

SUSTAINABILITY THROUGH INTEGRATED DECISION MAKING IN WATER DEMAND MANAGEMENT

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Abstract

Due to an ever increasing population and the associated economic growth, together with changing climate conditions, present water resources in South Africa are under pressure. With limited alternative water resources available, water demand management (WDM) will play a significant role in the sustainable delivery of water services in the future.

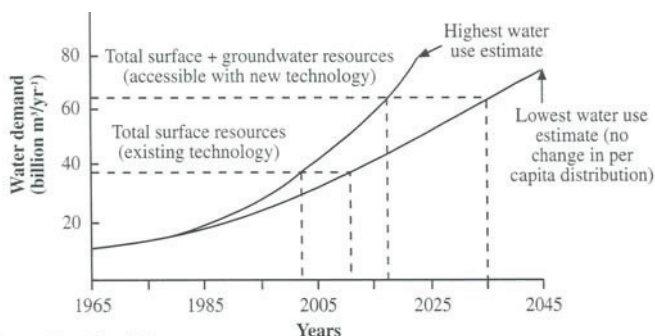
The reasons for the implementation of WDM differ significantly from one situation to another. Unfortunately WDM is frequently implemented as a "quick fix" solution to a short term water supply problem as opposed to an integrated approach towards the effective management of all available water resources. During a study, which included questionnaires and workshops, among 56 different communities in the Western Cape of South Africa, it was found that WDM projects in these municipalities focus mainly on the solving of the water supply shortfall instead of implementing solutions as part of an integrated water resource strategy.

The main focus of the discussions on WDM at a municipal level is on the understanding of the issues and the finding of the technical solutions to address the problems with water losses and the effective use of water resources. The study however shows that a lack of "project ownership" and clear implementation strategies are two of the main reasons for the lack in progress. To achieve sustainability with WDM it is important to provide an environment where a "mind shift" is possible and to ensure that appropriate institutional structures are in place to facilitate the implementation of the technical measures.

1. Introduction

South Africa (SA) is facing a serious water shortage within the next 25 years, and the government is currently in the process of implementing new legislation to address these water issues, with a specific focus on integrated catchment management. This is also the first time that the environment is being recognised in new legislation. The Constitution, the National Water Act (NWA), and the Water Service Act (WSA) each make provision for access to water as a resource, both for the natural environment as well as basic human consumption. SA is a land with unevenly distributed resources and huge climatic differences, and these conditions are further distorted as access to the available resources was not guaranteed to all in the past. In order to address these issues, and ensure economic development in SA, the water resources are therefore constantly being put under pressure.

The future water resource situation in SA (Turton and Henwood, 2002), as illustrated in Figure 1, clearly highlights the need for immediate action to secure a sustainable water resource for all. The Department of Water Affairs (DWA) predicted in 2004 that the water resources in SA will only be sufficient, at the present rate of consumption, till 2020 (DWA, 2004b).



Source: After Ashton 2000.

Figure 1: Water Resources in South Africa

Understanding the present water situation, and involving citizens at all levels of decision-making, are the cornerstones of South Africa's new water legislation. In SA, the responsibility to implement the relevant water legislation rests mostly with local government. It is therefore important to not only understand the role and functions of local government within the water context, but also to specifically focus on existing governance issues before the implementation of WDM can be discussed.

The main objective of the research presented in this paper is to provide Decision Support Systems (DSSs) for municipalities that will guide them through the decision-making process, and which will enable them to implement WDM in a sustainable and integrated manner.

2. The use of models

The process of making a good decision is based on a number of critical factors. Gough et al (1996) highlight two main aspects. Firstly, it is important to ensure that the process is good, and secondly, that the outcome or end result is good. To provide a good basis to guarantee that these two aspects can be achieved, it is important that appropriate decision support is provided. This was described by Gough et al as "data, information, expertise and activities" that can assist the decision-maker. DSS therefore combine decision analysis with the available information in order to provide clear guidance to the decision-maker.

In practice, the analysis part is frequently based on economic values, operational research, and management science. This requires that all participants in the decision-making process agree on the goals that are originally set. Gough et al (1996) concluded, and Andriole (1989) and Davis (1988) agree, that the essence of a DSS is the integration of information and methodologies from different sources to enable good decision-making.

Pieterse (2005) uses multiple criteria decision analysis (MCDM) to provide management strategies that deal with the unique characteristics and roles of groundwater in water resource management. He identifies the problems decision-makers have to face in deciding how best to make use of limited resources, and suggests that a well-structured critical pathway be developed to enable decision-makers to deal with complex decisions.

Experience gained by the author in municipalities highlights the lack of available expertise to select an appropriate MCDM technique, and more specifically, the implementation thereof. The majority of the municipalities investigated during the study indicated that they depend on external support to assist them with the compilation of their Water Service Development Plans (WSDPs) - one of their most fundamental water management tools (Du Plessis, 2007).

Dent (2000) highlights the severe shortage of skilled personnel in South Africa - specifically in the water science field - and the general lack of adequate data needed for these models to be effective. While Dent refers to highly complicated models that could be utilised, the lack of adequate and appropriately trained staff is clearly a stumbling block at a local government level. Dent quotes Quadri et al (1999), who stated that "...the impact of information technology on the water sector is not inherent in the technology but largely depend on the way society chooses to use the technology." It is therefore clear that communication will play an important role in any form of modelling. It is even more obvious that a meaningful DSS needs to involve end-users in the water sector, frequently down to the individual consumer level.

3. Integrated public governance

In SA, the water services sector falls under local government, according to the WSA (RSA, 1997). Local government, as part of government in general, is exposed to a number of well-documented behaviour theories. The overview presented by Hughes (2003) shows decision-making at a government level during the so-called "golden age" (1920 to 1970), when it was believed and practiced that a well-structured public sector provides a better level of service to all. In contrast, the last two decades before the end of the 21st century saw governments around the world changing their administration in order to allow more freedom to individuals for decision-making, as well as to decentralise power.

Batley et al (2004) also discuss governance theories, and conclude that, due to the failure of governments to produce what is expected from them – a conclusion based on the economic crises experienced by both rich and poor countries as well as the general public criticism on the effectiveness and efficiency of public services – a number of very specific interventions are required. These interventions involve a shift from the traditional public bureaucracy experience in public administrations towards a new public management (NPM), which includes some principles already present in the private sector. The term NPM was introduced in 1989 by Hood (Hood, 1989), following an evaluation of the administrative procedures followed in various countries, including Canada, the United Kingdom, New Zealand, Australia, and the United States.

While much of the literature on public management - specifically within the framework of NPM - discusses the issue of cooperation between different stakeholders in order to facilitate partnerships, these principles can also be made applicable to ensure cooperation between different departments within government structures. Many of the problems experienced in the field of water resources management at a local government level in SA can possibly be related to a lack of cooperation.

Collaboration between different role-players in order to ensure workable partnerships between multi-organisation structures is well researched. Some of the critical issues identified by Lowndes et al (1998) include the level of trust between role-players, and the mutual benefits for the participants. The fact that these factors have been highlighted as very important for cooperation indicates that the lack thereof might be the biggest problem in the SA water management context.

Salamon (2002) defines a management tool, as opposed to policies and programs, as an “identifiable method through which collective action is structured to address a public problem”. To ensure the successful management of the water sector, it has become clear that additional tools need to be developed, which can be used to guide decision-making when an effective WDM plan needs to be implemented. These tools need to be generic, generate trust between the decision-makers and the implementation staff, and provide a mechanism to ensure that mutual benefits are achieved for all of the local government department stakeholders, as well as the political structures.

4. Institutional arrangements

The South African Constitution (RSA, 1996) assigns functions to the different spheres of government. The functions of local government are discussed in Part B of schedule 4 and schedule 5 of the Constitution, and include the provision of a potable water supply, as well as domestic waste water disposal systems. The Constitution also tasks the National Government to provide Acts to ensure the implementation of the provisions as stated in the Constitution. The NWA provide for the main structures for the management of water in SA, while the WSA presents a clear mechanism for municipalities to ensure effective water management - mainly through the WSDPs.

According to NWA (RSA, 1998), ownership of water, previously vested with land owners, falls back to the government, with a system of licensing introduced to authorise the water use rights to individuals or organisations. The main reason for this was to ensure that sustainable utilisation of SA's water resources is maintained. The management of the water resources in SA, previously almost exclusively vested in the national DWA, was completely transformed to promote an integrated catchment-based management system. A three-tier structure (DWA, 2002) was therefore introduced, as illustrated in Figure 2.

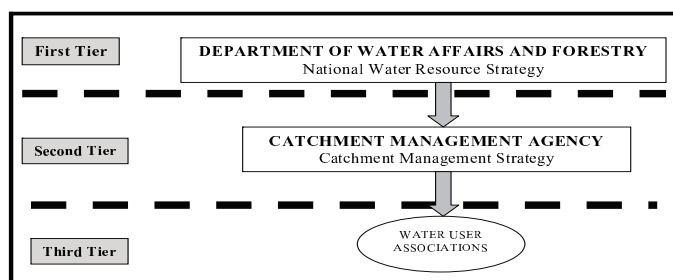


Figure 2: Three-tier water resource management structure

In SA, nineteen Water Management Areas (see Figure 3) have been identified originally, based on catchment boundaries. Catchment Management Agencies (CMAs) are in the process of being established for these areas, but new initiatives question the number of CMAs to be established.



Figure 3: Water Management Areas in SA

The cornerstones of the CMAs are the Water User Associations (WUA). WUAs are statutory bodies which normally involve a specific group of interested water users that need to share the same resource, and quite often develop around a specific water supply system. The NWA (RSA, 1998) makes further provision for the establishment of non-statutory bodies, called Catchment Forums. According to the Act, these forums may be established by any grouping of interested and affected parties, which could comprise of individuals or institutions.

An important aspect of these structures is that they consist of predominantly ordinary citizens. It is clear that almost all of the management functions previously vested in the national DWA are therefore being decentralised in order to directly involve role-players within a specific river basin. The importance of a well-informed and very active public, as envisioned by the prescribed three-tier structure, is therefore clear. Cooperation and trust between the different role-players has been highlighted as vital in the international literature, but it is also clearly non-negotiable for the successful implementation of the new water management structures in SA.

With an understanding of the management structures of water resources in SA, it is important to analyse the link between these structures as provided by the different legislation, and to understand the nature of integrated water management.

5. Integrated water management

An integrated approach towards water management needs to focus on a number of different water chain steps - as suggested by Johnson et al (2002) and adapted by the author - as illustrated in Figure 4. WDM can be implemented with differing levels of success at each of these stages.

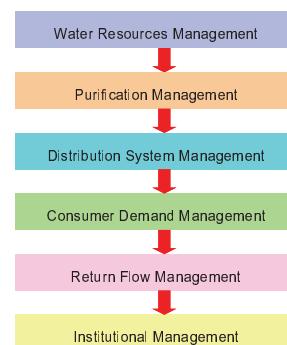


Figure 4: Water Chain Steps

Water Resource Management refers mainly to the management of the catchment and the determination of save yields of the different resources. The available water needs to be weighed against the projected demand, but the water quality also needs to be managed. The eradication of alien vegetation

in the catchment forms an important part of this process.

Purification Management refers to the optimal management of the process of treating the raw water to potable standards. Back-wash cycles during sand filtration, and the correct dosing of chemicals, are of utmost importance.

Distribution System Management involves mostly the day-to-day activities of the municipalities in maintaining their distribution systems. The main focus of effective WDM during the distribution of water from the bulk storage facility to the end user is to limit possible losses. Metering plays a critical role in this process, and a water audit is essential.

The simplest form of a water audit is to monitor that the water entering the system is delivered to the end user. Municipalities are facing a serious challenge in this regard, because this brings the technical challenges of delivering water in direct contact with the financial systems, which are responsible for the metering and billing of individual households. The importance of coordination between the consumption figures collected through the billing system, and the bulk and zone meter information respectively, is obvious.

Consumer Demand Management deals with the changes in attitudes towards water consumption, and focuses on raising the awareness of end users to the need for implementing water-saving measures. Most of these measures need to be initiated by the municipality, but implemented by the end users.

Once the water has been used, the WDM on Return Flows focuses on the management of the quality thereof. Once the quality of the return flow falls below acceptable standards, the integrity of the water cycle for downstream users becomes threatened, and the focus on integrated management is lost.

Institutional Management includes training, capacity building, bylaws, credit control, complain centres, incorporation of WDM into the building plan approvals, and rezoning applications.

The responsibility for the implementation of the different water chain steps, and the relevant Acts applicable to the different levels of government, are illustrated in Figure 5.

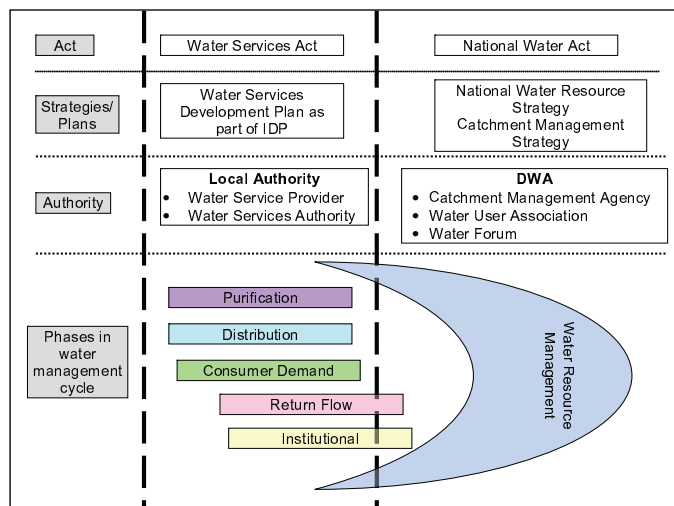


Figure 5: Decision-making responsibility

From Figure 5, it is clear that the main responsibility for the implementation of WDM in the water chain rests with municipalities. The link between the different role-players is critical, and the roles and responsibilities of specifically the political decision-makers at a municipal level need to be included in a WDM implementation DSS.

The Municipal Structures Act (RSA, 1998) prescribes the way in which municipalities must be managed. Municipalities are managed by Councillors who are elected through different legal structures. The most widely-used management system in SA municipalities is referred to as the "executive mayoral" system.

In this system, an executive committee is appointed by the mayor, who is also the chairperson of the committee, to act as the primary decision-making body of the specific municipality. Each member of the executive committee

chairs a specific departmental management committee within the municipality. Technical managers and heads of departments serve on these committees, and in this way they act as the interface between the political and the technical decision-making. The typical executive mayoral system is illustrated in Figure 6.

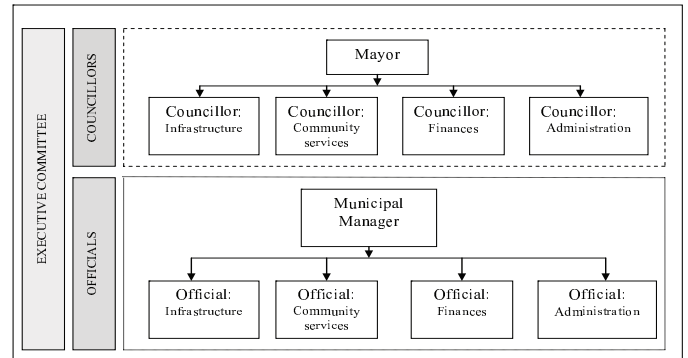


Figure 6: Typical Mayoral Executive Committee Structure

To bring governance closer to the voters, extensive use is made of the "ward" system. In the ward system, the elected councillor chairs a committee consisting of ordinary citizens in that ward. This committee therefore serves as a discussion forum in which valuable information can be shared.

With this structure in mind, it is clear that a huge amount of decision-making power and responsibility rests with the political decision-makers. It is therefore important that all councillors, but specifically the executive mayoral committee, be trained or at least be capacitated appropriately to enable effective decision-making regarding the effective use of water resources.

The involvement of the public is also critical in almost all of the water chain steps, and the successful implementation will depend on the arrangements in place to ensure successful public participation.

6. Water demand management

The availability of water resources or rather the lack thereof, is almost always the driving force behind a WDM initiative. In the past, the pressure on water resources were dealt with through effective water supply management, which ensured access through the establishment of new infrastructure, such as dams, pipelines, and treatment works. New legislation, however, forces government to focus not only on the supply side of water, but also on the demand side of the water cycle.

WDM and water conservation are in general terms considered to mean the same thing. There are, however, very well-defined differences between the two, and it is important to take note of these differences.

WDM is described as follows (DWAf, 2004a):

"The adaptation and implementation of a strategy by a water institute or consumer to influence the water demand and usage of water in order to meet any of the following objectives:

Economic efficiency, Social development, Social equity, Environmental protection, Sustainability and Political acceptability"

Water Conservation, on the other hand, is defined as (DWAf, 2004a):

"The minimisation of losses or waste, care and protection of water resources and the efficient and effective use of water."

These definitions need to be put into practice in such a way that water will remain a sustainable resource for generations to come. It is important to note that, although strategies and objectives needs to be defined, and policies put in place, it is in most cases the "plain common sense" of the day-to-day manager and the man in the street that will ensure success.

From a practical point of view, the main objective for a municipality is to ensure that no unnecessary losses occur within the water system itself, and that the end users utilise as little water as possible - without sacrificing their health and an acceptable lifestyle. In order to be successful with WDM, it is therefore essential that a proper management plan be put in place. The management plan must be used to focus all efforts in the municipality, and it must tie in

with the Integrated Development Plan and WSDP - both of which are requirements of the NWA (RSA, 1998b).

A management plan should include at least the following aspects:

- Objectives (Short-, medium-, and long-term);
- Methodology;
- Technical steps to be taken (Projects);
- Awareness campaigns;
- Budget;
- Time frames;

Decision Support Systems (DSSs) dealing with the technical steps required to ensure effective WDM must include at least the activities for each water chain step provided in Figure 7.

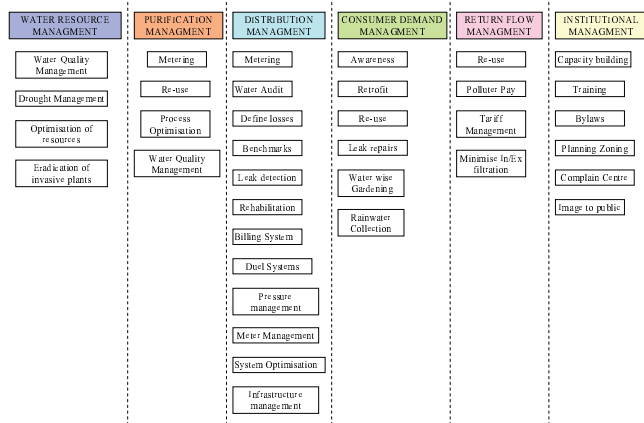


Figure 7: WDM aspects to be included in decision-making

These DSSs consist of flow diagrams indicating the logical sequence or steps to be considered to ensure that all aspects of WDM are attended to at a municipal level. Figure 8 illustrates the DSS for the Distribution management DSS.

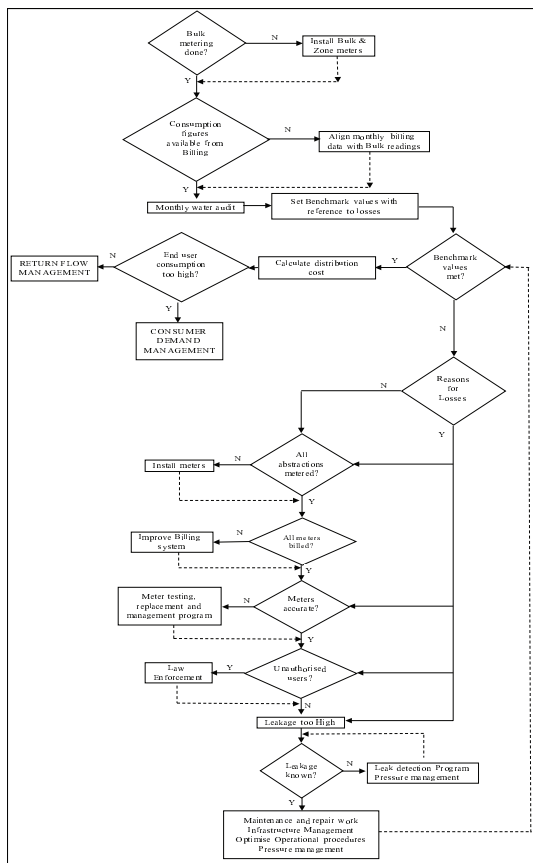


Figure 8: Distribution management DSS

7. Implementation

The success of the implementation of WDM at a municipal level depends on the involvement of the public. While a number of technical aspects need to be addressed, the challenge remains to follow a DSS that will ensure participation at all levels, but specifically also provide a link between political decision-making and the end-users.

The integrated WDM implementation DSS proposed in this paper was developed after interviews with key role-players at a municipal level and through initial discussions held with a selected group of water users, which included industries, municipalities, political decision-makers, schools, and a number of end-users. The discussions highlighted the following key points of interest to be included in the DSS:

- Integrated Approach - there was a very good understanding that the problem could not be resolved only at any particular phase of the water chain, but that every aspect of the water cycle needed to be integrated into the process;
- Unique Approach - participants felt that WDM could easily become only a “buzz” word, with every municipality spending some money and time on the issue. To really make a difference, it was considered essential to follow a new and a unique approach in the area;
- Community-based - it was considered to be a pre-condition that the project must be implemented through the community, and not through the existing municipality structures;
- Management Committee - the need for the establishment of a management committee to oversee the implementation of the project was highlighted;
- Volunteers - participants were not interested in their own financial gain - although finances were an important consideration. Instead, they considered participants to be volunteers who must be seen to take part in the process because they believed in the need for such a process;
- People as the main focus - the importance of changing attitudes were highlighted. Although it was recognised that aspects such as pressure management and leak detection are important, there was a strong feeling that these aspects would automatically be addressed once the general attitude towards water consumption was addressed.

The Implementation DSS developed consist of two stages. The first phase requires a preliminary intervention by municipal structures, while the second phase will represent the operational stage, during which the implemented structure begins to function, focussing on the real water demand issues and how to address them. The main focus of the DSS is to ensure effective stakeholder engagement, and Figure 8 illustrates the different phases of the DSS.

This DSS provides a base from which WDM can be managed and implemented. The link between the political structure and the management committee can be achieved through the incorporation of the ward system - with a councillor representing the ward also serving on the management committee.

South Africa is facing serious challenges in ensuring a sustainable water supply to all citizens. The implementation of WDM is one of the most important tools to ensure that the growing water demand is met. For WDM to be effective, it is important to ensure that it is implemented on an integrated basis, which includes all the steps of the water chain, from resource back to resource. The responsibilities for the implementation of WDM in the full water chain rest with different organs of state, with the biggest emphasis at the local government level - the municipalities. While it is known that WDM involves a number of technical issues which needs to be dealt with by municipal staff, the inclusion of the public cannot be ignored. To ensure that the initiative for the implementation of WDM remains relevant and active, the input received from the public needs to be incorporated into a structure that is not only acceptable to the public, but also the governance structures.

The DSS's developed and presented in this paper provide the required guidance to enable structure implementation and sustainable WDM at a municipal level.

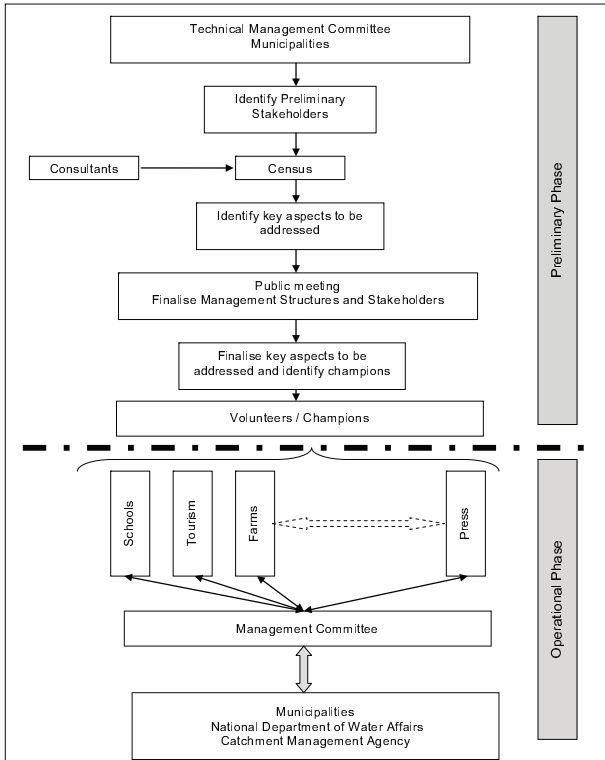


Figure 8: WDM implementation model

8. Conclusions

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