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HOW TO CITE:Inngs G, du Toit D. Data analysis is part of a better feedback loop for local government. S Afr J Sci. 2024;120(11/12), Art. #19198. <https://doi.org/10.17159/sajs.2024/19198>**ARTICLE INCLUDES:**

- Peer review
- Supplementary material

KEYWORDS:

data analytics, local government, service delivery, systems analysis, feedback loops

PUBLISHED:

30 August 2024



Data analysis is part of a better feedback loop for local government

Significance:

This Commentary addresses how local government in South Africa should organise its decision-making processes to best serve their residents. We illustrate and discuss how system analysis can be applied to local government decision-making in the South African context, in the vein of calls for “evidence-based decision making”. It also proposes how data analytic work may be incorporated into the local government system, both conceptually, as well as in practical terms, through organisational and cultural interventions.

Throughout South African society and beyond, it is widely accepted that local government is both critical to the delivery of basic services, and the site of some of the most significant failures thereof. There are many astute analyses of this in both the popular and academic press, and we do not feel that we have much to add to these diagnoses. What we believe we can offer is something of a remedy. Our suggestion does not necessarily directly address the reasons for service delivery failure, but rather, in our experience, provides the platforms or fora for doing so.

We argue that a relatively minor change in how we organise the work of local government, namely the introduction of analytic feedback processes, could have a transformative effect. We provide background on the relevant systems theory before expanding on two of the modes of feedback that we have observed in local government. Finally, we make some practical suggestions on how this could be realised.

Feedback loops

Figure 1 is a representation of one of the most important ideas in what was once called cybernetics theory, and is more commonly today called systems analysis: the humble feedback loop.

What we mean by *implementation* in this diagram is intentionally very broad. It is the occurrence of a defined process or behaviour of a system; for example, the balancing of power across the four engines of a quadcopter drone, or the monthly billing of residents of a city for municipal services.

This might seem very abstract, but a surprising number of quite varied activities can be mapped into this model, for example:

- A sports team over the course of a season or tournament, playing multiple matches.
- A recommendation algorithm for an online shop that decides what products to present to a user who has logged in.
- A person learning a musical instrument for the first time, taking periodic lessons with an experienced teacher.
- A car journey in which a driver is making decisions on a continuous basis, managing the functioning of the vehicle as well as guiding it to a destination.

For the purposes of this discussion, we define the components of the loop as follows, using the example of the car given above:

- *input* – anything that is required for the system in which we are interested to function. This might be a practical need, e.g. fuel needed for the engine of the car, or an informational need, e.g. the signal from the key being turned in the ignition.
- *decision* – the point at which some sort of intelligence, human or machine, is applied to the inputs, to determine the behaviour of the system. For our car, this would be the decisions made by the driver of the car, in response to the various signals received from the driver’s dashboard, as well as observations of the outside world.
- *implementation* – the occurrence of a process or behaviour of a system of interest. In our example, this would be the actual running of the engine, and in turn, its ability to cause the car to move.
- *effects* – what results from the occurrence of the process or system in which we are interested, i.e. the movement of the car resulting from the engine functioning. Other effects would include the emission of exhaust fumes.
- *feedback* – the capturing or measurement of the implementation. Of course, nothing can be measured perfectly, so this is a view on what occurred during, and as a result of, the implementation. In our car, this would be the information conveyed by the dials on the dashboard.

Any process that has some sort of cycle, or is repeated, and where those participating have memory of previous iterations, can be thought of as a feedback loop. And, although intuitive to understand, the introduction of feedback from the outputs of the system, to the decision point, results in dynamic behaviour that makes predicting future outputs of the system surprisingly difficult. We call such systems *complex* and this sometimes surprising behaviour *emergent*, as it arises from the interaction of various elements of the system, as well as past behaviours of the system itself, as opposed to the particular attributes of those elements in isolation.

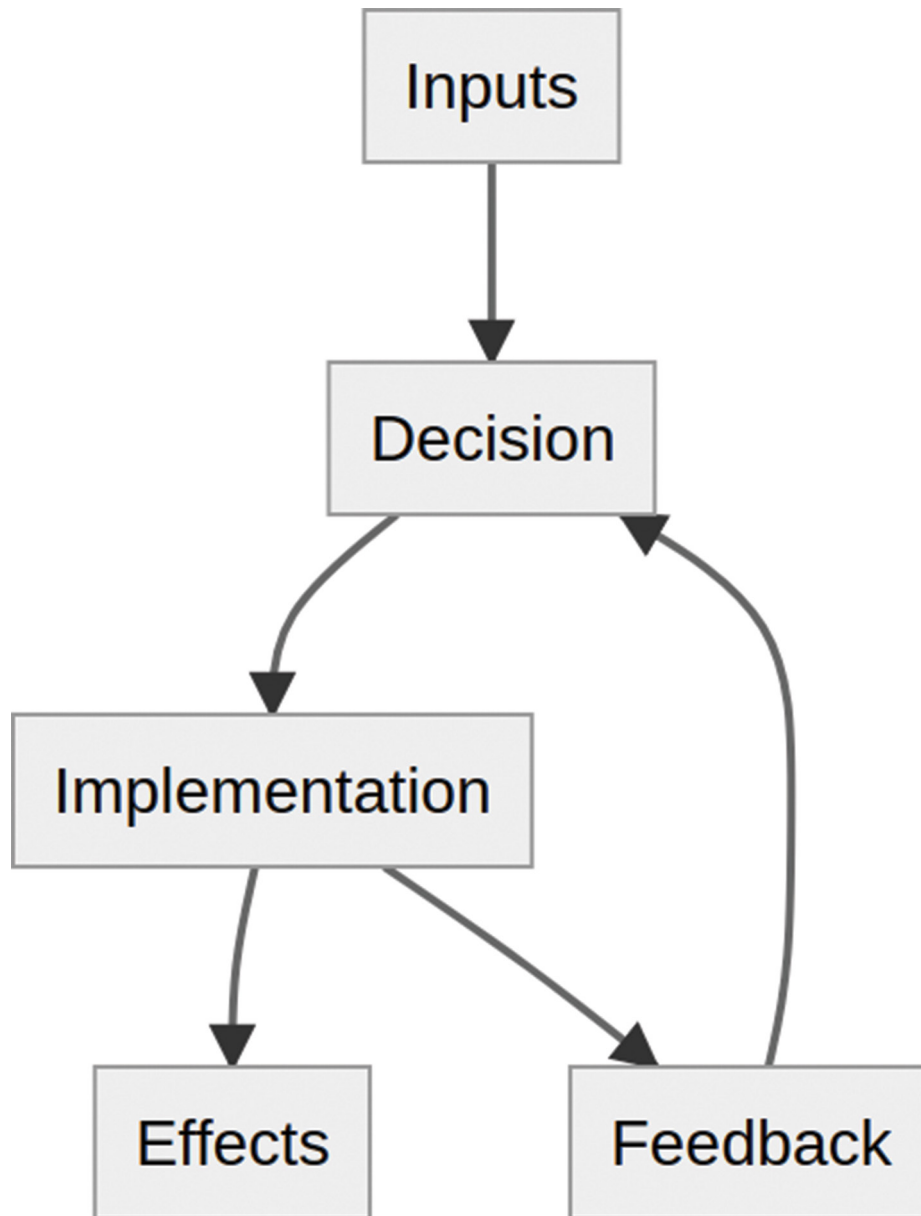


Figure 1: Simple system overview with feedback loop.

Generally speaking, if one is seeking stability and consistency in the outputs, we think about a *negative* feedback loop. This means that the feedback moderates or adjusts the inputs such that the outputs are kept at a constant level. A *positive* feedback loop amplifies inputs, such that they grow until they reach some sort of limit, such as exhausting the resources available.

Relationship to digital data technologies

Before moving onto how this modelling approach relates to local government, we discuss the relationship with the dramatic growth in digital computing capabilities over the last 100 years, the corresponding growth in data available for processing (often referred to as 'big data'), as well as techniques such as statistical computing and machine learning (and its related subfield artificial intelligence) for gaining insight from this data.

It is no coincidence that systems analysis emerged and has developed in parallel with these socio-technical trends, and indeed, many theorists such as Jay Forrester and John Von Neumann have played an important role in developing both. However, it is important to understand systems analysis as a distinct set of modelling techniques for reasoning about systems, whereas these digital technologies are often the means by which these systems are realised.

The availability of digital technologies, and more importantly the capability to implement and operate them within an organisation, often greatly increases the visibility of the systems in question, and, in this way, makes obtaining and putting the insights of systems analysis into action easier. But it must be stressed that these technologies ease the use of system analysis as opposed to being a prerequisite. No technology beyond a pen and paper is required to model a system, and nothing beyond a meeting with the appropriate people is required to put these insights into action.

There is sometimes a worrying tendency in government to conflate the use of these technologies (often in the form of 'digitalisation' programmes) with making better decisions, or progress more broadly. Our experience is that this is a very dangerous and potentially expensive mistake to make – having the right tools is no guarantee that a job will be done correctly.

Government decision-making as feedback loops

Implicitly, feedback loops are everywhere, and indeed are inherently part of how we all make decisions, both conscious and unconscious. After all, we often repeat activities, and have memories of those past attempts. However, much of this is implicit – only the very disciplined keep a detailed

record of past attempts, and repeat the learning process. Often, without thinking about it, we incorporate our experiences and beliefs about how the world should be, when deciding what we are going to do next.

However, in government, there are many reasons why we keep more track of the decisions we make, and the information considered when making those decisions. Often those decisions relate to the allocation of scarce resources and so efficacy and efficiency are desirable, or those decisions relate to the interpretation and application of legislated norms, and so would be subject to later scrutiny for accountability reasons.

So, we suggest that government itself, and particularly local government, being a socio-technical system responsible for the delivery of many basic services (at least, in the South African context), can be modelled usefully as systems with many feedback loops. There are often clear decision points, from which a variety of actions result, which in turn, result in various effects for those governed. There are also established ideas of measuring these effects, and this measurement is often seen as part of the work of government.

The alternative which we have encountered is that, when trying to describe these systems and their behaviour, language and concepts are simply borrowed from private sector organisations such as large corporations. While there are a lot of similarities, in that these are organisations of people with a common identity and nominally shared goals, public sector organisations have considerably more, diffuse objectives, in contrast to the private sector's single one. We believe that by using the language of systems modelling, and in particular of feedback loops, the often surprising, emergent behaviour of local government organisations can be better explained.

It is from attempting to use the measurement of the effects of past decisions, as well as the inputs at the time, to help make better future decisions, that we arrive at the idea of *evidence-based decision-making*. Or put more directly, if we hope to achieve what we plan, we have to learn from the past.

Feedback modes

There are indeed many feedback loops operating at all levels of local government, particularly in relation to service delivery, such that trying to map out and understand all of these would be a considerable undertaking. However, the mechanics of these loops are not all equal. As the final part of our discussion, we would like to examine a particularly pathological feedback typology that we believe inhibits service delivery, and we propose an alternative that we believe enhances it.

To examine these two typologies, we ignore the inputs and effects for now, and just focus on the decision-implementation-feedback components, as given in Figure 2.

The reporting feedback process

Figure 3 is a depiction of a very simplistic version of the feedback process, and is indeed one that we have often observed in local government.

In this process, data or information are gathered, and then tabulated into a pre-ordained structure. That populated rubric, matrix or *report* is then submitted to a decision-maker, on the understanding that the information is required for their decision-making. This is almost entirely a *feed-forward* process, with little or no information flowing back to those providing the information by design (it might happen informally, or outside this system).

However, often in this type of feedback loop, which is large, spanning beyond the local government organisation, the *report* is submitted to an oversight body for scrutiny. The mandated frequency loop is also often quite slow, spanning multiple months or even years from information being collected to being submitted for scrutiny.

This version of the feedback loop has its merits:

- It is simple to implement.
- It does not require special skills or knowledge to operate.

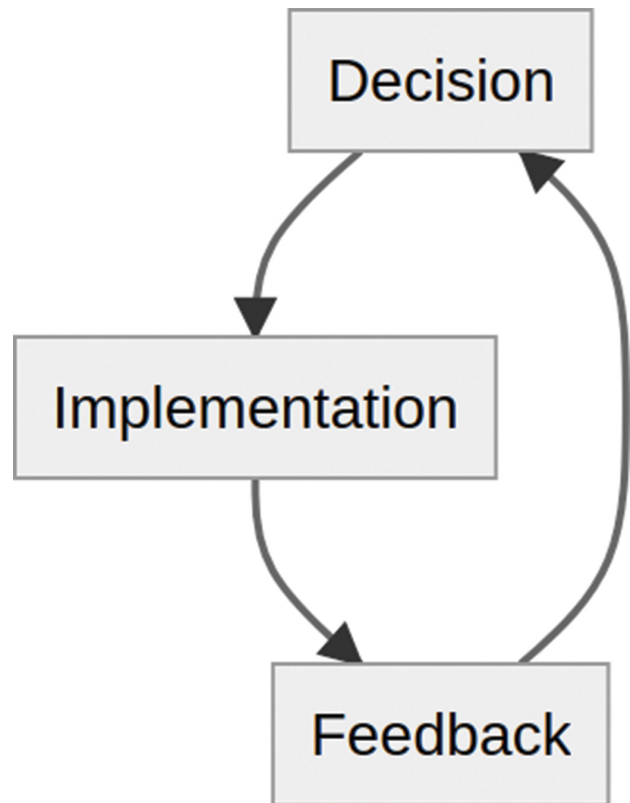


Figure 2: Overview of feedback loop components.

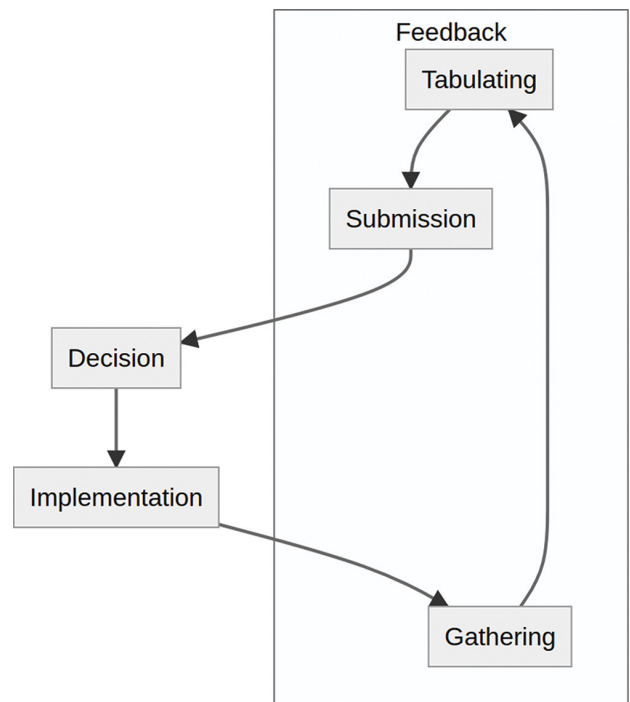


Figure 3: Feedback loop in the simplistic, yet widely observed 'reporting' mode.

As a result, it is often administrative staff who provide this information on a routine basis, usually by extracting it from transactional systems. These data are then typically manually manipulated into the form required, before submission. Other than ensuring the reports produced are in accordance with the predetermined structure, there is little to no expectation that these staff will overly concern themselves with the content of what is being produced.

In our experience, this feedback model has some serious problems:

- It is inflexible – an unfamiliar or unanticipated occurrence will fall outside the scope of what is being measured, or cannot be coerced into the predetermined structure. Dramatic events and the accompanying upheavals, such as the Cape Town drought of 2017, COVID-19 pandemic and July 2021 riots, are all examples of situations in which we observed that conventional reporting mechanisms became defunct, either returning readings that made no sense, or could not be completed under the circumstances.
- It is brittle – the nature of the system under observation only has to change slightly, and often the monitoring or evaluation framework has to be completely reworked to handle the new structure. An example is how the allocation of free basic services has changed over the last few years, and each change has upended reporting on the provision of these services.
- The focus is on process, not content – because those involved in creating the information are alienated and disconnected from the accompanying decision-making, their focus, quite understandably, is on getting this work out of the way as quickly as possible. At times, we have seen examples of reporting at a very high level of the consumption of services that are physically impossible, beyond the physical capacity of infrastructure to provide it.

As an aside, it is also telling that digital technology is mostly incidental to this feedback mode. Indeed, as far as we can tell, all that computers offer this reporting feedback model is a slightly more convenient way to produce and format tables of numbers.

Yet, by far the worst problem with this model is that there are bad incentives to participate in good faith. Because the content of the reports provided by the feedback mechanism is in turn often used to evaluate those running the feedback process itself, there is considerable pressure to submit the 'right' number, or at least the set of results which are less likely to warrant further scrutiny.

And even with processes in place to ensure the integrity of the information being submitted, admirably undertaken by entities such as the Auditor General, there is considerable risk in highlighting any limitations or failures of the system. This is because those most familiar with the system under observation are those gathering the relevant information, and are also those operating it, so are likely to be held accountable for its failures.

The analytic feedback process

The refinement that we propose is depicted in Figure 4, and simply incorporates a data analytic function into the feedback process.

In this model, data are gathered and analysed by someone or a group of people with data analytic training and skills. There is then a process to contextualise this analysis, which we think is best done by talking to relevant operational staff as well as those affected by the system (e.g. residents), and observing the processes described by the data in the real world. Finally, this contextualised analysis is reflected upon, usually in some sort of group setting such as an operational review meeting, with the relevant decision-makers present. This feedback process is a closed loop, with reflection on previous contextualised analysis driving further analysis.

This process addresses two of the main concerns of the 'reporting' process:

- It is flexible – as and when there are changes made to the system under observation, through the analytic and contextualisation activities, the feedback process can be adjusted accordingly.
- It provides better incentives to those involved – by defining the closed analytic cycle, it reframes the roles of those involved as seeking improved knowledge of the system and its behaviours. Hence, we believe this translates into different behaviour when strange or abnormal behaviours are detected. These anomalies are then opportunities for demonstrating the skill of those involved, and growing their knowledge of the domain. Knowledge of the system and domain thus becomes the mechanism by which they derive status.

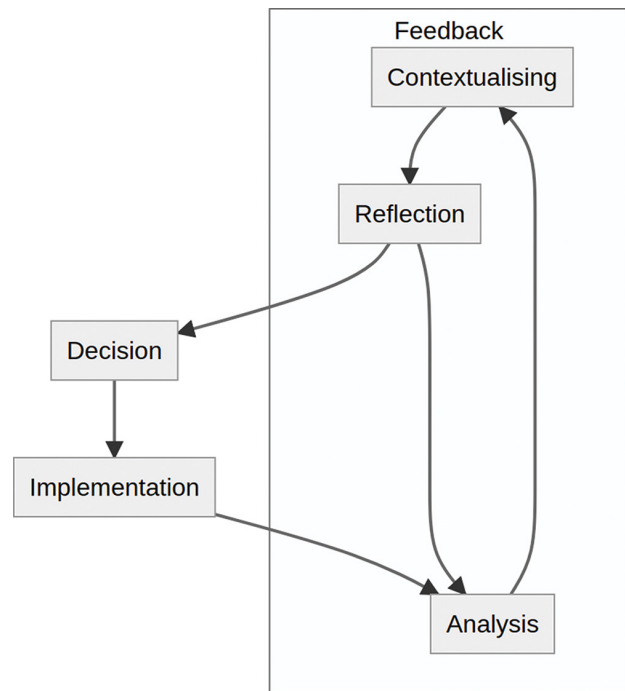


Figure 4: Feedback loop in our proposed 'analytics' mode.

We have seen the potential of such an approach in the service delivery turnaround programme run at the City of Cape Town in 2020 and 2021. Initiated to address the effect on service delivery caused by the COVID-19 pandemic, this organisation-wide effort used a data analytic-driven feedback loop to drive considerable improvements in service delivery.

Beyond the improvement seen in key performance metrics, such as the reduction in the backlog of service delivery related requests, as well as an improvement in the resolution time of requests, a marked feature of the programme was how often it transcended traditional organisational silos or structures. Beyond operational decision-making, functional areas such as human resources, vehicle and materials provisions, and contract management were all considered in driving overall system improvement.

Self-organisation, which is the ability of components of a system to improve coherency among themselves and become more efficient without intervention, has long been recognised as a key feature of robust systems. We believe that one of the great advantages of this data analytic driven feedback loop is that it encourages self-organisation in the delivery of basic services.

However, this data analytic model does require two significant commitments:

- Skilled people to participate – local governments, particularly those in rural areas, will struggle to attract and retain people with such a skillset.
- A degree of psychological safety, in which anyone involved can talk openly about the problems they observe, and pursue them without concern of reprisal. Traditional hierarchies and silent deference to age need to be suspended for these feedback loops to function.

In our experience, achieving both of these, particularly given the constraints of the South African local government context, is extraordinarily challenging, but highly rewarding.

Conclusion

We have described feedback loops, and how they prove a useful tool to think about decisions made within government in the South African context. In particular, in their potential to explain the often counterintuitive behaviour of government organisations, they show their value. We also described two models of feedback loops appropriate to supporting service delivery, one widespread and ineffective, and the other costly, but highly potent.



In closing, it is also worth reflecting that even thinking of government organisations as systems, or a set of tools for delivering services, is itself a somewhat radical notion. Instead, we too often view our bureaucracy as an immutable structure that cannot tolerate alteration or adjustment. Regardless of whether you accept our framing and suggested remedy, you would surely agree that we need to be willing to try to do better.

Recommendations

These are practical suggestions that we believe would help towards creating and supporting *analytic* feedback loops:

- Map out the high-level feedback loops for the provision of each basic service provided by a local government organisation. Particularly important is understanding the latencies or time delays in the flows of information, as this determines the speed of the system's response.
- Improve the data analytic capability of the organisation. Our experience is that this skill has to be hired, as it is difficult to retrain existing staff, particularly those who are very comfortable with the existing reporting process. Analysts from third parties or service providers can possibly be used in the short term, but it is difficult for them to acquire enough context in the organisation to be truly useful.
- Intervene in the organisational culture to educate around and promote *curiosity* and *humility* as core organisational values. This should be done in pursuit of creating the relevant psychological safety required for good analytic work to occur.

Acknowledgements

A working version of this Commentary was presented to our colleagues in the Data Science branch, and many of their helpful questions and

comments resulted in considerable improvements. More broadly, our colleagues across the City of Cape Town, particularly those with whom we collaborate, continuously pursue service delivery excellence in making Cape Town a City of Hope.

Declarations

We assert that this Commentary is the result of our own efforts. Furthermore, we declare that generative AI was not used in writing the body of this Commentary.

Meta's Llama 3.1-8 Billion Parameter Instruction tuned model was used to obtain suggestions for the statement of Significance. The following prompt was used, in addition to the body of the Commentary: "Please suggest a 100 word or less significance statement for this commentary, articulating why it is important beyond academia."

The returned content:

This commentary highlights the limitations of current feedback models in government service delivery and proposes a new analytic feedback process that can improve decision-making. Its significance extends beyond academia to inform policy reforms and organizational changes that can enhance public service effectiveness and accountability. By bridging the gap between data analysis and operational realities, this approach has practical implications for local governments seeking to optimize resource allocation and improve citizen outcomes.