT@cput.ac.za

Abstract. The lack of a model for assessing Incident Command System (ICS) is affecting the efficiency and effective use of the system, from both business and information technology (IT) perspectives. This study aims to develop a model for assessing ICS in organisations. The qualitative method was employed, and the semi-structured interview technique was used to collect data. The analysis of the data was guided using moments of translation of actor-network theory (ANT). From the analysis, (1) Collaboration, (2) Heterogeneity, (3) Governance, (4) Interconnectivity, (5) Requirements, and (6) Top-down approach was found to be the factors that can used in assessing the implementation of ICS in organisations. Additionally, the study highlights the attributes of the factors. Based on the factors and their attributes, a model was developed, and the associated values were formulated. Significantly, the study adds to the strengths of the ICS, from both business and IT perspectives. This contributes to the progression of ICS and its principles. Additionally, the study adds to the advancement of ANT in information systems research, methodologically.

Keywords: Actor-network theory, Assessment Model, Incident Command System

1. Introduction

The incident command system (ICS) is often defined as a hierarchical management system used by governmental agencies such as law enforcement to respond to emergencies (Johnnie & Iyamu, 2023). Matear (2023) suggests that the adoption of ICS signifies a significant change in the environment and the services that they provide. However, the significance associated with the system is hardly demonstrated or visible in many organisations. Despite limited empirical evidence, Cole (2017) asserts that there have been few innovations that were as impactful as ICS when it comes to managing emergencies. However, since the development implementation of ICS, there have been debates on the effectiveness of adopting the system (Bradley-Smith, Tippet & Fitzgerald, 2024; Chang, 2017). This makes an assessment model important.

The assessment of information technology (IT) solutions such as the ICS in organisations, including government administrations, is an important process and can be rigorous. This is due to many factors, such as methods and principles that can be applied from both technology and business units' perspectives. Nor (2016) refers to assessment as a set of principles, methods, and techniques/tools used to effectively assess the potential value of a technology and its contribution to an organisation's competitiveness and profitability. ICS assessment provides clarity to its suitability in supporting various functions and aspects of an organisation (Sabri et al., 2018). This cements the criticality of assessment in the process of determining the effectiveness, efficiency, and return on investment (ROI) from both business and technical perspectives (Odhiambo, 2023; Song & Letch, 2012).

The significance of IT solutions assessment or evaluation has lured governments of many countries to embark on assessing processes and projects. Several studies have introduced IS evaluation models, which include DeLone and McLean's IS Success Model (DeLone & McLean, 2003); Enterprise Systems Success (Gable et al., 2003), and IS Effectiveness Matrix (Seddon et al., 1998). Scott et al. (2016) proposed a Public Value theory, which encompasses three essential success attributes: efficiency, effectiveness, and value within the context of government. Iyamu (2022) proposes a model for assessing IT solutions from an architectural standpoint. None of these models are specific to ICS.

This research aim of this research is to develop a metrics model for assessing the efficiency and effectiveness of the incident command system (ICS) in an organisation. This study intends to evaluate the adoption of an incident command system in a municipality. It therefore requires an understanding of the roles of involving actors and agencies in the use of ICS, for service delivery, Thus, actor-network theory (ANT) is selected to underpin the study. The selection of the theory is based on its core components and strengths, which other theories do not focus on.

ANT is a socio-technical theory that focuses on actors' interactions and relationships within actor-networks (Callon, 1986). The core components and strengths of ANT are (1) the formation of an actor-network, to gain an understanding of the allied interest; (2) following the actors, to gain insights into why things happen the way they do (Iyamu, 2021); (3) translation of events from one stage to another (Heeks & Stanforth, 2015); and (4) shifting negotiation, to gain comprehension of how events transform (Callon, 1986). ANT is primarily concerned with how actors (or actants) are brought together in a heterogeneous network (Iyamu, 2022).

The paper is organised into seven main sections. It begins with an introduction, followed by a literature review of ICS and ANT. Thereafter, the research methodology applied in the study is discussed. Next were the data analysis and discussion of the findings sections. The assessment model is presented and discussed. Finally, the paper is concluded.

2. Literature review

Incident Command System

The incident command system (ICS) is a flexible and scalable system that is applicable for emergency purposes, in any complexity and longevity across various sectors and organisations. Hannestad (2005) examined how the US government integrated ICS with its emergency management strategy by assessing its weaknesses. Zhang and She (2014) conducted a comparative study of two Chinese administrations to understand how they respond to incidents. Similarly, the Florida Department of Agriculture and Consumer Services has employed a response structure based on ICS to effectively respond to natural disasters and mosquito-borne disease threats (Clark & Rogers, 2020). More recently, during the COVID-19 outbreak, Farcas et al. (2021) conducted a study on the use of ICS for disaster preparedness. In the South African context, few studies have been conducted on the adoption of ICS. None of these studies have explored or examined the efficiency and effectiveness of the ICS from both technical and business perspectives. Odhiambo (2023) identifies some challenges such as a lack of cooperation by multiagency, waste and duplication of resources, and difficulty in coordinating response activities in the absence of the ICS.

Despite the advantages ICS has brought, its adoption remains challenging (Lombard, 2023). Some of the challenges have persisted for a long time. Hannestad (2005) alluded that ICS may not be an ideal system for large-scale emergency management. Waugh (2009:172) states that such systems, by their very nature, are inflexible, slow, and cumbersome and would be much less adaptable in task environments characterised by uncertainty and rapid change. Even though Hannestad (2005) and Waugh (2009) identified these challenges over a decade ago, the evolution of the system has yet to address them. According to Zang and Lee (2014), the pre-established hierarchies are often not adequate for the specific features of a given crisis and enabling self-organisation during a crisis is the most effective approach. Johnnie and Iyamu (2023) affirmed that the challenges continue to derail services. Thus, assessing the implementation of an IT solution is critical.

Also, many organisations are challenged with the implementation and assessment of ICS, from both technical and non-technical perspectives (Matear, 2021; Severson, 2019). It gets worse in some developing countries and contributes to the failure rate, to a substantial extent (Elkadi, 2013). This is prohibitive in many respects such as cost and negative effect on service delivery. Bradley-Smith, Tippet and Fitzgerald (2024) argued that because of the challenges some agencies of governments have not implemented the ICS, which makes the multi-agency response to disasters cumbersome. Hence, it is important to identify and understand the factors that influence the success and failure of an IT solution, in an environment (Iyamu, 2022). Identifying these factors is achieved through an assessment process, using a formal model. Once an evaluation has been conducted, there is an irrefutable basis to justify and account for IT investments (Rammea & Grobbelaar, 2017). Additionally, the assessment process creates an ability to identify strengths and weaknesses, shapes new guidelines and establishes best practices for the implementation of IT solutions in an environment (Balslev et al., 2022; Kunstelj & Vintar, 2004).

An assessment model can be used to address the many concerns about the ICS, in various organisations. For example, there are concerns among practitioners in some sectors that ICS may not be as flexible and scalable for emergencies such as pandemics, as it is portrayed (Jensen & Waugh, 2014). This includes the concerns of law enforcement agencies in some countries over the command structure of ICS, stating one of the challenges is its frequent conflicts with the powers normally granted to police officers on the streets (Matear, 2021). Furthermore, ICS has been criticized for ignoring the importance of inter-departmental relationships, the spontaneous nature of the response, the role of volunteers, and the potential for conflict between responding agencies (Lombard, 2023). Seevatheean and Cadersaib (2024) suggest that although some challenges with ICS are known, the efforts to address them have yielded little or no results.

Actor-network theory

Actor-network theory (ANT) is a sociotechnical theory that embeds translation as one of its mantras (Law & Latour, 1986). From the perspective of ANT, translation is employed to underpin this study.

In ANT, translation constitutes four moments: problematisation, interessement, enrolment, and mobilisation, as shown in Figure 1 (Callon, 1986). During the four moments, human actors engage to negotiate one another's interests and to enrol actors into a network (Iyamu, 2024). Since the translation process is one of ANT's main strengths (Johnson & Iyamu, 2019) and one of the focal areas of this study, the moments of translation were suitable for the data analysis.

Translation is the central process through which a network grows or dissolves. For example, the translation of events or activities dictates the effectiveness of the development and implementation of IT solutions and how the actor-network is formed and strengthened (Govender & Chitanana, 2016). There exist different activities and tasks in the adoption of ICS that require translation to enhance collaboration and improve service delivery.

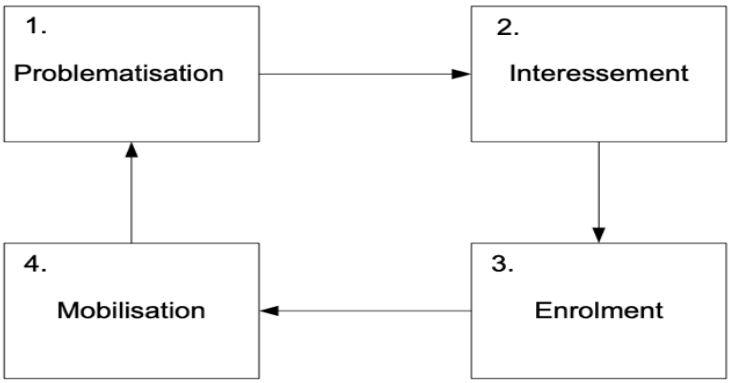

Fig. 1: Moments of Translation (Callon, 1986)

Problematisation is the first moment of translation. It is the point where the main actor identifies the problem to be solved (Iyamu, 2013) and the identification of actor roles within an actor-network (Nguyen & Nyella, 2010). It is worth noting that in its literal sense, the word "problem" has a negative connotation of something that is broken. However, in ANT, a problem is not necessarily that, but it can be an innovative improvement of a situation (Iyamu, 2018). It is during this stage that the main actor convinces all other actors to accept the proposed network (Afarikumah & Kwankam, 2013).

Interessement is the second moment, wherein interested actors join a network where an issue has been problematised (Nehemia-Maletzky et al., 2018). During the interessment, there are a series of processes that the main actor follows to lock other actors into positions that have been offered to them in the network (Afarikumah & Kwankam, 2013). The main actor convinces the other actors that the interests defined initially are in line with their interests (Andrade & Urhuhart, 2010).

Enrolment is the third moment. During this stage, the main actor attempts to define and interrelate the various roles taken up by other actors (Shim & Shin, 2016). Here, alliance networks are formed, and stakeholders form groupings of common interests (Iyamu, 2018). Only the actors who have accepted roles assigned to them in the interessement moment get to participate in the activities of that network (Iyamu, 2022).

Mobilisation is the final moment of the translation process. During this stage, the main actor, an appointed or self-appointed representative, is responsible for representing the actors within that network (Iyamu, 2022). The representative communicates the interests and roles of actors and the formed network (Shim & Shin, 2016). Iyamu (2022) highlights the importance of a strong network representative as this helps to strengthen the network.

During the development and implementation of some IT projects, the concept of moments of translation is applied (Afarikumah & Kwankam, 2013). Iyamu (2013) ascertains that when ANT is applied as an underpinning theory, it is purposefully to gain knowledge of the development and implementation of IT-enabled systems. However, to gain such an understanding, it is important to

successfully traverse the moments of translation and create a powerful enough actor-network that can carry a technology through to its successful implementation (Govender & Chitanana, 2016).

3. Research Methodology

The qualitative method was employed primarily because it allows in-depth insights into the phenomenon being studied (Conboy, Fitzgerald & Mathiassen, 2012). This includes an understanding of the subjective views and experiences of individuals and groups contained in the data (Collins et al., 2021; Iyamu, 2018). Another important rationale is that the qualitative method seeks to understand the causes that influence the actions of human beings (Galliers & Huang, 2012). The case study approach was employed as prescribed by Yin (2018). A municipality was selected and assigned a pseudo name, Kwa-Maspala. This is to avoid disclosure of the municipality's identity. From the qualitative perspective, the semi-structured interview technique was applied, to collect data.

Based on the characteristics of semi-structured interviews and the objectives of this study, the semi-structured interview process is the most viable data collection method. Data was collected from the participants of the studied case via a set of open-ended questions. Open-ended questions are used to explore topics in-depth, to understand processes, and to identify potential causes of observed correlations (Weller et al., 2018). As a guideline, for the data collection process, interviews should continue until a point of saturation is reached (Weller et al., 2018). Saturation is used in qualitative research as a criterion for discontinuing data collection and/or analysis because no additional data are being found (Saunders et al., 2018). The participants were identified and selected based on a set of criteria. Iyamu (2018:10) highlights that "the criteria should include and highly consider factors such as experience (length of service), area of specialisation, and level in the organisational structure (or society)".

Participants were selected from both the IT and business units involved with the ICS in the organisation. The participants were identified and selected based on the set criteria, which states that the participants must have been: (1) in the organisation for at least two years; (2) involved with using the ICS; and (3) willing to participate in the study. A total of fifteen interviews were conducted, at a point of saturation. This means no added information was forthcoming from the twelfth participant. Ten and five of the interviews were conducted in the business and IT departments, respectively. The interviews were conducted one-on-one with the participants, and they lasted an average of an hour. Also, the interviews were conducted in English language, which is the common spoken language in the environment.

The moments of translation concept of ANT were used to guide the analysis of the data. Since the study intends to propose a metrics model, an understanding of the roles of involving actors and agencies in the use of ICS, for service delivery was critical. ANT draws a distinctive approach to actors' roles (Latour, 1996), through shifting negotiation that entails in-depth interactions between actors, and translation at different stages or moments (Callon, 1986). Furthermore, ANT helps to achieve from three standpoints. First, gain a better understanding of the ICS functions through problematisation of how things came to be. Secondly, it reveals a deeper understanding of how the translation of events is associated with the ICS. The analysis followed a process:

i. How the various actor-networks were formed, in the use, support and management of ICS in the organisation. This is to understand how roles and expertise align with the adoption and use of technology.
ii. The relationship and interaction between actors, to determine the differences in views from the business and technology units, in the areas of efficiency, effectiveness and ROI, in using ICS, to improve service delivery.
iii. How the negotiations between the business and IT units shift in understanding the efficiency, effectiveness, and ROI, in the adoption and use of ICS, to improve service delivery. In the organisation.

Based on the analysis, six factors were found to influence the use of ICS to enable service

delivery in an organisation. The factors are (1) Collaboration, (2) Heterogeneity, (3) Governance, (4) Interconnectivity, (5) Requirements, and (6) Top-down approach.

The findings were interpreted to gain a better understanding of the factors. This was to have deeper insights into the attributes that constitute each of the factors within the context of the study. The interpretation process was conducted by following the subjective approach.

4. Discussion of the findings

This section presents the interpretation of the factors that were found to influence the implementation, use, and management of ICS in Kwa-Maspala. In the interpretation, Figures 2 to 7 are used to diagrammatically demonstrate the links and relationships of the factors and their attributes. This is intended to enhance the understanding of the interpretation of the findings.

Collaboration

Collaboration is the act of working together. Stout and Keast (2021) ascertained that collaboration is a description of a process in which people from different departments or teams work together to form networks, alliances, or joint ventures to solve a problem. According to Waugh (2009), collaborative processes are effective when responding to emergencies of any scale. This means that collaboration supersedes silos (or individual) effort and helps to generate an opportunity to solve complex and challenging problems in an environment. In the emergency environment in Kwa-Maspala, responding to an emergency is usually an unplanned event that often requires the collective effort of multiple departments or teams. However, collaborative effort is always as smooth as it is sometimes portrayed. Hence, the attributes of collaboration in the context of ICS were examined in this study.

Thus, collaboration was a critical factor in the implementation, use, and management of ICS in Kwa-Maspala. In the operation of ICS in Kwa-Maspala, collaboration was influenced by two main attributes, coordination, and communication. As depicted in Figure 2, the attributes are also linked.

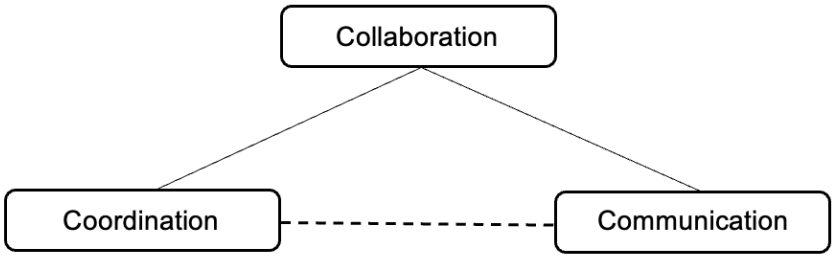

Fig. 2: Collaboration

Coordination is a process through which separate, or a variety of things can be made to work together. Markowitz et al. (2003) suggest that coordination is a stage-oriented process where participants synchronise interactions and activities. Subsequently, coordination is often employed to effectively align resources to meet objectives in many organisations. In Kwa-Maspala, coordination manifested from collaboration, to join multiple law enforcement departments in a common platform of the organisation. Coordination facilitates more effective and efficient responses to incidents. Also, the coordination effort helps to align and synchronise business processes and standards of practice towards improving response time for emergency purposes.

The other aspect of collaboration is communication. The human actors rely on communication to remain at the same wavelength. Communication is the process of either receiving or sharing information. It is often considered a critical pillar of a collaboration effort (Martin et al., 2016). It thus

guides how actors respond to emergency incidents. In the case of ICS for emergency incidents, communication is critical, primarily because it enables the effort of the law enforcement agents to coordinate their responses. The criticality arises because failure or lack of information can result in detrimental circumstances. For example, agents employ various resources to respond to an emergency based on the information that they have access to. Thus, communication is an attribute embedded in the collaboration factor that influenced the operationalisation of ICS in Kwa-Maspala.

Heterogeneity

Heterogeneity refers to the replication of an entity in another environment. According to Latour (1996), each element in the network is simply defined by the heterogeneous list of its associates. Iyamu (2021:75) suggests that "heterogeneity is reflected in different organisational principles that are in simultaneous action and interaction". In Kwa-Maspala, the implementation, use, and management of ICS entail heterogeneity of people (employees) and synchronisation of processes, as illustrated in Figure 3. Also, there is an interwoven relationship between people and synchronisation. The relationship is drawn from the fact that synchronisation happens with the aid of humans, which in turn, enables human effort in interaction and executing activities.

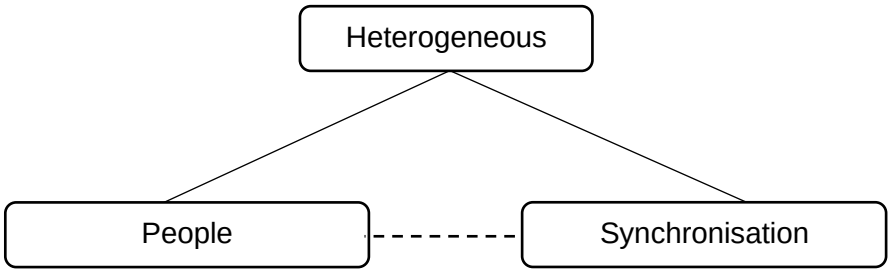

Fig. 3: Heterogeneity

People (employees) make up various networks that operationalise ICS in Kwa-Maspala. Some of the groups (networks) constituted managers who were employed by the business and IT units. These groups also formed members of the steering committees and governance networks. The heterogeneity of the people and the networks contribute to defining how ICS is implemented, used, and managed including the output, in Kwa-Maspala. In other instances, the traffic officers, firefighters, and the tool (ICS) that they use form part of existing networks, in responding to incidents or providing services.

The functionalities of ICS are not unique to a specific team or department. The functions are replicated in ways that allow diverse groups of people to use them for their processes and activities. For example, when citizens report an emergency, ICS allows for the dissemination of requests to responsible departments and processes and actions are synchronised in responding to the incident. To be more specific, the traffic officers and firefighters synchronise processes and activities in their quest to respond to incidents and deliver services. Synchronisation helps to avoid conflicts and eradicate or reduce duplications using the same functionality. It therefore means that the organisation can have a holistic view of the different subnetworks that have synchronised their activities.

Governance

Governance comprises a set of standards, principles, and policies, as shown in Figure 4. Governance is an integral part of an organisation's processes, activities, and events. As revealed in the analysis, the processes and functions of ICS rely on governance, from standards, principles, or policies perspectives. Also, as shown in Figure 4, the attributes of governance are interrelated. The attributes, standards, principles, and policies influence each other.

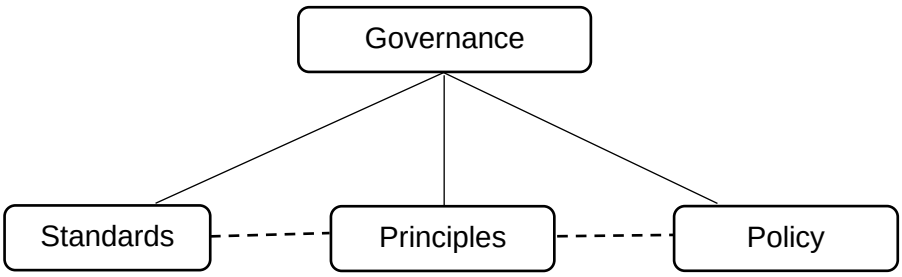

Fig. 4: Governance

Standards are a set of established norms or best practices, which are often used to guide the selection and management of IT solutions such as the ICS, in an organisation. Additionally, implementations adhere to standards towards achieving the set objectives. They are critical to the compatibility and interoperability of ICS, in ensuring the execution of its processes and functions for an improved service delivery to the citizens. Bai (2021) suggests that standards are powerful tools that can help to drive innovation and increase an organisation's productivity. ICS is a system that is integrated with other systems and functionality, which makes standard critical during integration.

Principles are formulated to guide the operations of an organisation. The principles are intended to steer resourcing and technology decisions, which include implementation and the use of IT solutions. According to Juiz et al. (2014), principles encourage better decision-making and the efficient use of resources. It also enforces accountability for the managers of those resources. In Kwa-Maspala, ICS was implemented as a mission-critical emergency management system that was required to have maximum uptime. As such, one of the principles was that critical systems had to be accessible, user-friendly, and well-integrated to enable the activities of the different business units. Based on principles, standards are defined and policy statements are formulated.

Another important pillar of governance is policies. The policies outline the specific guidelines and procedures that govern an organisation's IT activities and resources. In the context of ICS, policy provides guidelines on implementing, using, and managing the solution to ensure that service delivery is improved. ICS is a complex IT solution primarily because it is used by many people and teams across an organisation with varying requirements and needs. The guidelines help to simplify and streamline the use and management of ICS in an organisation. For example, ICS is used by law enforcement agents or units for various policing reasons. This includes storing sensitive, private, and confidential-related data. The IT security and privacy policy in Kwa-Maspala is one of the most critical policies. This is because the policy serves as a guide towards secure inter-departmental use, storage and sharing of data guided by standards and principles.

Interconnectivity

Interconnectivity refers to how different aspects of an organisation are connected, towards achieving goals and objectives. In the context of ICS, cross-unit and cross-function are the two main attributes of interconnectivity. The attributes are interlinked as shown in Figure 5. The interconnectedness of units and functions allows people (employees) and teams to have easier and more flexible access to data and resources across an organisation.

The interconnectivity enables and supports the implementation of ICS in Kwa-Maspala, which allows managers to manage incidents in unified and consistent ways between units and functions. Also, the interconnectivity of units is important to allow personnel in different units, with differing roles and responsibilities, to integrate their efforts in using ICS to provide services.

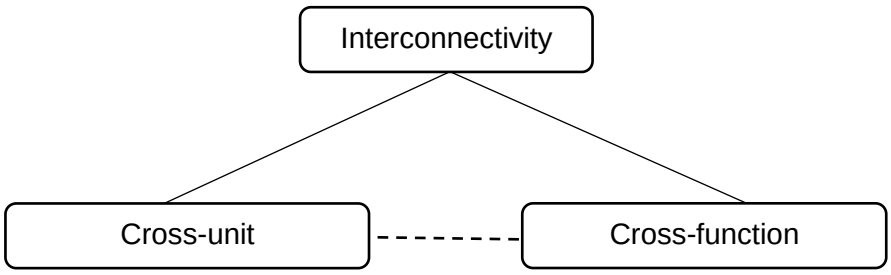

Fig. 5: Interconnectivity

When an incident occurs, the department relies on ICS to connect the various responding units. ICS is used to ensure coordinated and accurate communication among the units. For instance, when an incident is reported, the call centre agents trigger the interconnectivity across units and functions by sending them to the respective personnel authority for action. If the incident requires the functions of firefighters and disaster risk management (DRM), the units are connected through functions that will be performed in response to the emergency. In such a scenario, the responding units connect to effectively respond to the reported incident.

Requirements

A requirement is a set of conditions that need to be fulfilled to achieve a defined objective. Aslaksen and Merz (2003) define requirements as the process of writing things towards the creation of an end goal. In the context of this study, requirements provide a detailed description of what ICS should do, how it should behave, and the constraints and other factors that it must satisfy. Thus, organisational requirements consist of requirements from both business and IT units, as shown in Figure 6. In Kwa-Maspala, the two sets of requirements influenced the operationalisation of ICS.

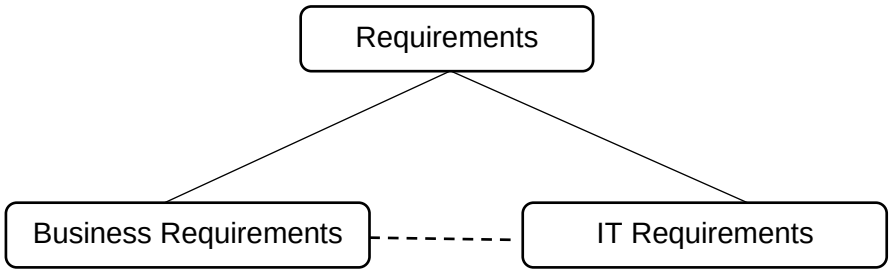

Fig. 6: Requirements

The business requirements are solicited from the business units. The requirements represent business needs at the time. Business requirements are about the activities and processes which the ICS should enable and support. However, the business requirements should not be disconnected from the IT requirements. This is primarily because IT requirements are the building blocks of business requirements. This means that IT requirements describe how the proposed solution will deliver business requirements.

In the implementation of ICS, it is vital to comprehensively define IT requirements and align them with business. This ensures a more comprehensive and holistic coverage of the organisational needs. Also, it enables the assessment of the system, from both business and IT perspectives, in the organisation. Based on the assessment, a better understanding of the return on investment (ROI) can

be achieved. The ROI helps to determine the level of use and benefits to the organisation. From the analysis, the business units have a high reliance on ICS in maintaining and improving service delivery. This makes IT requirements for ICS a mission-critical task, which must be completed to enable the organisation's law enforcement unit.

Top-Down approach

The top-down approach is one of the decision-making strategies of many organisations. Following this approach, decisions in an organisation are made at the top (executive or senior management) level and are drilled down to the lower levels (rest of the employees). This approach was employed across business and IT units of the organisation during the implementation of ICS. In Kwa-Maspala, two attributes, buy-in and performance informed the top-down approach in operationalising ICS. The two attributes can be linked as shown in Figure 7.

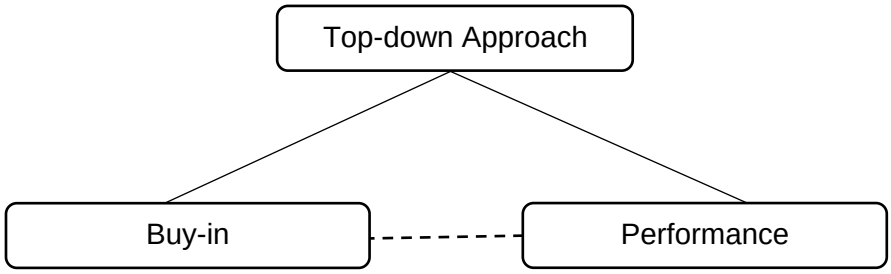

Fig. 7: Top-down approach

Executive management buy-in is a form of agreement or approval by the top or senior management of an organisation. This means that executive management has complete visibility of the proposed solution and is completely on board with its implementation. The top-down approach manifested itself through buy-in from the executive stakeholders. Based on the essentiality of the ICS, its approval must be decided by top management. Such approval instils motivation for the use and management of ICS, which potentially improves organisational performance.

However, the approach influences how employees perceive the system. In Kwa-Maspala, the top-down approach was not well received by some of the employees. The view of this group of employees was that the decision-making process was not inclusive of them, and ICS was imposed on them. For example, some employees felt that the exclusion from the implementation of the system meant that they did not know the technical details of ICS even though they were obligated to support it. Some of the users felt that the system was a means of monitoring and tracking them. When interpreting these views, it means that the system is perceived as a challenge and a tool of micromanagement. As such, some end-users resisted using the system while some support staff felt obligated to support the system. Some of the reasons stakeholders hesitated with ICS in the organisation ranged from; (1) insufficient training and system introduction, (2) loyalty to legacy ways of working, and (3) the perceived complexity of ICS.

A Metrics Model for the Incident Command System

This study aimed to develop a metrics model that could be used to guide organisations implementing ICS. Metrics are a powerful tool used in organisations, usually to set goals and determine the usefulness of products and levels of service (Dmitriev & Wu, 2016). The authors ascertain that metrics need to be correctly defined because of their fundamental influence on outcomes.

Based on the findings from the analysis and interpretation of the findings, a metrics model is developed. As revealed from the data analysis, six factors influence the implementation, use, and

management of ICS to improve service delivery. The factors were interpreted, based on which thirteen attributes were found to influence and determine the operationalisation of ICS in an organisation The attributes are (1) Coordination, (2) Communication, (3) People, (4) Synchronisation, (5) Policy (6) Principles, (7) Standards, (8) Cross-unit, (9) Cross-function, (10) IT Requirements, (11) Business Requirements, (12) Buy-in, and (13) Performance.

However, this study does not suggest that these are the only factors or attributes that influence the implementation, use and management of ICS. The factors and attributes are based on empirical evidence from this study. The attributes were therefore used to develop a metrics model (MM) for ICS. The MM is a two-phase approach, which is defined in Phase #1 (Table 1) and Phase #2 (Table 2), respectively. Phase #2 depends on Phase #1.

Phase #1 – at this Phase, Table 1 is employed. The table consists of the Y (row) and X (column) axes. The attributes are listed on the Y axis while the X axis consists of numerical-based strengths. The values are from 0 to 5, lowest to highest, respectively. Using MM, each attribute is allocated a numeric value based on individual or group assessment. The score value is calculated on average.

Table 1: ICS determining attributes

#	Influencing Factor	5	4	3	2	1	0
1	Coordination						
2	Communication						
3	People						
4	Synchronisation						
5	Policy						
6	Principles						
7	Standards						
8	Cross-unit						
9	Cross-function						
10	IT Requirements						
11	Business Requirements						
12	Buy-in						
13	Performance						
Total:							

Once all the influencing factors have been calculated and summed up to determine the average, the weight is used to determine the final evaluation of the adoption of ICS in the organisation. The sum (scoring) of the influencing factors is referred to as the ICS organisational value, as illustrated in Table 2. The scoring range and status are as follows: > 60 means the system is strategic, 50 – 59 means the system needs to be maintained, 40 – 49 means the system needs to be improved and maintained, and 0 – 39 means the system needs to be phased out.

Phase #2 - The table presents phase 2 of the model. The Table should be read with the discussion below, to gain a better understanding of the phase.

Table 2: ICS organisational value

Value	Description	Score	Status
Comprehensive	ICS is implemented in the organisation with an improvement in the efficiency and effectiveness of business processes and an attainable ROI. The system is scalable and robust enough to enable additional features and improvements.	> 60	Strategic

Standard	ICS is implemented in the organisation with an improvement in the efficiency and effectiveness of business processes and an attainable ROI.	50 - 59	Maintain
Satisfactory	ICS is implemented and offers standard features that work as per business requirements. The processes may be efficient but not effective. As such, there is little evidence of ROI.	40 - 49	Improve and maintain
Basic	ICS is implemented but does not meet the business requirements. There is no improvement in the efficiency and effectiveness of business processes. As such, there is no ROI for the organisation.	0 - 39	Phase out

When an organisation's score is > 60, it means the system is strategic. Strategic systems are IT solutions that contribute to the organisation's business strategies. They are IT solutions that focus on long-term planning and important decision-making that guide the overall direction of the business. The operationalisation of strategic systems enhances the efficiency and effectiveness of business operations. Similarly, a score of 50 – 59 means the system needs to be maintained. These types of IT solutions are operational systems. They are concerned with daily operations and what needs to be done to meet short-term goals and immediate requests.

On the other hand, a score between 40 – 49 means the system needs to be improved and maintained. Organisations improve and maintain IT solutions to make them more efficient, secure, and user-friendly. Thus, improving on aspects such as system performance, scalability, and integration capabilities, while a score between 0 – 39 means the system needs to be phased out. Organisations phase out IT solutions when technology becomes less useful. This could be because newer, better technology is becoming available. Furthermore, software vendors stop supporting older versions of the system thus decreasing the system's initial value and future functionality.

5. Conclusion

This study advances our understanding of the complex interplay of factors influencing the architectural design of big data. The use of actor-network theory to underpin the study helps to identify the factors and their attributes required for assessing the ICS in an organisation. Practically, the study contributes to the nuance of using ICS, to achieve organisational objectives. From the theoretical angle, the study contributes to the literature on ICS by providing a refined perspective on how a model can be used to assess its efficiency and effectiveness in an organisation. Also, the study adds to the advancement of actor-network theory in its use in IS research, to gain an understanding of complex organisational phenomena.

However, the study also has some limitations, such as non-validation of the assessment model. Future studies should aim to validate the findings and model in organisational settings, to ascertain the feasibility of ICS efficiency and effectiveness from both technology and business perspectives.

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