# THE ITO MODEL: A FRAMEWORK FOR DEVELOPING AND CLASSIFYING PERFORMANCE INDICATORS.

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This paper explores a tool that was built for use in a significant national performance indicator study. That tool, called the ITO model, offers a mechanism to explain how outputs and outcomes are related. It also provides a basis for the systematic classification of measures.

## Context.

Various studies have been undertaken over the past few years into different aspects of Australian social and industrial infrastructure. These projects have featured extensive work on performance measurement.

In 1992 AustRoads commissioned the author to lead a team charged with development of a set of performance indicators for both the Australian national road system and all State/Territory authorities.

Very early in this exercise the study team faced a problem which everyone involved in this area comes up against sooner or later - distinguishing between outcomes and outputs. While the linkages between inputs, processes and outputs are well understood, there appears to have been no correspondingly rigorous explanation of how outputs and outcomes are related. In many disciplines it appears as though the conventional wisdom was based on a rather hazy view that production of outputs in some sense automatically generated outcomes - but it was recognised that the production of outcomes is a less direct mechanism then the generation of outputs.

The author proposed a model for use in the AustRoads study which he called “The ITO Model (Input-Transform-Outcome Model)”. This proved to be an extremely valuable tool from a number of perspectives:

- It appeared to provide a plausible and useful explanation of how outputs and outcomes are related.
- It simplified the discussion of indicators for stakeholders in the study by clearly separating outcomes and outputs.
- It clarified the issue of accountability for outcomes versus outputs.

## The IPO model.

A discussion is appropriate of the traditional IPO (Input-Process-Output) model - one of the most fundamental and important of all descriptive tools. Various representations can be found in virtually every discipline. For example:

- In psychology it is the framework to describe stimulus-response phenomena
- In electrical engineering linear systems theory it provides the foundation for signal transforms.
- In software engineering it has been adapted for data flow diagramming.

The discussion then covers the ITO model as an elaboration and extension of the IPO approach.

The IPO framework simply links outputs to inputs via a process.

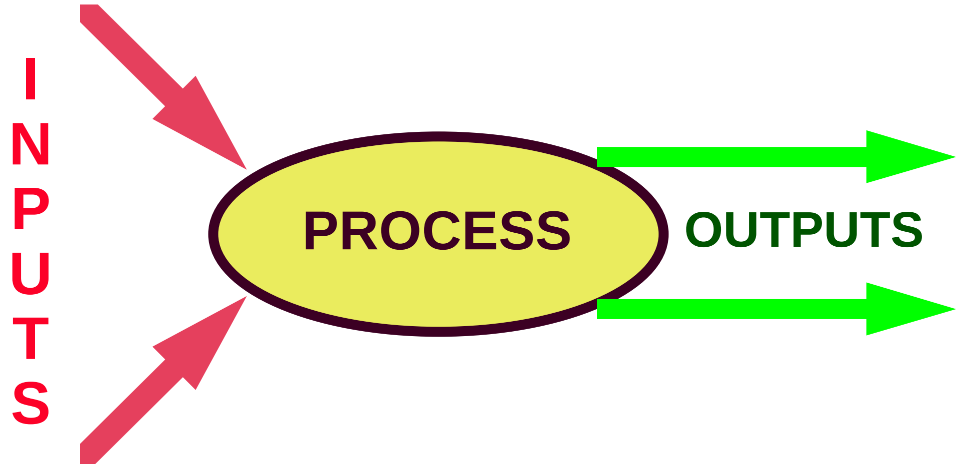


**Figure 1**

Figure 1 shows this concept in its most generic form. Because of fundamental changes sweeping modern capitalist democracies, there is an extraordinary interest in the efficiency of processes. Accordingly, in this paper we will confine our inputs to *those which are used up by the process concerned*. Thus while *policies* and *procedures*, for example, may well be regarded as inputs to some office process, we will not consider those as inputs in the following discussion because policies and procedures are not used up by the processes which refer to them. In this respect, our view of inputs is similar to that of economists where the focus of attention is on *allocation decisions* as far as scarce resources are concerned.

There are three points at which measures can be made in the IPO model.

- **Inputs** can be measured, for example the labour used up in a process.
- **Outputs** can be measured, for example the number of vehicles produced in a process.
- By linking measures of input with measures of output (usually in a simple ratio) we get an **efficiency** or **productivity** measure.

As far as performance measurement is concerned, the IPO model, while helpful, is severely limited because it goes only as far as describing **outputs**. It says nothing about the generation of **outcomes**. Processes are undertaken not to produce outputs per se, but to produce outputs which somehow contribute to outcomes.

In business we are ultimately concerned with **goals**. Goals can be expressed as the extent to which desired outcomes are generated. We make an assumption that outputs have something to do with the generation of outcomes and hence we consume resources in the production of outputs - driven by that ultimate goal.

The question immediately arises from this discussion "*Where do outcomes arise*?"

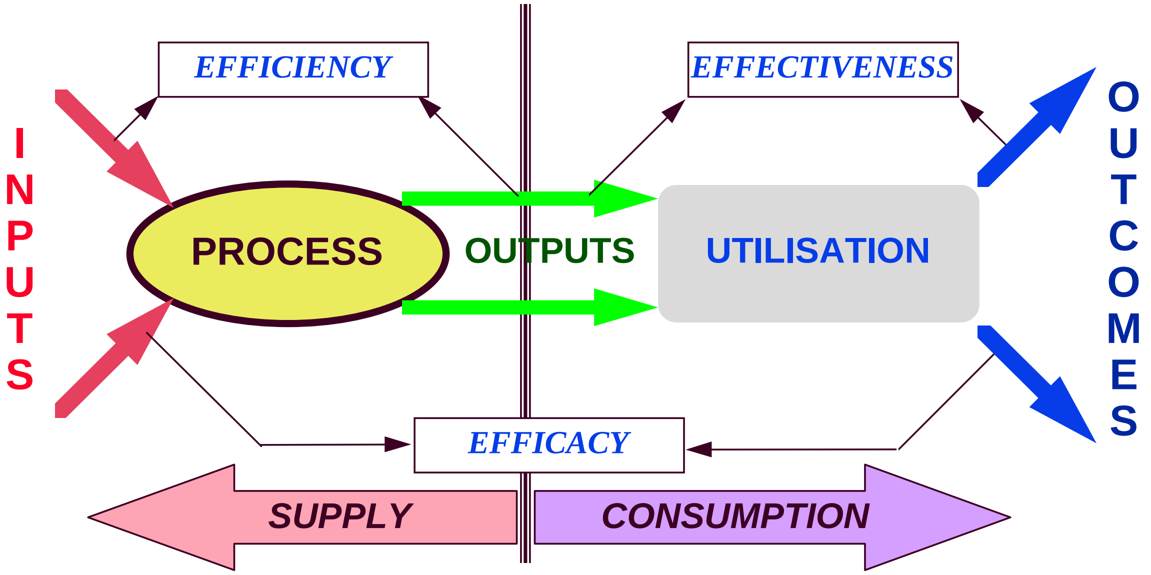


**Figure 2**

Figure 2 suggests an answer to this question. This is the general ITO model. It is divided into two parts, the left hand side being referred to as **supply**, the right hand side called **consumption**.

The left hand side is nothing more than the traditional IPO model. The right hand side incorporates an extension - of which the central component is a special mechanism called **utilisation**.

The ITO model proposes that *outcomes are the result of outputs being utilised by stakeholders*. The stakeholders who utilise outputs are, in general, not the same entities as those who manage the processes by which outputs are produced.

It now becomes clear why outcomes can often appear so tenuous and how their delivery can appear so difficult to achieve. Process managers can, at best, only **influence** utilisation. They cannot determine it, nor are they in a position to guarantee outcomes. As displayed in Figure 1 the ITO model shows a linear flow from outputs, through utilisation, to outcomes. It should be noted that, in general, outcomes may involve the utilisation of outputs from *more than one process*. In this general case, unless **all** of the outputs necessary to fulfil utilisation are available, then outcomes cannot occur. It should also be noted however that, even if all outputs required for utilisation are available, there is still no guarantee that outcomes will occur.

The ITO model suggests there are three conditions necessary for the delivery of outcomes.

- That **outputs** are completely *fit for purpose*
- That a **stakeholder** or (stakeholder groups) undertaking utilisation are *fully competent* to consume the available outputs
- That **external influences** (for example the weather) *do not inhibit* the way in which utilisation takes place.

Drawing on existing conventions, Figure 2 shows how **effectiveness** can be defined. Just as measures can be made of *inputs* and *outputs*, they can also be made of **outcomes**. Therefore if we take a measure of outcome and a measure of output and link them mathematically (usually by a ratio), the result is a measure of the *effectiveness with which utilisation* is taking place.

For completeness we have available to us a <u>third</u> derived measure in which a measure of *outcome* and a measure of *input* are linked. This is called **efficacy**.

The ITO diagram clearly illustrates why confusion often arises in selecting measures for a particular application. *There are as many measures of efficiency as there are pairwise relationships between outputs and inputs*. The same observation applies to effectiveness measures which are each the result of a single pairing of an outcome with an output. Similarly there are many possible measures of efficacy. Therefore in a real life case involving, say, two inputs, two outputs and two outcomes, there will be four measures of efficiency, four potential candidate measures of efficiency, four potential candidate measures of effectiveness and four potential candidate measures of efficacy. I refer to measures of inputs and outputs and outcomes as **primary measures** while those of efficiency,. effectiveness and efficacy are termed **secondary measures**.

The right hand side of the diagram has been labelled as *consumption*. Consumption is the mechanism of *converting sets of available outputs into desired outcomes*. Those outcomes could be of interest to the consuming stakeholder but they could also be outcomes that are of interest to other stakeholders.

Effectiveness in common language is often applied to *outputs* rather than to the *mechanism of utilisation*. The ITO model appears to cope with this semantic problem in the following way. As was pointed out above, the three determinants of success with utilisation are; output quality, stakeholder competence and external influences. It is proposed within the ITO model that where utilisation is discretionary then effectiveness is ambiguous in its meaning. High or low effectiveness measures could result from any combination of; *the behaviour of the consuming stakeholder*, the *quality of the output* (as utilised by the stakeholder) or *changed external influences*.

To summarise the concepts of supply and consumption:

- Supply is the production and delivery of specified outputs to a consuming stakeholder - that is a customer. The supplier is defined as the process manager. The supplier is accountable for both the efficiency of the processes involved and for the quality of the outputs delivered. By quality here is meant the compliance of output attributes with those specified by the customer.
- Consumption on the other hand is the utilisation of outputs by a consuming stakeholder to generate outcomes. The stakeholder utilising outputs to generate outcomes is called the customer. The customer is accountable for specifying outputs which are fit for purpose and also for the effectiveness with which utilisation is carried out.

## Illustrations of the ITO model.

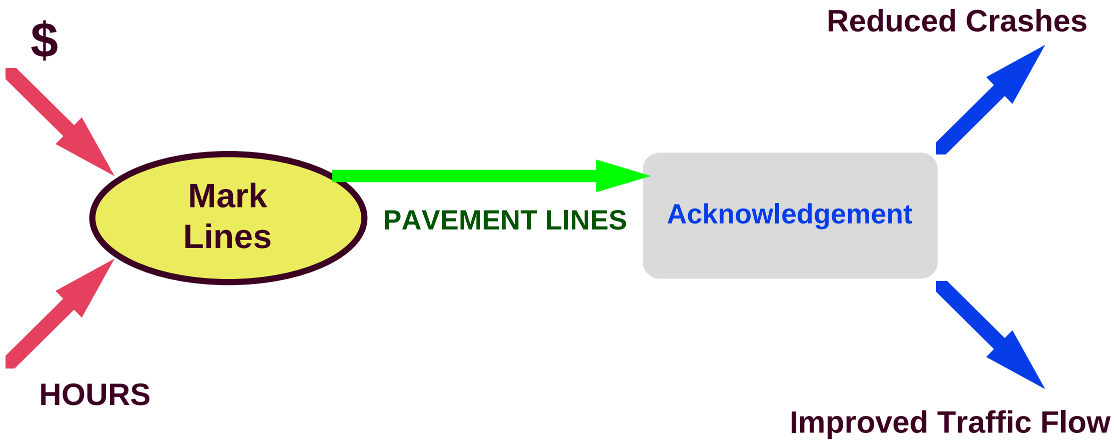


**Figure 3**

Figure 3 shows an ITO representation of a roads based process and utilisation. In this case the process is identified as **mark lines**. The inputs are **funds** and **labour**. The output is **pavement lines**. **Utilisation** takes the form of compliant (or non-compliant) behaviour on the part of the driver. This behaviour is called *acknowledgement* in the figure. Two representative outcomes displayed - **reduced crashes** and **improved traffic flow**.

| ELEMENT | SAMPLE MEASURE |
|---|---|
| Input | funds |
| Process Efficiency | lane kilometres / dollar |
| Output | kilometres of fully marked lane |
| Utlilisation Effectiveness | crashes / lane kilometer / year |
| Outcome | crashes / year |

**Table 1**

Table 1 suggests a number of measures relevant to this illustration. The table of measures could be extended to include efficacy (for example **reduced crashes per dollar** spent on linemarking). This has not been included here because of the extremely tenuous linkage between road crashes and money spent on linemarking alone.

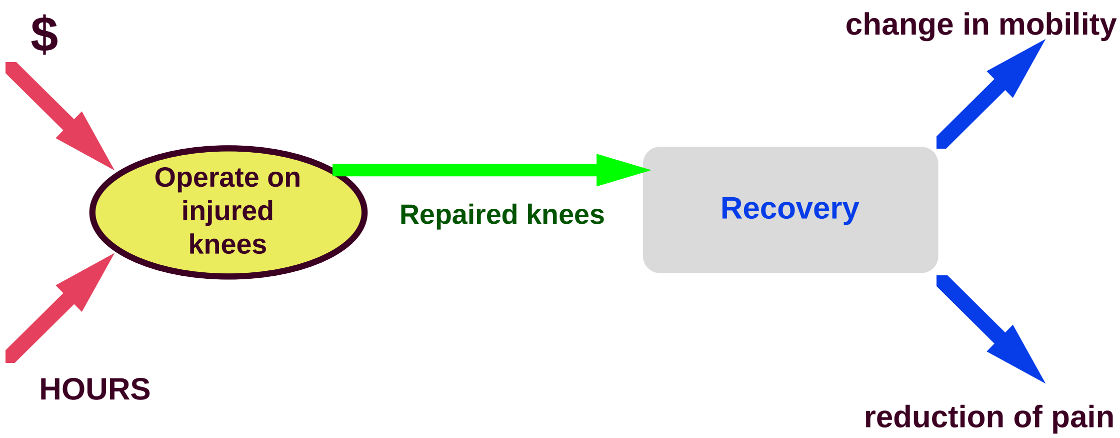


**Figure 4**

| ELEMENT | SAMPLE MEASURE |
|---|---|
| Input | funds |
| Process Efficiency | dollars/operation |
| Output | count of completed operations. |
| Effectiveness of repair | change in mobility / operation |
| Outcome | change in mobility |

**Table 2**

Figure 4 and Table 2 provide corresponding information for a health based illustration of the model. Efficacy could again be measured here by the change in mobility after the patient’s recovery is complete divided by the labour that went into the operation itself.

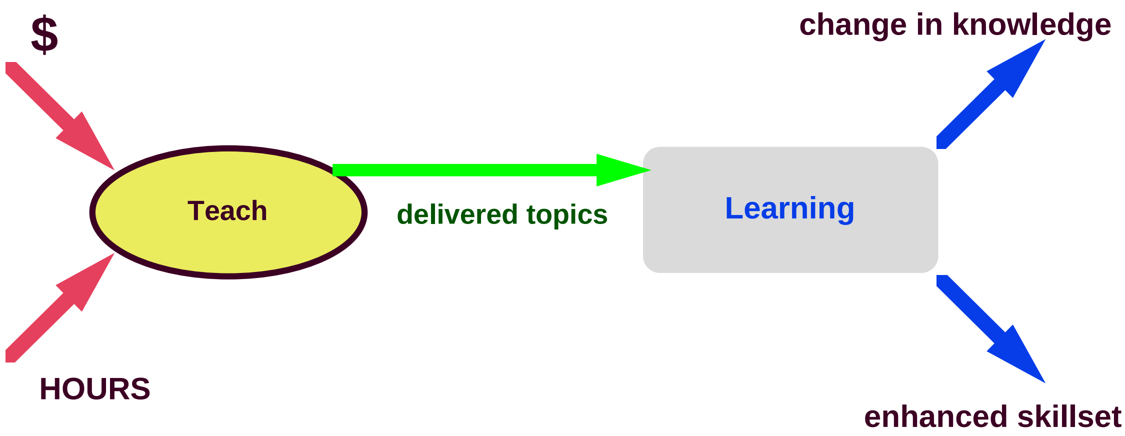


**Figure 5**

| ELEMENT | SAMPLE MEASURE |
|---|---|
| Input | (teacher) hours |
| Efficiency of teaching | delivered topics / hour |
| Output | count of delivered topics. |
| Effectiveness of learning | change in knowledge / delivered topic |
| Outcome | change in knowledge |
| Efficacy of class | change in knowledge / (teacher) hour |

**Table 3**

The third example provided here is displayed in Figure 5 and Table 3. In this case we have drawn from education where the process is **teach** for which the output might be defined as delivered topics. Utilisation here is **learning**. In the measurement table the efficacy definition appears particularly appropriate because in this case it would give rise to the **efficacy of the class**.

## Perfect versus partial measures.

The question now arises - *how valuable are these pairwise measures and how do they relate to what we might see as being intrinsically perfect measures*? If we had a **model** of a system involving multiple outcomes, multiple utilisations, multiple outputs, multiple processes and multiple inputs, the parameters of such a model would give us access to the individual and collective contributions of each input to each output, and each output to each outcome in each utilisation. Therefore armed with a model, given any mix of inputs we could predict (with perfect accuracy) all the resulting outcomes from:

- Use of those inputs in processes
- Subsequent utilisation of outputs by consuming stakeholders.

The model would yield what are called **total performance measures**. In economics the field known as *production theory* is rich with conceptual mechanisms of this kind. Total performance measures are **perfect measures**.

The author's experience with performance measurement suggests that, when organisations embark upon performance measurement studies, sponsors of such projects appear to be driven by the belief that perfect measures do exist and that the performance measurement exercise is really in the nature of a hunt. If the hunters arrive back at camp at the end of the day with no perfect measures then clearly they have either been incompetent or they have not conducted their hunt in an appropriate way. The reality, however, is that perfect measures require perfect system knowledge and in general this is something we do not have. Because we don't have perfect systems knowledge we don't have the data to build models. Without models we cannot develop total performance indicators. Without total performance indicators we have no perfect measures.

We are therefore confined to a set of partial or imperfect measures. In what way are the measures of real life *partial* or *imperfect*? In terms of the ITO model we are limited to *primary* measures (which are measures of single variables) and *secondary* measures which involve simple operations on pairs of variables. There is no mechanism at our disposal, for example, developing measures which involve, say, three variables. To do so would require a model, and again we run up against the problem of generally having no information to build models.

Partial measures give us very restricted pictures of what is going on in the underlying real model. The multi dimensional features of the underlying model are not available to us and so we are restricted to one or two dimensional representations. This problem is somewhat akin to that faced by engineers who are required to represent the three-dimensional world in which they work on basically two-dimensional drawings or CAD screens. Because our measures are partial, we, like the engineer, must seek to address the limitation of our measures by using *a number* of complementary measures - in place of the *single* model that we would otherwise use.

## Criteria for selection of PIs.

How can we determine the appropriateness of a candidate set of PIs for a particular measurement problem? It would appear that there is still a lot of work to be done here however experience to date suggests that a number of criteria can be applied to generate useable PIs. Amongst this list the following are prominent:

- **Simplicity**. Is the PI readily interpreted by those for whom it is intended?
- **Acceptability**. Is this PI acknowledged by its user as a relevant measure?
- **Completeness**. Do complimentary partial measures adequately cover a particular need?
- **Directionality**. Is the direction of desirable movement obvious?
- **Attributability**. In ratio measures are the components related by cause and effect?
- **Usefulness**. How well does a proposed PI support decisions?
- **Cost**. How much does this PI cost to implement and use?
- **Parsimony**. How small can we make the proposed set if PIs for a particular need?

## Conclusion.

The ITO model builds on a number of established concepts to offer an explanation of the relationships amongst *inputs*, *processes*, *outputs*, *utilisation* and *outcomes*. The claimed novelty of the device surrounds utilisation - whereby stakeholders produce outcomes by applying particular *outputs*. The experience to date suggests that the model is helpful as a tool in both the development and analysis of performance indicators.