

# **Simulation Models to *Test* Improvement Proposals in Land Administration Before Investing**

[Special reference to Developing Countries]

**Ken LYONS, Australia**

**Key words:** Land administration; simulation, development assistance

## **SUMMARY**

Simulation is used in business to develop and test business plans before investing. To the author's knowledge this does not occur in LA (administration) in development, although the literature and anecdotal comments indicate that widespread success and sustainability remains elusive. This is seen as a capability gap.

Strategy Dynamics uses simulation and focuses on improving the performance of a system. Its application to LA is illustrated in examples showing how proposals to improve performance can be tested both for effectiveness with aid and sustainability post aid, before investing. Using the simulation model as a living business model during implementation is also shown. The examples demonstrate that simulation models can be used to close the capability gap. They are a new tool for the LA toolbox.

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Simulation Models to Test Improvement Proposals in Land Administration Before Investing [Special reference to Developing Countries] (11911)  
Ken Lyons (Australia)

FIG Working Week 2023  
Protecting Our World, Conquering New Frontiers  
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# Simulation Models to *Test* Improvement Proposals in Land Administration Before Investing [Special reference to Developing Countries]

Ken LYONS, Australia

## 1.0 THE *NEED* - FOR A PERFORMANCE IMPROVEMENT TESTING TOOL

**A Capability Gap Exists** - Simulation models are routinely used to develop and test business plans before investing. To the author's knowledge, they have not been used in land administration (LA) for development, even though the literature and anecdotal comments indicate that widespread success and sustainability remain elusive despite much development assistance. This is seen as a capability gap.

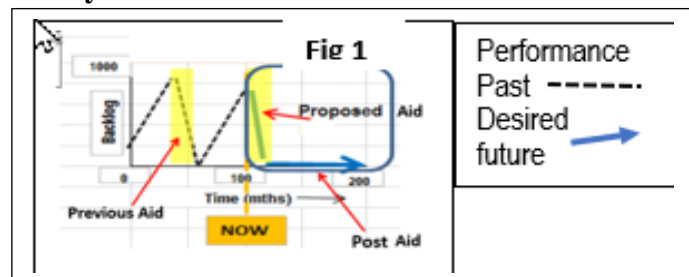
### Closing the Capability Gap using Simulation Models enables:-

- Testing proposed improvements for *effectiveness*, with aid, *and sustainability*, post aid as well as determining an improvement strategy before investment decision are made.
- The provision of a living business model (LBM) during implementation

The simulation model is not intended to be predictive, but to simply provide insights. In this context effectiveness is achieving project objectives and sustainability is maintaining them with in-country budgets.

### The Test for Effectiveness and Sustainability

The test is how well does a performance trajectory from a model align with a desired future as shown by a POT (performance over time) graph. Fig1 is a POT for backlog in a LR (land registry); more in Sec 3.0.



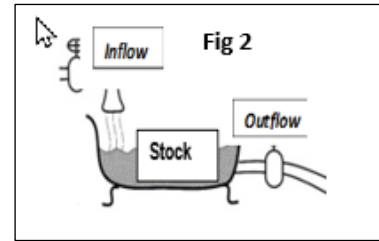
**Acknowledgement** - The advice from Dr Kim Warren of Strategy Dynamics is gratefully acknowledged. All responsibility is the author's.

## 2.0 STRATEGY DYNAMICS -THE SIMULATION APPROACH USED

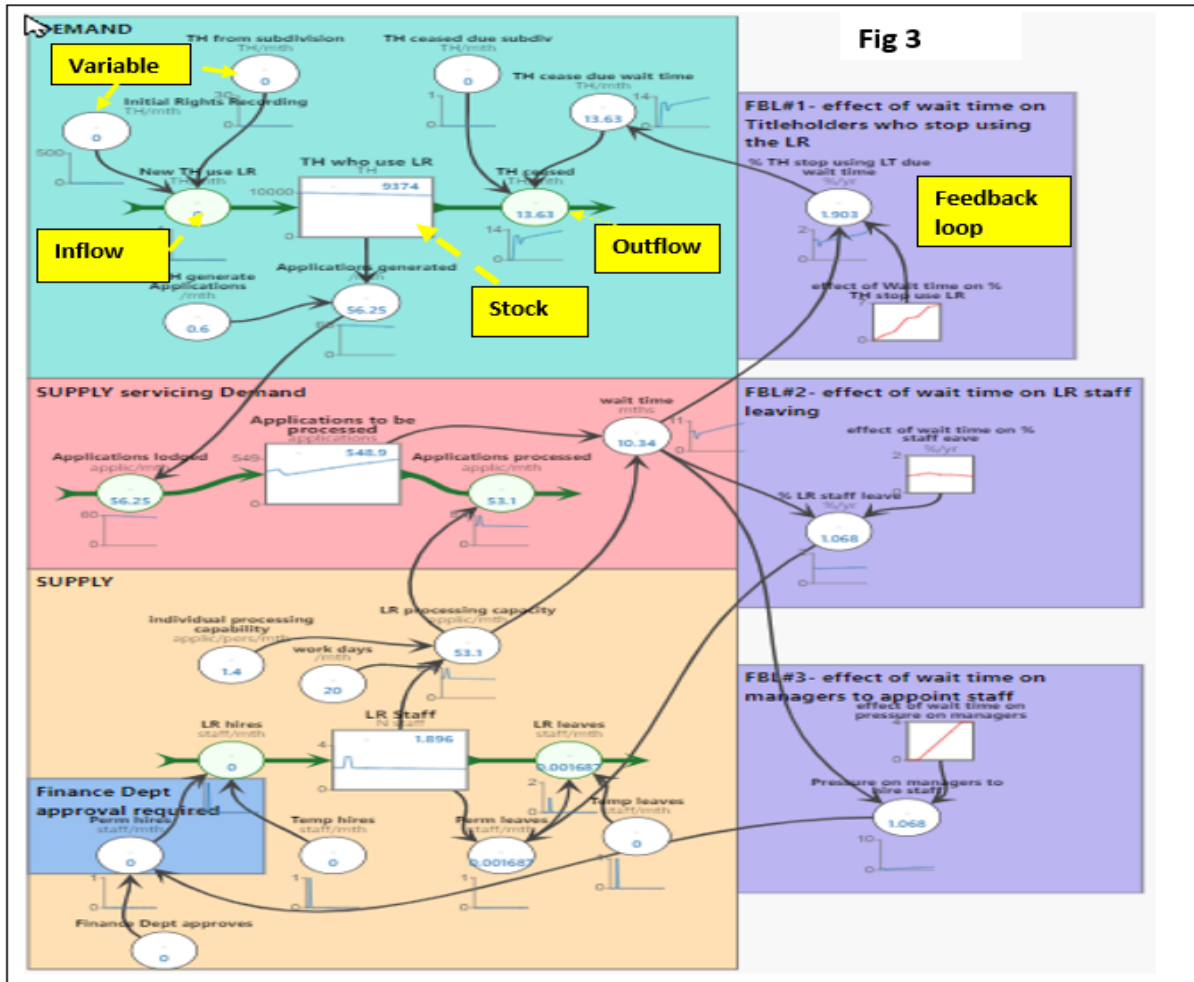
The simulation approach used is Strategy Dynamics (SD), Warren (2009). SD focuses on improving the performance of a *system*. SD enables:- Determining if a plan will work; Designing a system that can perform well; Managing a system so that it does perform well; Fixing a system when problems occur. SD is based on system dynamics (sd).

Stocks and flows are used in sd and illustrated in Fig 2 by the bathtub analogy.

The amount of water in a tub (the *stock*) at any time depends on the amounts *flowing in* and *draining out*, as well as what was in the bathtub initially. The *stock* (bathtub) units are litres. *Inflow* and *outflow* (the *flow rates*) are expressed in the same units as the resource but per periods of time (e.g. litres/minute).

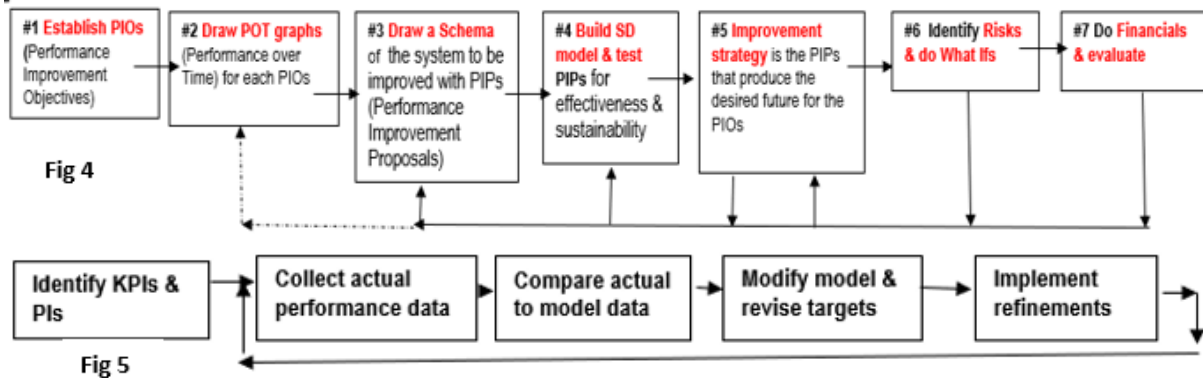


**What a simple model looks like** -Fig 3 is an image of a model for a system of processing applications in a land registry (LR). This model is developed in example 1, Sec 3.0.



There are three main parts to the system;- a Demand side generating applications; a Supply side with processing capacity; a Supply servicing Demand which can give rise to waiting times, which in turn gives rise to feedback loops (FBL). FBL#1 is where titleholders cease using the LR because of long waiting times. More in Sec 3.

**The Workflow developed for applying the SD to LA** -Fig 4 is the workflow for design /testing and Fig 5 using the model as a LBM (living business model) for implementation.



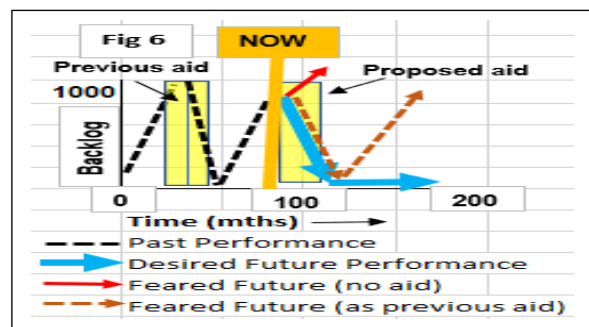
**The examples used to illustrate the SD approach** Four examples are outlined in this paper. Example 1:(Sec 3) Removing a backlog in a LR. Example 2:(Sec 4) Improving quality in a LR, winning back customers; achieving financial sustainability. Example 3:(Sec 5) Quality has subcomponents under the control of different agencies. Example 4 :(Sec 6) Raising development capital if banks accept titles as collateral. Full details in Lyons (2022).

### 3.0 EXAMPLE 1- REMOVING A BACKLOG IN A LR AND KEEPING IT LOW

#### 3.1 Applying the workflow to test Performance Improvement Proposals (PIPs) [Fig 4]

**Step#1- Set the PIO** (Performance Improvement Objective)– Remove the backlog, with aid, and keep it low post aid; (i.e. be sustainable).

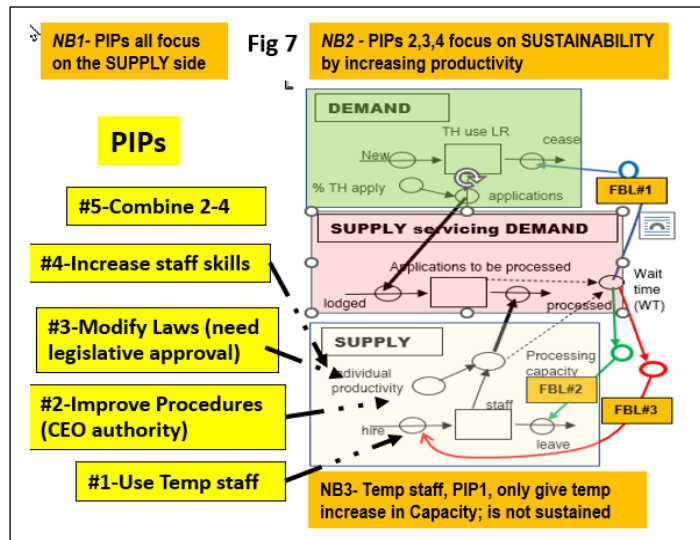
**Step#2 -Draw POT Graphs** (Performance Over Time) **for the PIO** Fig 6 refers.



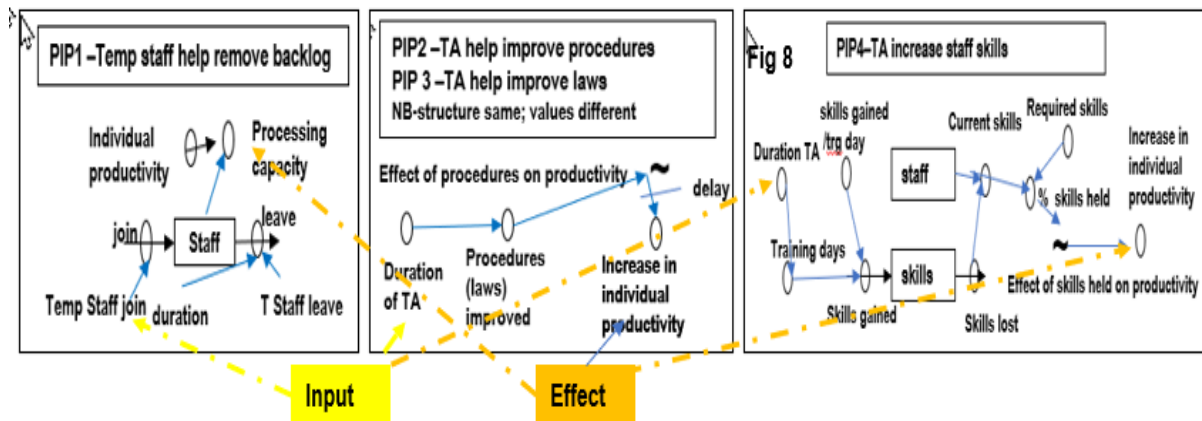
**Step#3 -Draw a schema, SCS (Schematic of the Core Structure), of the system to be improved,** [right side Fig 5] **with PIPs** [left side Fig 7]. The right side of Fig 7 is the SCS of the model image of Fig 3. The right side of Fig 7, with POTs of the main stocks and flows, and a Why Why diagram, provide an initial indication of *the dynamics at play*.

Dynamics are:- demand (applications for processing) is greater than supply (capacity of the LR to process); Processing capacity is low because:- productivity is low (low skills; workflows unclear); staff cannot be increased due to low budgets.

Understanding the dynamics at play leads to listing PIPs; left side of Fig 7 refers.

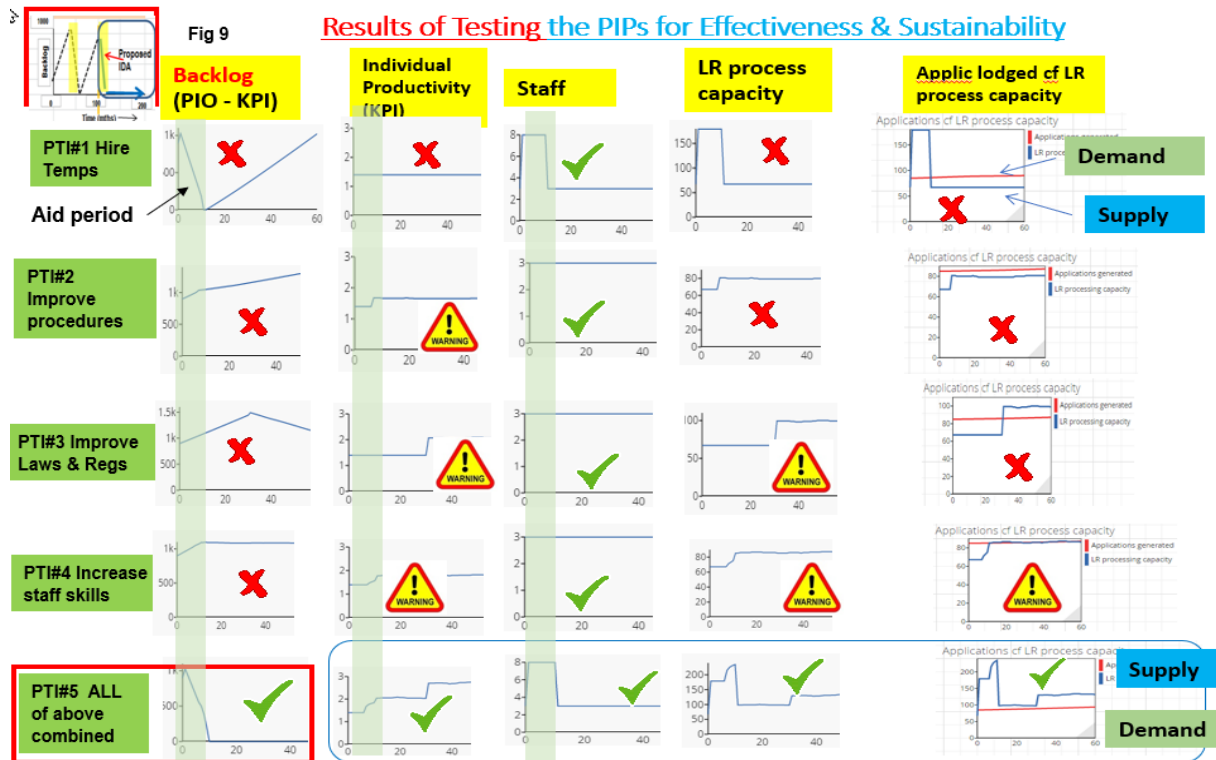


A SCS for each PIP, (Fig 8) is required so that, with the SCS of Fig 5, a model can be built. An image of part of the built model was shown as Fig 3.



### 3.2 Results - from using the model to test the PIPs for effectiveness and sustainability

The test was outlined in Sec 1.0 and Fig 1. Fig 9 shows the results of testing the PIPs. [PIP and PTI are used interchangeably]. The first column shows the POTs for backlog, the PIO (a KPI, key performance indicator), from testing each PIP. Other columns show POTs from the model for other KPIs/PIs. The other KPIs/PIs can be identified from an understanding of the model shown as Fig 3. Together they indicate the likely effectiveness and sustainability of the PIPs. Desired future POTs can be compiled for the other KPIs/PIs.



The improvement strategy should be based on PTI#5 as it is the only one where the backlog trajectory from the model aligns with the desired future for the PIO, and other KPIs/PIs are improved. **The improvement strategy in summary is:** (1) with aid – 5 temporary staff for 10 mths to assist clear backlog; 3 TAs (technical advisers) for 6 mths to improve procedures, laws, increase staff skills and productivity; executives engage with politicians to pass changes to laws: (2) post aid - executives engage with politicians until laws passed; managers monitor actual performance to targets (covered in Example 3 Sec 4.0).

**Take home points Example 1** -Simulation models can be developed to test performance improvement proposals and determine an improvement strategy before investing. Full details including risk What Ifs and financials in Lyons (2022).

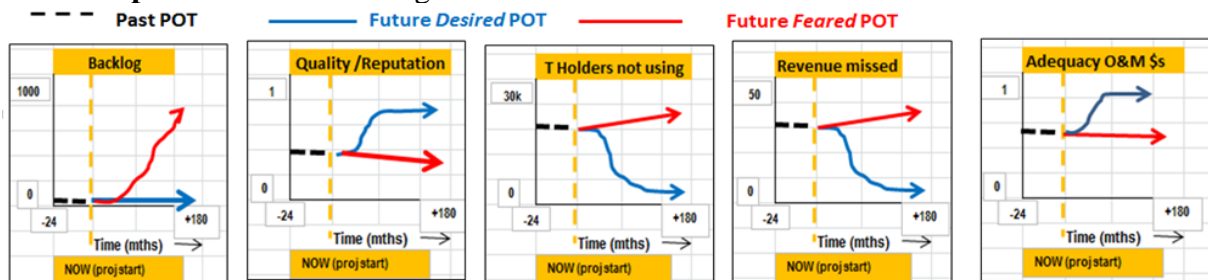
#### 4.0 EXAMPLE 2- INCREASING QUALITY IN A LR, WINNING BACK CUSTOMERS, FINANCING SUSTAINABILITY

##### 4.1 Applying the workflow, Fig 4, to test PIPs (Performance Improvement Proposals)

**The PIOs:-** 1-Improve quality 2-Win back titleholders not using the LR; 3-Increase revenue 4-Maintain low backlogs 5-Make financially sustainable using some of increased revenue



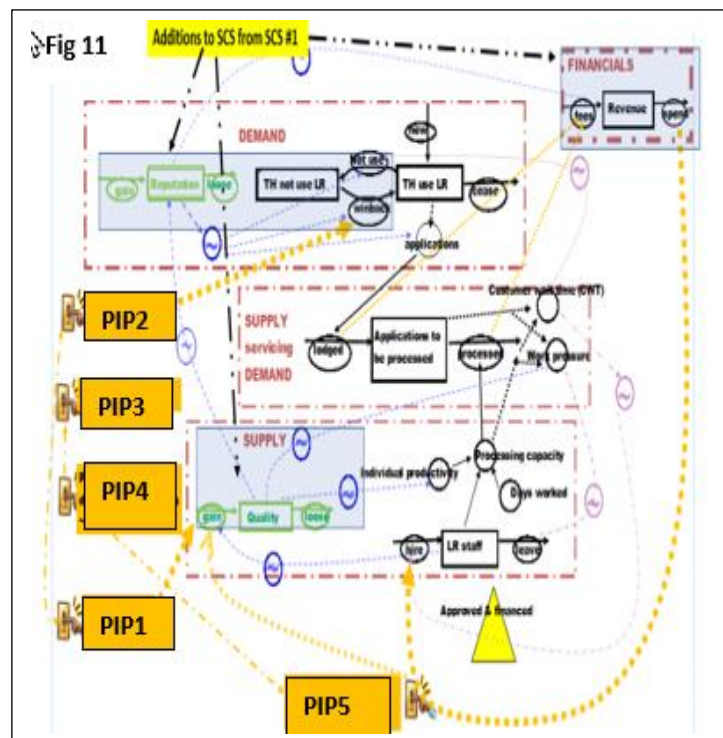
## POT Graphs for the PIOs – Fig 10



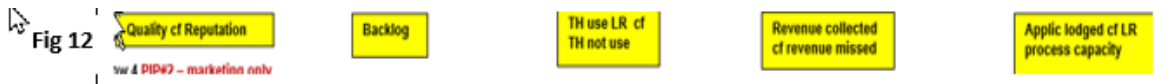
**SCS of the system to be improved** - Fig 11 is a SCS that indicates where quality, reputation, titleholders not using the LR, and financials have been added to the basic SCS of Fig 7 Example 1. Included are the PIPs showing the parts of the system they affect.

- PIPs:**
- 1-Upgrade quality [if quality rises, so will reputation, after a delay];
  - 2-Conduct a winback campaign for titleholders not using the LR;
  - 3-Do PIPs 1 & 2 concurrently;
  - 4-PIP3, but commence PIP#2 when Reputation reaches a certain level (~0.7);
  - 5-PIP4 + using some of increased revenue to:- fund additional staff; maintain increased quality; do increased processing; achieve adequate O&M budgets; establish a sinking fund (SF)

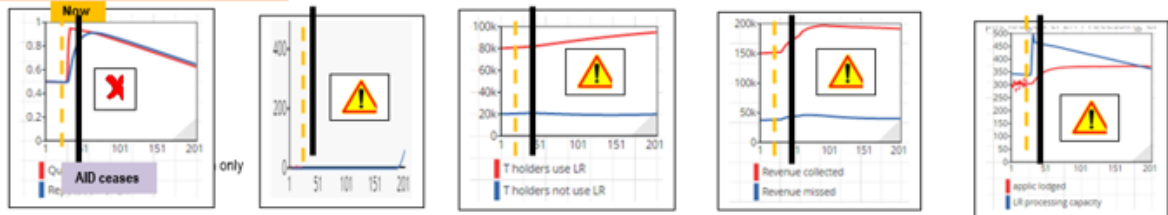
For a SCS of each PIP see Lyons (2022). An image of part of the built model is Fig 14.



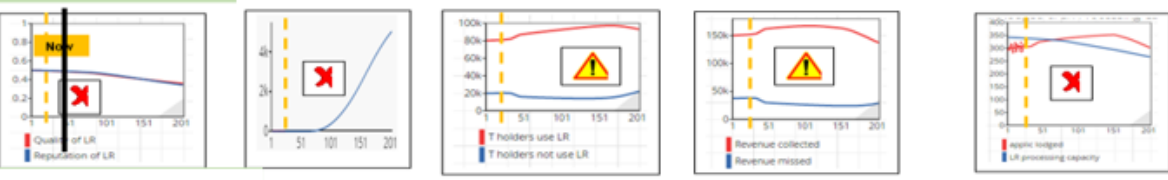
**Results from the model for testing PIPs** Fig 12 refers. Only 3 of 5 results shown here.



PIP 1- upgrade Quality ONLY



PIP 2- Winback ONLY

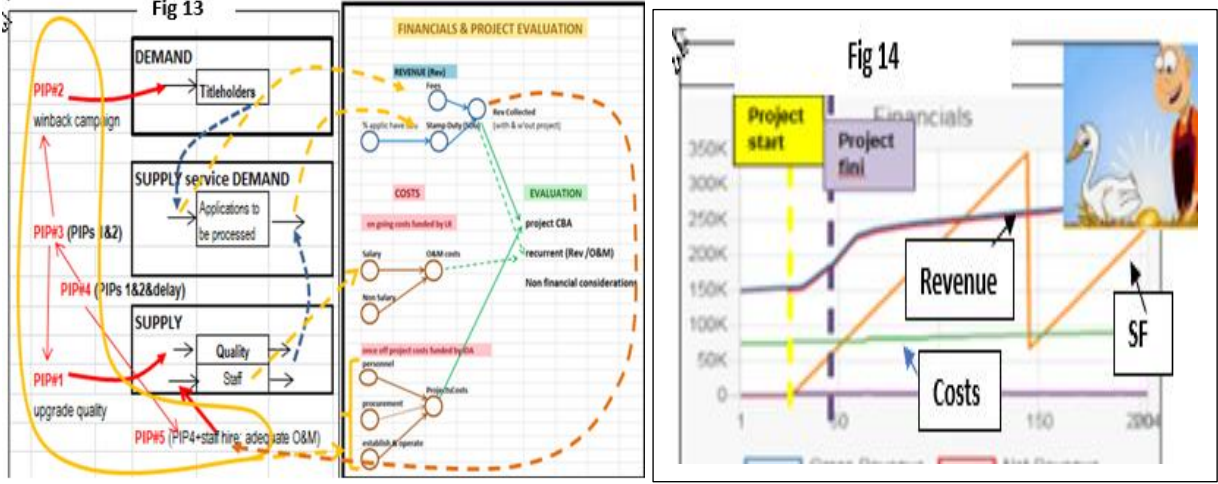


PIP 5- PIP 4 & use % of revenue to get adequate budgets



The improvement strategy should be based on PTI#5 as it is the only one where the model trajectories align with the desired future for the PIOs (POT graphs of Fig 10).

**Project Financials** - step 7 in the workflow for design/testing (Fig 4). Fig 13 shows the SCS of Fig 11 compacted to include financials. Fig 14 shows costs and revenues and SF balance. Benefit /Cost is 1.6 over 20 years and Revenue/O&M cost is 2.4



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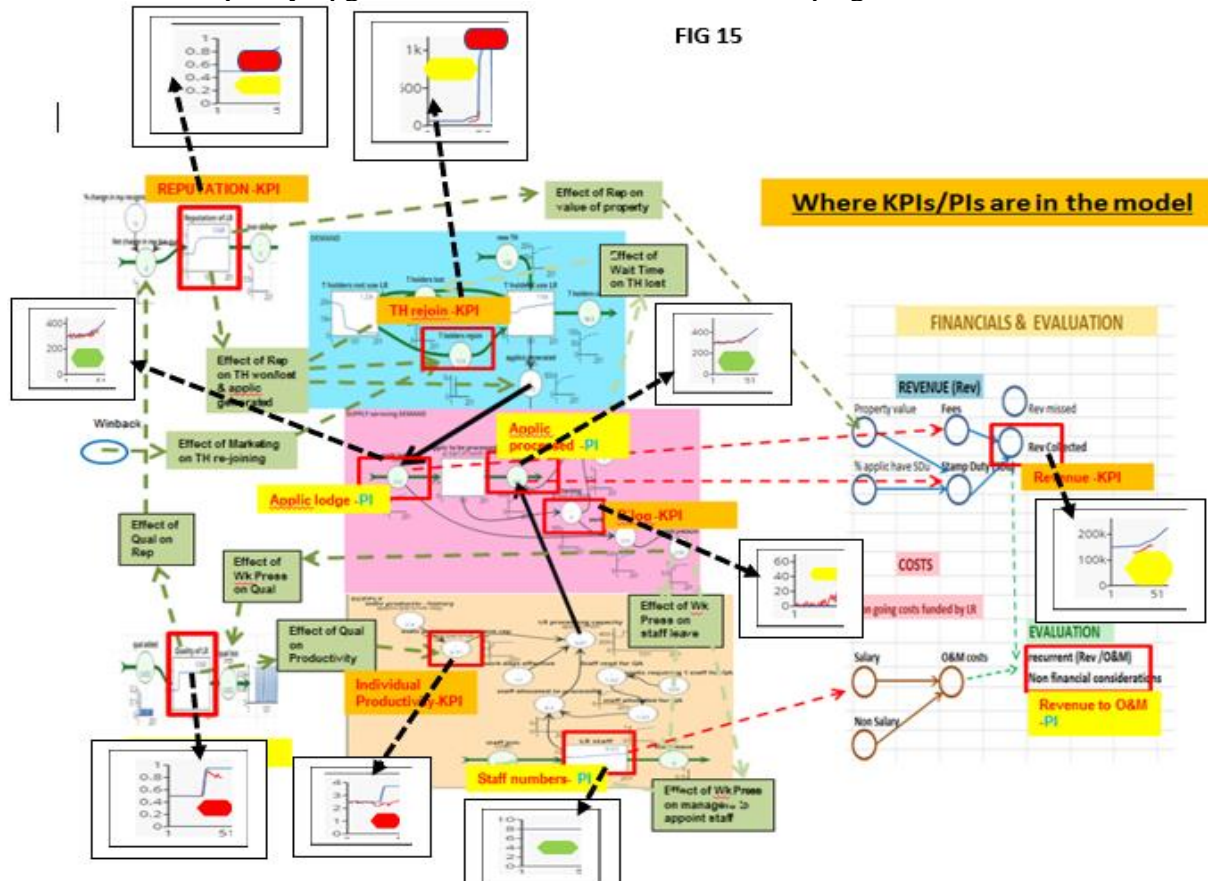
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**The improvement strategy in summary is:** 1. with aid - use TAs, Staff (temporary and permanent) to upgrade quality, conduct winback, increase staff skills and productivity, gain agreement to retain some revenue. 2. post aid - ensure budgets are adequate, maintain quality.

**4.3 Using the sim model as a living business model (LBM) during implementation** [Fig 5]

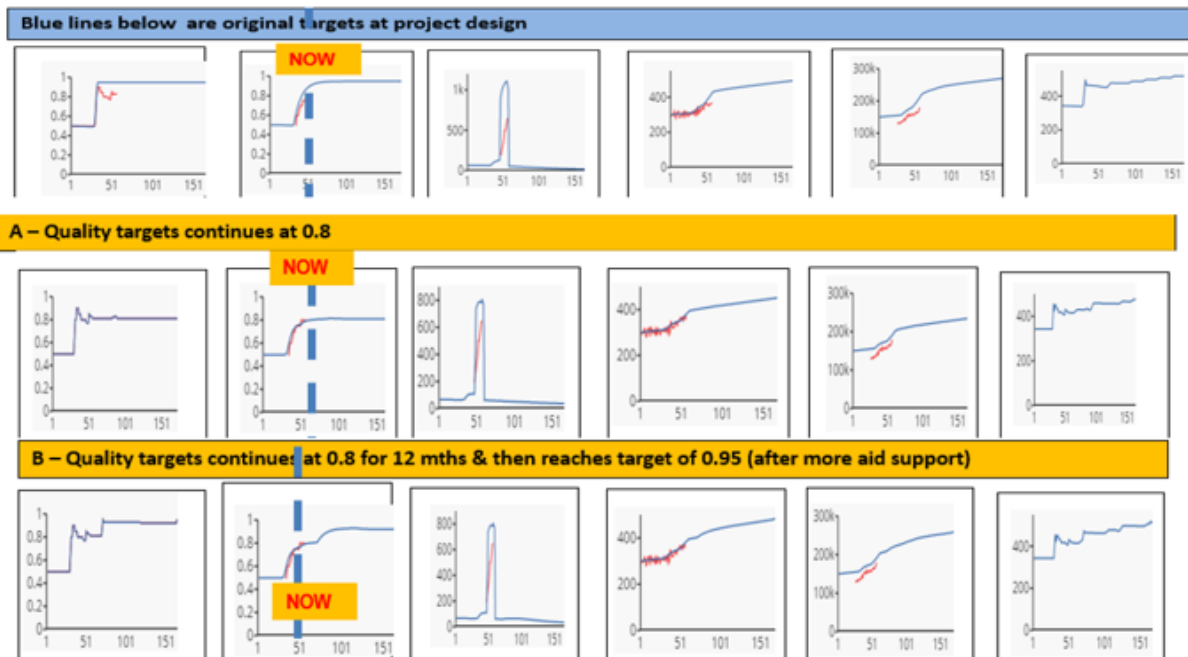
Fig 15 shows where KPIs/PIs are in the model. Also shown are POT graphs for KPIs/PIs showing actual performance (red lines) and targets (blue lines). The time is 7 mths after aid, 23 months after quality upgraded; 8 months after winback campaign finishes.



The colour of the “traffic light” in each POT graph indicates its performance status. **Red** is seriously below target viz Quality, Reputation, Individual Productivity, Titleholders who rejoin the LR. **Yellow** is of concern viz Backlog, Revenue. **Green** is targets largely being met viz Applications Lodged, Applications Processed, Staff numbers.

**Evaluate and revise performance targets if necessary** – Managers decided to explore two What ifs. What might be the target performance of dependent PIs if (A) quality stays at 0.8? (the current achieved level); or (B), continues at 0.8 for a further 12 months when it reaches 0.95? (due to further aid). Fig 16 shows model results for the two cases. The course of action selected is a management decision.

Fig 16 **Qual of LR** **Reputation** **THolders rejoin** **Applic lodged** **Revenue** **LR process capacity**

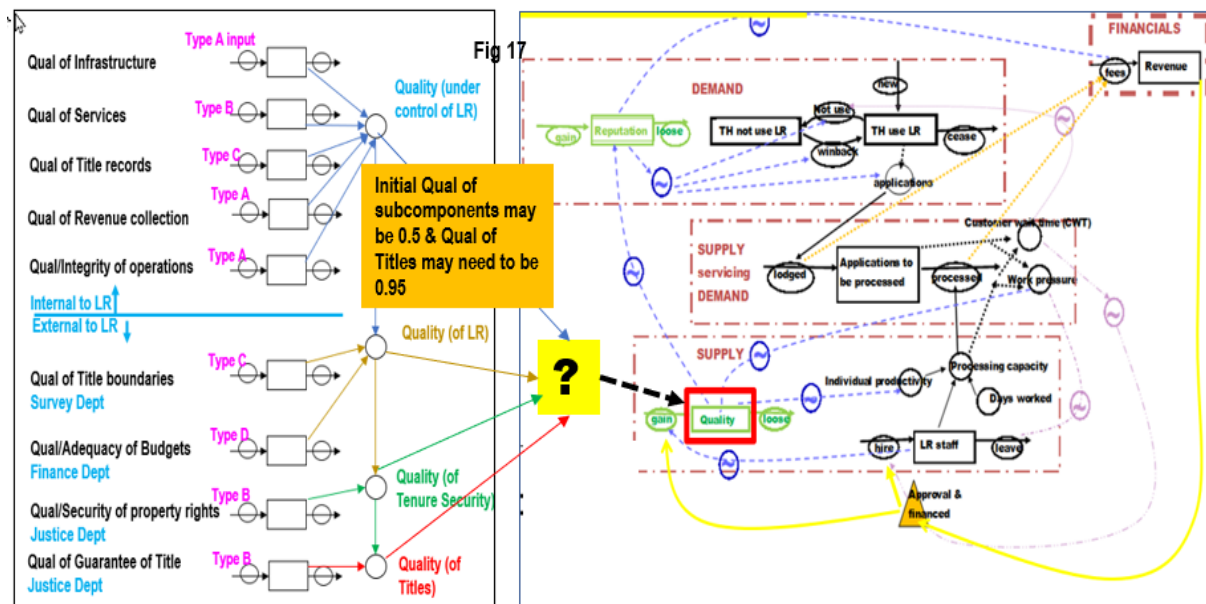


**Take home points Example 2- 1.** SD can be applied when multiple PIOs and a more complex system exists. **2.** Clarity on the PIOs and their POTs is important. **3.** Budgets can be adequate and improvements sustained if some revenue is reinvested. **4.** Using the model to identify KPIs/ PIs clearly identifies what affects what. **5.** The model can also be used as a LBM to assist implementation.

### 5.0 EXAMPLE 3 – IMPROVING QUALITY, WHERE QUALITY COMPRISES SUB COMPONENTS UNDER THE CONTROL OF DIFFERENT AGENCIES

**Aim -** To illustrate how quality can be treated when it has subcomponents under the control of different agencies. Includes the issues that arise.

**A SCS for incorporating subcomponents into “the system to be improved”** - Fig 17 shows the LR system of Fig 11, Example 2) on the right hand side, and the subcomponents of quality and the responsible agency on the left. Each subcomponent (assumed for the example) is shown as a stock with an inflow and outflow.



Depending on the combination of subcomponents, four different measures of quality could be calculated; viz Quality under control of LR; Quality of LR; Quality of tenure security; Quality of Titles.

**SCS of the inputs** to increase each quality subcomponent are not shown, for brevity. In some cases there is interdependency between subcomponents. e.g. quality of title records can only reach a certain value (say 0.7), without access to reasonable quality property boundaries, and then the two agencies working together to raise their subcomponent to say 0.95. Four SCS input structures (Type A,B,C,D) are annotated in Fig 17.

**Effort, cost and time required to increase quality** – To increase any of the four calculated measures of quality it is necessary to raise the quality of one or more subcomponents, (say from 0.5 to 0.95). The amount of work and cost to do this will likely vary markedly. These costs flow through to the various calculated measures of quality. Sufficient O&M budget is necessary to sustain each subcomponent’s quality. Extra budget may well be required.

**The Need for Clarity of the Aim and Expected Outcomes** when seeking to increase quality where quality has subcomponents - Table 1 shows some possible aims and outcomes.

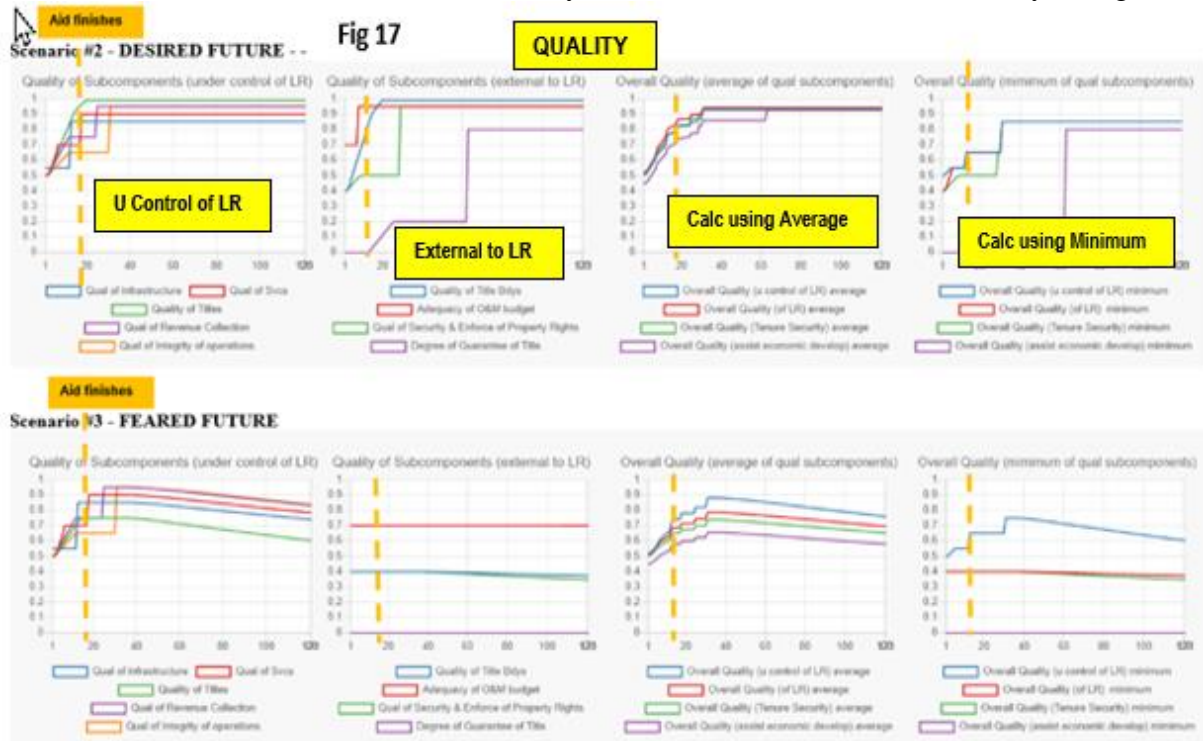
<b>Table 1: Possible Aim</b>	<b>Possible Outcome sought</b>
Increase quality in a single component	Meet an agency's internal business need
Increase quality in some subcomponents	Happier customers
Increase Quality (under LR control)	Win back titleholders not using the LR
Increase Quality (of LR)	To use some revenue to fund adequate budgets
Increase Quality (tenure security)	Titles accepted as providing secure rights
Increase Quality of Titles	Banks accept titles as collateral

The question then arises -which is the most appropriate measure of quality to be used to replace the previous single entity of quality.

A SD model was used to “explore” the scenarios in Table 2 and to better understand the ramifications of different aims and outcomes.

	<b>Table 2: Scenario Name</b>	<b>extra budget</b>
1	Base Case -Continue As Is	0%
2	Desired Future (all agencies participate)	100%
3	Feared Future (LR goes it alone)	0%
4	Justice alone does not participate	100%
5	Desired Future BUT delays doubled	100%
6	Desired Future but extra budget varies	varies widely

**Results from the Model for Scenarios-** only scenarios 2 and 3 shown for brevity in Fig 17.



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**The scenario results indicate** – that the desired future is the only one where quality targets are achieved and sustained. All others fall short by various amounts.

**Take home points – Example 3:-** **1.** SD models can be used to “explore”. **2.** The cost and time to increase “quality”, is dependent on the aim and outcome sought so it is vital to have clarity of the aim and outcomes sought, before commencing. **3.** Sustaining an increase in quality is largely dependent on having adequate budgets which may require approval to use some revenue. If quality is not sustained, the outcomes and initial investment will decay as shown in scenario 3, Feared Future, Fig 17. **4.** It would be prudent to have cooperation agreements settled with other agencies, including finance, before implementation.

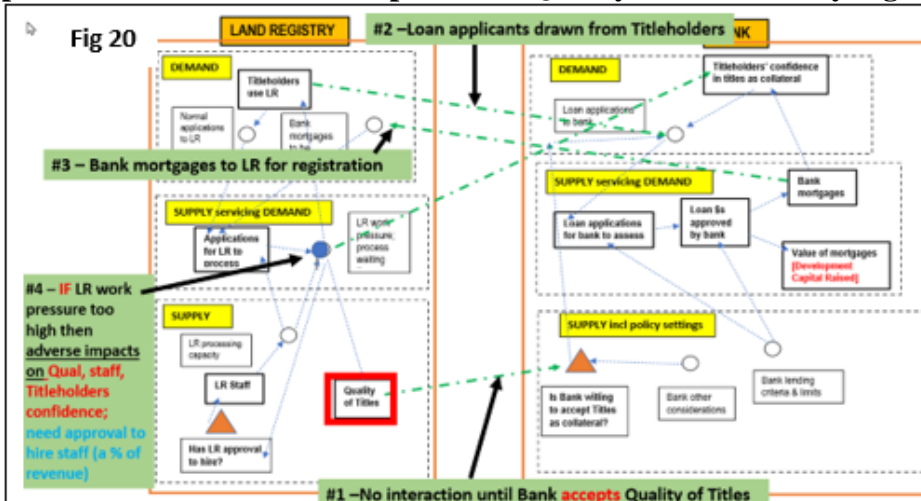
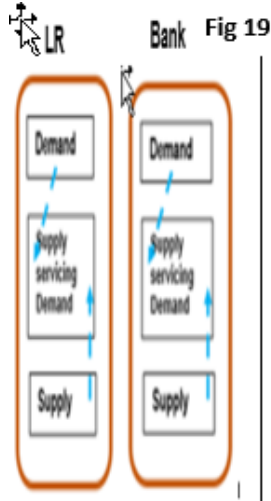
## 6.0 EXAMPLE 4 – RAISING DEVELOPMENT CAPITAL BY BANKS ACCEPTING TITLES AS COLLATERAL

**Aim** -To help provincial officials understand the development capital that might be raised if banks accepted titles as collateral, and what could happen if LRs could not maintain very high Quality of Titles [Little description is given as that has been provided in previous examples].

**PIOs-** **1.** Raise capital by banks accepting titles as collateral. **2.** Maintain *Quality of Titles* at a very high level. **3.** LR processing wait times stay low

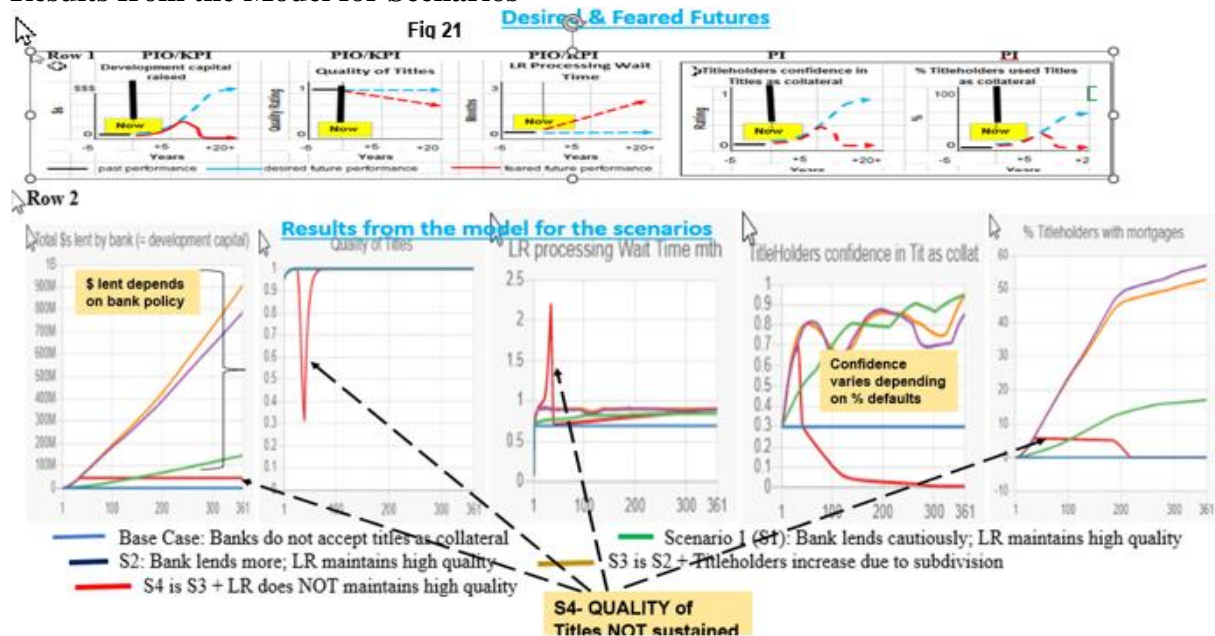


### SCS -Banks not accept titles      SCS - Banks accept titles if Quality of Titles is very high



**Scenarios - Base Case:** Banks do not accept titles as collateral; **S1:** Banks lend very conservatively, and LR maintains a very high *Quality of Titles*; **S2:** Banks lend less stringently, and LR maintains a very high *Quality of Titles*; **S3:** S2 + an increase in titleholders and LR maintains a very high *Quality of Titles*; **S4:** S3 BUT LR unable to maintain a high *Quality of Titles*

## Results from the Model for Scenarios



**Take home points Example 4 – 1.** Simulation can be used to “explore or better understand”. A more detailed model would be required if subsequent discussions with banks were encouraging. **2.** This model can be integrated with the model of examples 2 or 3 if required.

## 7. OTHER EXAMPLES

Other examples in Lyons (2022) are:- Addressing Informal Go Fast Fees; Skills development, increasing capacity; Options for IRPR (Initial Recording of Property Rights) re cost, time and human resources required; The scaling up of IRPR.

## 8. WRAP UP

### 8.1 How simulation models add value to current approaches

SD adds value to qualitative methods like the logframe and theory of change by:-

- Being quantitative; no implicit assumptions; handling indirect cause and effect
- Enhancing stakeholder buy in by showing *what* is to happen, *how*, by *when*
- Extending timeframes past the periods of aid, and examining sustainability post aid
- Containing all aspects in a single model; any change is immediately reflected throughout.
- Being able to use models in project appraisal, M&E, reviews, as well as in design

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- Models, being easily modified and components used in new situations.
- Being able to incorporate the pathways of FELA (Framework for Effective LA) and FFP

### **8.2 Conclusions re using simulation models for land administration improvement**

The examples, while illustrative, are drawn from the author's field experience. They are considered a "proof of application" of the use of simulation models for design, and as living business models (LBM) during implementation. It is not necessary to agree with the models illustrated. The important point is the SD approach, its principles and logic. It demonstrates that simulation models can be used to close a Capability Gap in LA development assistance. They offer a new tool for the LA toolbox.

### **8.3 Taking it further**

Time and effort needs to be invested to become familiar and proficient with the SD approach. Such investment is necessary for all new workplace tools, but yields a good return by increasing the likelihood of success. Further steps could be:-

- Form a community of interest in simulation for LA, perhaps as part of an existing initiative of FIG Commission 7. Such a community could include a university with postgraduates and a strong interest in LA in developing economies
- Develop an online/hybrid course to provide the knowledge and skills
- Apply the SD approach to some past and current LA projects and evaluate the results

### **REFERENCES**

Lyons (2022), Land Administration: Improve Performance by Testing, A Strategy Dynamics Approach, Special Reference to Developing Economies. <https://landadminsistemas.com> .  
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<https://strategydynamics.com/>

### **BIOGRAPHICAL NOTES**

Ken Lyons has had a long and varied career. In later years over 20 years working on land administration development projects in a variety of positions and countries. He holds Bachelor, Master and PhD degrees. He is an Emeritus Professor of the University of Queensland. After leaving academe he led his own consulting company for 30 years. His early career was as an Australian army officer specializing in surveying and mapping.

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