Research Summary

The role of Local Innovation for a Transformative Shift towards sustainable Water and Sanitation in African Cities

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Background and Objectives

African cities are moving towards the SDG 6, but still millions of people lack safe and adequate water and sanitation services. For most key actors such as utilities, municipalities, governments, and development partners, it is obvious that a key to success is to promote innovation in the sector. We need to do things differently to be able to serve the low-income population living the in the informal settlements of our cities. “Innovation” is not a hard word to say, but successfully managing innovation and change processes can turn out quite complex.

The purpose of this research project is to understand how the large systems for urban water and sanitation change in sub-Saharan Africa contexts, and in particular, how local innovation can contribute to system-level change.

Thanks to a grant from the Swedish Research Council FORMAS, this research project, with a focus on East Africa, has been carried out between 2016 and 2019. The research has been led by Associate Professor David Nilsson at KTH Royal Institute of Technology in close collaboration with Associate Professor Pär Blomkvist at Mälardalen University, both based in Sweden. Regional research partners have been Dr. Lewis Sitoki and Mr. Benard Juma of Technical University of Kenya, together with research assistants Rebecca Ouma, Suter Felistus,

Cecilia Faith and Georgin Nekesa. In Uganda we are grateful for the collaboration and support from Associate Professor Shuaib Lwasa and Mr. Gerald Ahabwe, Makerere University.

Our Approach

We take our point of departure in an academic tradition often known as STS; Science and Technology Studies. In short, we use ideas and methods from social sciences and humanities to study technology and how it relates to environment, people, organisations and ideas. While STS scholars have engaged with virtually all areas of technology, from space industry to professional education, so far the area of urban WASH innovations in the global South has been relatively little explored. Our hope is to contribute knowledge that can enrich policy and sector actors' efforts to meet the SDG6. We do so by taking a practical approach; by going out and talking to actors on the ground and observing first-headedly how the innovation process moves forward (and backward). Our emphasis is on qualitative questions (how, what, why) rather than quantitative analysis (how much, how many). We want to emphasise this is about learning – not about evaluating or rating.

Water, sanitation and hygiene belong together and the well-being of people depend on all of them. However, we have delimited our studies to water supply. The reason for this is that we are keen to understand how innovation happens when relatively well developed or "mature" public organisations face challenges in areas such as informal settlements. These larger public organisations - so called "regime actors" - are typically part of the state or municipal structure, are professionalised, and often play a dominant role in service development. We have focused on water because many regime actors in East Africa, are stronger in the area of piped water than in sanitation. We hope that some of our findings can be applicable also to innovation in sanitation and hygiene.

Our framework

To analyse and understand the innovation processes we are studying we have developed a framework derived from several theories. Our most important sources of theoretical inspiration are found in the area of Business and Innovation Studies, History of technology, and Sustainability Transitions.

Our premise is that technical systems grow as long as they are well adapted to their environment (including their users), and as long there is a net positive balance between the service production and the financial return flow. History shows that regime actors will strive towards **vertical integration** of the system; to streamline components and practices in order to ensure control and an efficient management of all parts of the system.

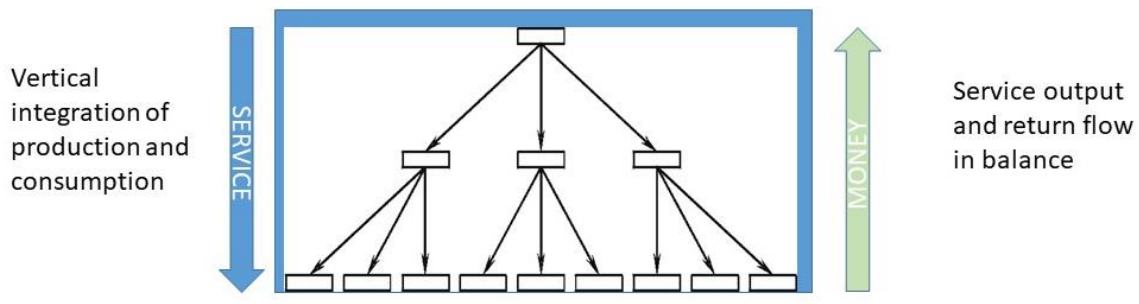

Figure 1. Conceptual description of a conventional networked infrastructure system

However, all systems will eventually reach a point where they stop growing. This can depend on market saturation (virtually everyone is connected) and further growth simply will be un-economical. Additional users will not be able to generate a sufficient (socio-) economic return through either consumer tariffs or subsidies.

A certain proportion of the potential customer base will therefore remain outside the system. In rich parts of the world, e.g. most of Europe, these are typically residing outside the urban areas. In low-income regions of the world they can be found also within cities. The boundary space between the system and the un-connected potential customers are what we call **the critical interface**.

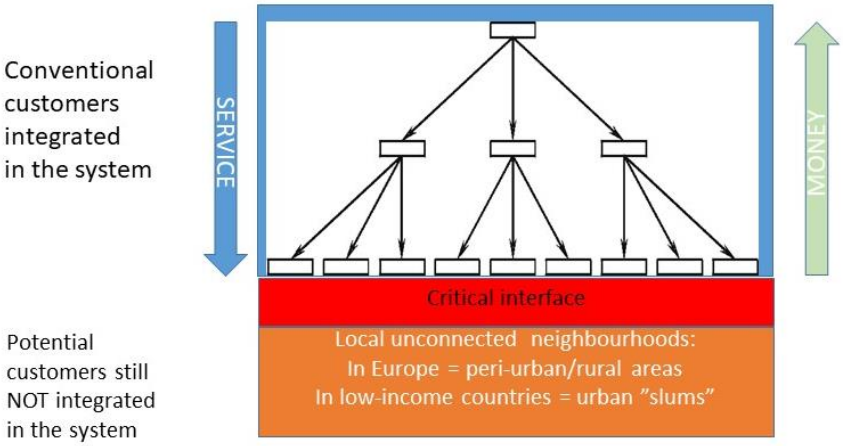

Figure 2. Conceptual description of a network infrastructure with a critical interface between the system's reach and non-integrated potential consumers

For decades regime actors thought of their job as "rolling out" services by expanding into new areas. But it is difficult to expand into areas that do not comply with the system's requirement for vertical integration. Informal areas with low-income, fluid, and heterogeneous populations often without land tenure are difficult to integrate without changing the requirements. We say that there is **misalignment** between the regime level and the local level. Simply speaking, the regular service provision model does not have a good fit with actual conditions on the ground.

Exploring the "critical interface" – where the larger technological service system meets the unconnected residents in for example informal settlements – is key for our investigation. Are there ways in which the regime actors can find solutions together with local actors that can bridge the critical interface and provide services sustainably?

We have explored this critical interface through our case studies using the concepts vertical integration and misalignment. In particular, we have studied how regime actors design and implement innovative solutions to address misalignments, focusing on factors and barriers for success. In doing so, we have gradually refined the framework. We believe it is meaningful to distinguish between four different types of misalignments that can arise in local innovation processes in the critical interface.

Table 1. Four types of misalignment that can arise in local innovation processes

Internal misalignment		
When the utility corporation develops a new service provision model (e.g. pro-poor tariffs) which comes into conflict with already established objectives and practices in the corporation.		
Critical interface misalignment		
Socio-politics When the innovation is not well tailored for its local social and political context. For example: elite capture, security and vandalism, attitudes, affordability.	**Technology** When the innovation malfunctions from a technological perspective. For example: pressure, leakage, breakdown, spare parts, incompatibility with the rest of system.	**Business model** When the innovation faces problems of pricing, payment, and customer care. For example: unclear or unfair pricing, high transaction costs, difficult for customers to pay, free-riding.

Case studies

1. Pre-paid dispensers in Kampala, Uganda

In 2006, the National Water and Sewerage Corporation (NWSC), the parastatal body in charge of urban water and sewerage in Uganda, began implementing a pilot project for improving the access to service in low-income informal settlements in Kampala. Public standpipes and water kiosks, aimed to offer affordable water to the poor, typically had been under the control of water vendors that hiked the prices, making the poor pay 5 to 10 times higher water tariff. The corporation launched a strategy aimed at "cutting out the middle men" through prepayment and automated water dispensers (PPD). The utility has installed over 1,500 meters, each designed to serve 20 household or approx. 100 people. The customers use an electronic token to draw water from the dispenser located in their neighbourhood, and these tokens are recharged at official sales points.

A preliminary case study was carried out during 2017 which included visits to the Kisenyi informal settlement, and a limited number of face to face interviews officials with NWSC, a donor and Kampala Capital City Authority (KCCA). A stakeholder discussion group was organised which included participants from community groups and users, an NGO, KCCA and the water utility NWSC. More interviews with NWSC officials followed in 2018. During 2019 a more elaborate field survey was carried out by Makerere University, the results of which are still being analysed.

Figure 3 (a) pre-paid water dispenser in Kisenyi, Kampala; (b) sales point for water credit. Photo: David Nilsson

The Kampala case study clearly shows the width and complexity of the innovation activity that a utility has to deal with when not just trying to do "business as usual". In implementing the PPDs in Kampala challenges NWSC faced spatial and technical challenges as well as those related the company's business model. At the same time the corporation is trying to learn from previous challenges and instilling a culture of innovation.

The preliminary findings were discussed in a paper presented at a research conference in May 2017, and later at a seminar at EAWAG in Switzerland. The preliminary case study was important in developing the framework.

2. Pre-paid dispensers in Nairobi, Kenya

In 2014, Nairobi City Water and Sewerage Company (NCWSC) adopted a five-year strategic plan that would among other objectives, increase access to water in informal settlements by installing 4,000 new pre-paid water dispensers (PPD). In 2016 the first PPDs were operational in the low-income area of Mathare Valley, and by October 2018, 147 units had been installed. Essentially, a PPD is an automated device that delivers a specific amount of drinking water against a fixed charge. Payments are done by subtracting an amount of money from a credit account, electronically stored on a "token" held by the user (sometimes called "water-ATM card" or "shoptags"). The token is recharged by uploading new credit through a sales point, managed either by the water company or by an appointed sales person manning the PPD. The water is supplied by the NCWSC, who is also responsible for installing and maintaining the PPD, and for issuing the tokens and sales points. The key idea is that the water company can do away with the problem of "middle-men" who re-sell water at inflated rates, sometimes 10 to 20 times higher than the normal tariff for piped water. Other advantages are that the utility receives payment in advance, 24-hour service for customers and no risk for disconnection due to payment arrears.

Figure 4. A pre-paid dispenser in Nairobi. Photo: Rebecca Ouma

Figure 5. The electronic tokens or "shoptags" in Nairobi where water credit is stored. Photo: David Nilsson

During 2018, a field study was done by TUK in Mathare Valley which included visiting 30 PPD units to observe their status and interviewing users, PPD caretakers, water vendors as well representatives of NCWSC, the Nairobi City County, and the regulator WASREB. A total of 24 persons were interviewed, some more than one time. Our focus has been on observing the various types of problems or "misalignments" that the NCWSC has had to face when trying to implement the PPD strategy.

Through applying the framework described above (Table 1), we were able to uncover a long list of misalignments that NCWSC has had to deal with by means of various types of adaptation responses with varying degree of success. Not seldom did one adaptive response generate a new type of problem of the "internal misalignment" type. In short, whenever the company tried to solve one problem it met when trying to implement the PPD initiative in practice, it also gave rise to new challenges internally in the organisation. As an example, the erratic supply and rationing militates against a pre-paid approach. The NCWSC has tried to counter that by equipping the PPD stations with a local elevated tank, which can be filled with tanker trucks. However, this creates new logistical challenges for the utility, and also seems to affect consumer acceptability.

The field study was documented in a report available here. A paper has been accepted for publication in the scientific journal *Technology in Society*.

3. Self-read meters in Nairobi, Kenya

The JisomeeMita (JM)/Self reading meter is an innovative technology in water supply funded by the World Bank and supported by the "MajiMashinani" (Water at the grassroots) to guarantee residents of informal settlements clean and affordable water by the Nairobi City Water and Sewerage Company (NCWSC). The initiative which was launched in 2014 and piloted at Kayole-Soweto was also aimed at maximizing water revenue collection by the NCWSC, as much of water revenue is unaccounted for. Informal settlements are highly characterised by low income earners and illegal water connection by a few people who make business out of it. The introduction of JM technology was meant to address these socio-economic and service provision challenges.

The core idea of the JM innovation is that a customer with an individual connection is able to read the water meter at the end of the month and send the number of water units consumed to the NCWSC and get an automated response with the billing information. The customer then pays the water bill via Safricom's M-PESA mobile money transfer platform. The JM thus involves the consumer in the process of measuring his/her own consumption and also facilitates the financial transaction, which is supposed to increase cost recovery and reduce the non-revenue water.

Figure 6. Self-read meter installed inside a locked meter box, in Kayole Soweto, Nairobi. Photo: Lewis Sitoki.

The purpose of this study was to carry out a field survey to investigate any potential misalignments between the water provider and the local users, i.e. in the "critical interface". A total of twenty households/JM users were interviewed in Kayole Soweto during field studies in 2018 (2 landlords and 18 tenants). In addition we also carried out interviews with a few regime actors, such as NCWSC, the Nairobi City County and WASREB (same as for PPD case study).

Our findings were multi-faceted in a number of ways, including observations regarding the physical installations, performance, competition with other provision modes and the local socio-economic conditions.

Figure 7 (a and b). On-property storage necessitated by the strict water rationing in Kayole Soweto, Nairobi. Photo: David Nilsson

For the JM innovation we noted several misalignments of technological character. The water rationing stands out as a severe threat to the success of the JM and its ability to out-compete the vendors, but also aspects of maintenance and reliability of the installations were noted. The JM is fairly well aligned with the corporation's regular business model and if the technological aspects and the rationing were sorted out it is likely to boost cost recovery. However, there are instances of socio-political misalignment, such as consumers' fears for contamination, non-willingness to pay and resistance from vendors. A somewhat remarkable finding is that there is no way for the sector regime actors to regulate the end-user price, since this is determined by the landlords alone. Thus, the JM vertically integrates the landlords as parts of the regime, but a new critical interface arises within the private property between the landlords and the tenants, now beyond the meter and beyond public control. A scientific paper is currently being developed based on the JM case study.

4. Delegated management in Kenya (Naivasha and Kisumu)

Our fourth case is mainly a reference case based on previous studies and recent literature but which also involved a field visit to Naivasha in 2018 and a small number of interviews. Here we focus on an organisational innovation known as Delegated Management Model, which was implemented in Kisumu and in Naivasha from around 2007-2008.

In Naivasha the model has been built on contractual relationships between a community-based operator in the area of Wagetari (an informal settlement of around 20,000 people), private bulk water supplier, and the municipal water company Naivawass. The community groups and water user associations are strongly involved, as well as an international NGO (WSUP). The private borehole owners deliver water in bulk to the operator, who runs a small water distribution network including pumps, high-reservoirs, mains and distributions and 14 water kiosks, plus a number of individual household connections. Each water kiosk is manned by the operator and also has a decentralised treatment facility installed in each kiosk. The water naturally has a very high content of flouride, but with the decentralised treatment, consumers buy treated (de-flourided) water at a higher cost. Much investment has gone into educating the consumers to understand what the untreated water is good for, and when to use the treated water. Hence, the DMM water system in Naivasha involves a dual product (treated/untreated water). The water company has only been overseeing the operations, including water quality testing, and charging a commission from the operator meant to cover major repairs of the system. The O&M costs are included in the tariff of the water sold, which is revised continuously in dialogue between the community based organisation (a church in the neighbourhood) and the user association, after approval of the water company. The model was however very recently discontinued in Naivasha. A similar model has been tried in Kisumu but with important differences. In Kisumu the municipal water company also supplied the bulk water to the local operator, and the focus was on individual connections.

Figure 8. The local Water User Association and the operator of Karagita delegated management system. Photo: David Nilsson

In the DMM case we can see a different kind of misalignments. Since the core idea of the DMM is to outsource sub-system to be managed by a local operator, any critical interface misalignment will be felt by the local operator who also must manage the local innovation process. Consumer awareness, vandalism, as well as technical and capacity challenges, such as

the flouride treatment, are examples of misalignments dealt with by the local operator. However, from the utility point of view, the DMM could be producing internal misalignment since the utility in practice changes role from being service provider to being regulator and long-term asset manager. In Kisumu the utility provides the bulk water, but in Naivasha the local system is not even connected to the municipal water corporation's regular infrastructure.

Conclusions

The four case studies offer three different models, which all test innovations in the critical interface to provide services in areas otherwise difficult for utilities to work in. We conclude that all models deal with the critical interface but in three distinctly different ways (see illustrations below).

The **PPD** model is the one that most explicitly **bridges** the interface. Here, the utility extends small but dedicated technological connectors into the informal areas, linking up the end consumer with the main network. In fact, the PPD could be said to be an "adapter" in the same sense as a DC adapter for a laptop or mobile phone.

Jisome Mita does something completely different; it integrates the costumer owning the connected property (the landlord) into the regime and makes him/her part of the official provision system. The relationship between the landlord and the end consumer, however, is not regulated. Therefore, the JM **relocates** the critical interface into the private property but the end consumer's right to water can still not be protected.

DMM finally, **regulates** the critical interface using a contractual relationship. An operator is tasked with operating a local sub-system that can be developed to suit the local requirements, rather than the regime requirements.

When regime actors (mainly public water utilities) innovate in the interface, naturally they meet challenges. The innovations are from the start often misaligned with the local conditions in terms of socio-political, technical and business models. The innovations may also generate conflict within the utility itself; so called internal misalignment. The ability of the organisations to manage, predict and reduce these misalignments is likely to be important for successful service improvement in low-income areas. Hence, the solutions to reach SDG6 may be less dependent on finding "the magic technology" than development of the organisations' capacity and culture for sustained innovation work.

When trying new service provision models the organisations in most cases work through a dedicated "pro-poor unit". Hence, the organisations apply what we call an **ambidextrous strategy**; a two-handed strategy**.** They are learning to do two things at the same time. While developing and testing new provision models in low-income areas they continue regular operations for the already integrated consumers. This is a strategy that large industrial companies like HP (developing the Ink-jet printer)have successfully done when under pressure to innovate and meet new demands from markets. Others have failed to innovate, like Kodak and Nokia. The car industry is right now facing the same challenge, when trying to keep the traditional automobile and simultaneously develop electrical drivetrains. To put it mildly,, managing ambidextrous organisation can be difficult. It requires a cautious approach since it may also create conflicts with the regular operations and business models. Resolving some of these potential conflicts - for example how to prioritise supply to low-income areas under situations of scarcity - may also be beyond the control of utility managers and are ultimately shaped by political decisions.

We believe that our framework could provide a basis for developing an assessment tool that could help utility managers, municipalities and regulators to detect and prepare for

misalignment when engaging in pro-poor service provision. To meet the SDG6 targets, business as usual is not an option. We also hope the lessons learnt in our research project can inform regime actors in East Africa - and beyond - in their endeavour to become ambidextrous organisations.

Finally, we think that our method, which has involved mainly qualitative local field studies and a collaboration over great geographical distance (Sweden, Uganda and Kenya) has proven to be useful. It also deserves to mention that this research project is not part of Swedish development cooperation but is financed by FORMAS, one of national scientific research councils in Sweden. The questions at hand are not of importance to developing countries only. In fact, we can all learn a lot from studying local innovation in places like Kampala and Nairobi. This is, after all, "where the action is".

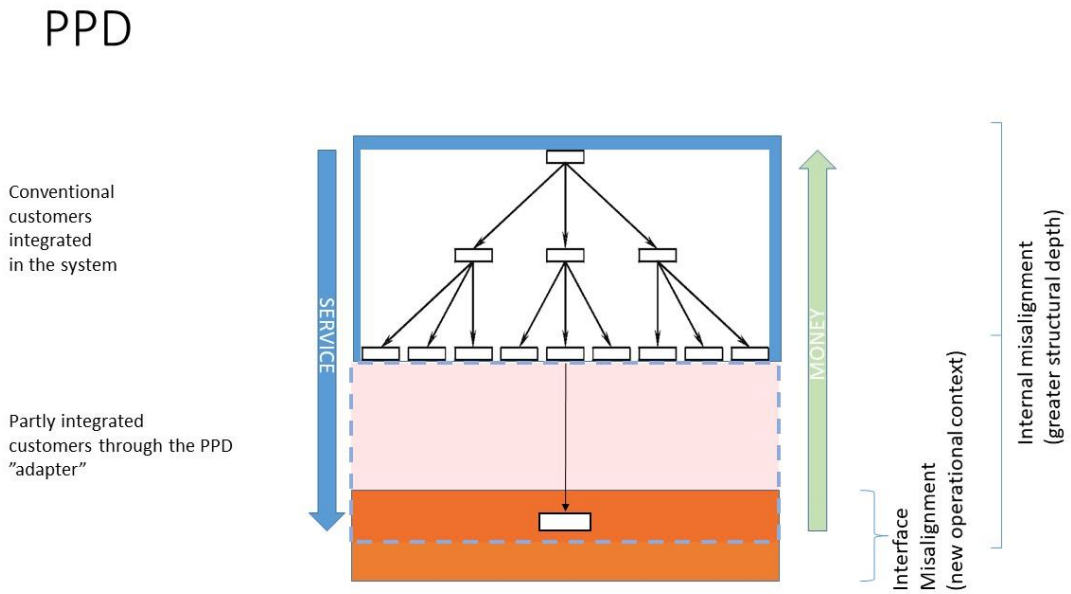

*Figure 8. The **Pre-Paid Dispenser bridges the critical interface** where the PPD functions as an "adapter" through which the utility can connect the end consumer*

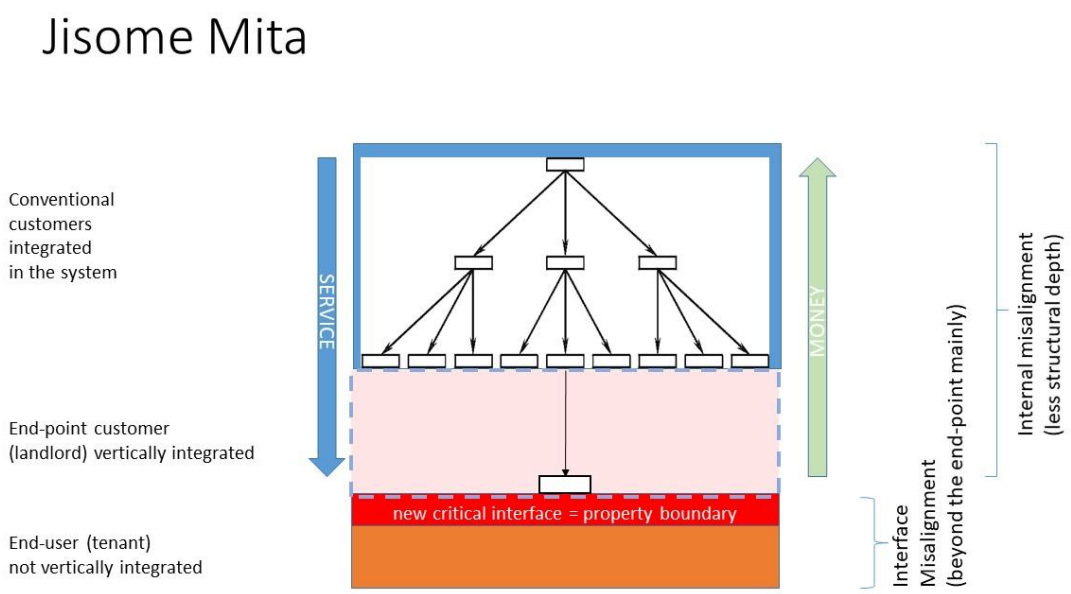

*Figure 9. The **Jisome Mita relocates the critical interface** into the private property, where regulation is impossible today*

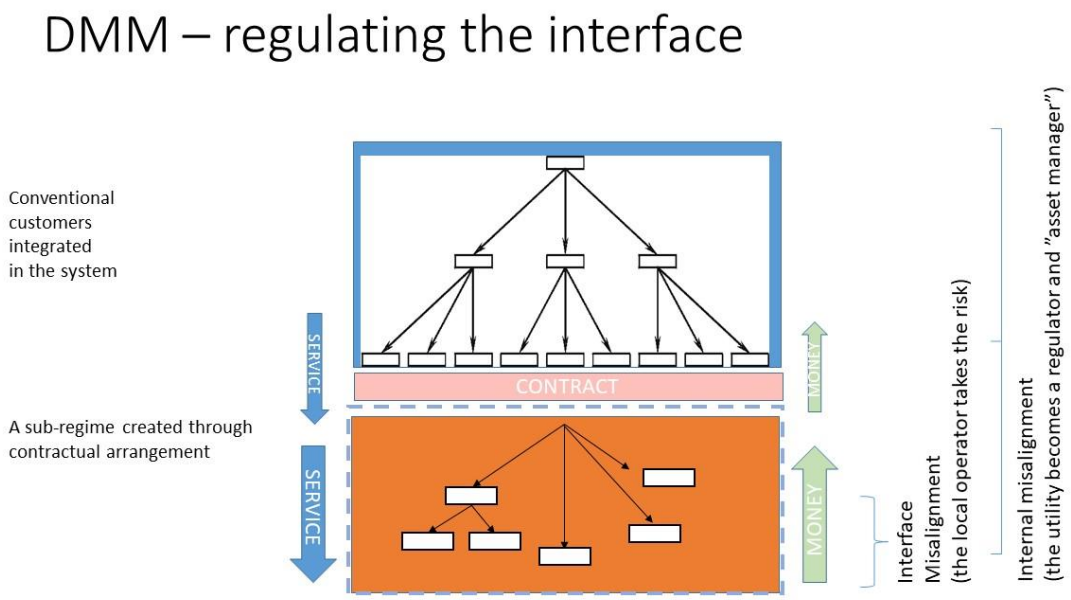

*Figure 10. The **Delegated Management Model regulates the critical interface** through signing up a local operator of a sub-system, through a contract*