System Archetypes as a Learning Aid Within a Tourism Business Planning Software Tool

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ABSTRACT

Various studies have identified a need for improved business planning among *Small-to-Medium Tourism Enterprise (SMTE)* operators. The tourism sector is characterized by complexity, rapid change and interactions between many competing and cooperating sub-systems. System dynamics (SD) has proven itself to be an excellent discipline for capturing and modelling precisely this type of domain. In this paper, we report on an SD-based *Tourism Enterprise Planning Simulator (TEPS)* and its use as a learning aid within a business planning context. Particular emphasis is focussed on system archetypes.

Keywords: tourism, business planning software, system dynamics.

1. Introduction

In a recent study conducted for the Australian *Sustainable Tourism Cooperative Research Centre (STCRC)*, improved business planning was identified as one of the most pressing needs of *Small-to-Medium Tourism Enterprise (SMTE)* operators (McGrath, 2005). A further significant problem confronting these businesses was coping with rapid change: including technological change, major changes in the external business environment, and changes that are having substantial impacts at every point of the tourism supply chain (and at every level – from international to regional and local levels).

As a result of these findings, the STCRC provided funding and support for a follow-up research project aimed at producing a *Tourism Enterprise Planning Simulator (TEPS)*. Distinguishing features of TEPS are:

- Extensive use is made of system dynamics (SD) modelling technologies and tools (for capturing and simulating key aspects of change).
- The enterprise simulator sits inside a destination-level simulator. In this way, TEPS addresses a major problem associated with the multitude of generic, low-cost business planning tools available – namely, they fail to take into account tourism-specific, contextual factors.

- TEPS operates at different levels of granularity. At the very fine-grained level, actual data is used to establish relationships and to instantiate model variables. At the more coarse-grained levels, a restricted set of destination archetypes is induced and users assign values to variables through an ‘impressionistic’ (or fuzzy) process.
- Artificial intelligence tools (such as rule-based deductive inference, case-based reasoning and fuzzy logic) are used to complement the base SD technology employed.

An account of the development, validation and potential use of TEPS is presented in (McGrath, 2006). In this paper, we focus on how SD archetypes might be employed to instruct users in the hidden complexities of many socio-economic systems (in this case, tourism) and, in particular, on how well-intentioned actions may sometimes lead to unintended consequences (Senge, 1990: 378-390).

The paper is organized as follows: In the following section, the motivation for our work is briefly presented and then, in Section 3, the TEPS model and simulator is overviewed. In Section 4, the four SD archetypes currently implemented within the simulator are described in some detail. Model validation is then briefly discussed in Section 5 and concluding remarks are presented in the final section.

2. Motivation

The lack of a strategic approach to running their businesses has long been recognized as a problem among SMTE operators (see e.g. Sharma et al., 2000; Morrison and King, 2002; Mistilis et al., 2004). In particular, Morrison and King (op. cit) characterised most SMTE operators as “lifestylers”, mostly on their second (or later) career, with little exposure to business fundamentals and technology, having a real distrust of bureaucracy and governments, and having little involvement in regional or local affairs. Morrison and King’s focus was on acceptance of new technology and, in a more recent piece of research addressing the same issue, Mistilis et al. (2004) identified the lack of a strategic focus as the main impediment to the uptake of online technologies among Sydney hotel operators. Nevertheless, there are indications that things might be changing for the better and, in our earlier study, one State Tourism Authority (STA) representative asserted that:

> *Not a day goes by when we are not approached by at least a couple of prospective operators looking for help with their business planning. --------- You can look at business planning as,*

> *maybe, a 14-16 step process. We talk to them [prospective operators] at Step 1, and the next time they hear from us is after they are established. Then, we are asking them for information! We need to do more for them.*

(Interview, 2004)

Thus, at least some SMTE operators are looking to improve their business planning and, given the high rate of enterprise attrition in this sector (Baker, 2000; English, 1995), some attempts have been made to provide the necessary support. For example, the *Decipher* tourism data warehouse (Carson and Richards, 2004) provides business planning support through its website, Tourism Victoria is planning to implement a similar product and the STCRC has recently released a business planning ‘toolkit’ for property owners considering ‘Farm and Country Tourism’ ventures (Fausnaugh et al., 2004). TEPS is intended to complement these products (the current intention being to eventually implement it within Decipher).

3. *TEPS:* An Overview

The bulk of the TEPS model is specified and implemented within a SD framework. A knowledge base, implemented primarily as rules, sits within the SD framework and is called to perform specific functions (such as the calculation of certainty factors based on a fuzzy logic approach). Values returned from the knowledge base component are used to dynamically instantiate variables within the SD model.

SD goes back to the work of Forrester (1961) and has proven to be an excellent formalism for capturing and modelling change. Over the past ten years or so there has been a resurgence of interest in SD – in part, because of the advent of a number of excellent modelling and simulation software products (such as *iThink, Vensim and Powersim).* The usual approach in developing a SD model though, is to: i) specify the problem domain as a *causal-loop diagram (CLD);* and, then, ii) implement it in the slightly more complex *stock-flow* syntax employed by the software packages listed above, Here, because of space limitations, we restrict ourselves to a (simplified) CLD representation of our domain and this is illustrated in Figure 1.

The diagram represents one view of the classic sustainable tourism conundrum where, ideally, development and preservation of the natural environment should be in balance. While our representation is a long way from complete, it has been 'tweaked' to make it a little more realistic. It also has more of a focus on tourism *enterprises* than other, similar models we know of – which aim to model tourism dynamics primarily at the destination level (see e.g. the *Tourism Futures Simulator* SD model produced by Walker et al., 1999).

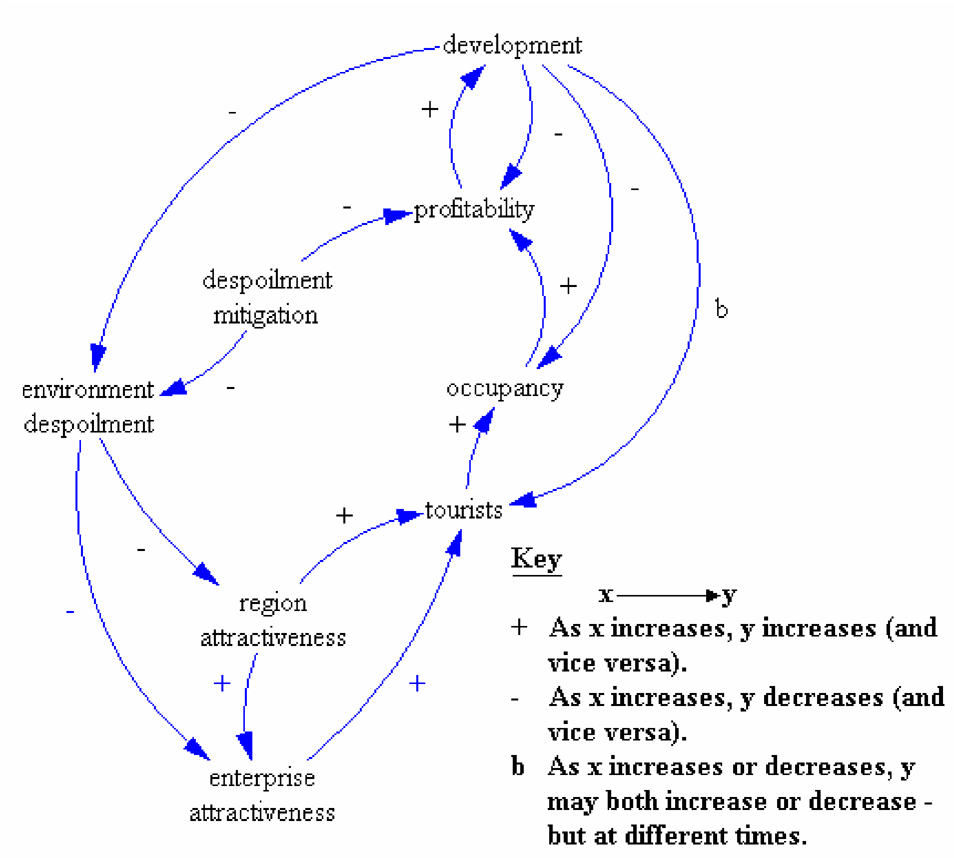

Figure 1: *System dynamics representation of some critical factors associated with tourism enterprise profitability within a regional context.*

Region attractiveness is at the heart of the model presented in Figure 1. An attractive region makes local enterprises more attractive themselves and, together, region and enterprise attractiveness lead to more tourists. More tourists result in healthier room occupancy rates and (with qualifications) this, in turn, improves enterprise profitability. As enterprises become more profitable, more development takes place and, up to a point, developed regions and enterprises will draw even more tourists, resulting in a classic reinforcing loop. This, of course, holds true only to a point as, consistent with the 'tourism life-cycle model' (Butler, 1980), over-development eventually leads to a tourism decline. (This accounts for the *b* annotation on the *development* → *tourists* link in Figure 1.) Reinforcement is also moderated by the tendency of development to impact negatively on both enterprise profitability and occupancy rates.

In addition, development leads to environment despoilment and, in turn, this detracts from both region and enterprise attractiveness. Thus, with the addition of this balancing loop, we now have the essence of the classic sustainable tourism model (Ritchie and Crouch, 2003). Damage to the environment, however, may be limited by appropriate mitigation measures. There is a cost associated with effective and committed environment despoilment mitigation though and, ultimately, part of this must be borne by local tourism enterprises (as indicated by the *despoilment mitigation* → *profitability* link in our diagram).

4. System Archetypes

The model presented in Figure 1 is specified at a very-high level. Already though, a degree of complexity is apparent and this illustrates one of the benefits of SD modelling as claimed by its proponents: specifically, the approach can counter our tendency to over-simplify complex problems and issues into simple cause-effect relationships we can readily understand within the limits of our cognitive powers (Vennix, 1996). Of course, this is true of many conceptual modelling approaches and each of these have their own strengths and weaknesses. SD, however, is particularly well-suited to domains where feedback loops and time are significant (Richardson and Pugh, 1981) and both of these feature prominently in tourism models (see e.g. Ritchie and Crouch, 2003: 60-78).

A further strength of SD models is that, in basic CLD form, they are comprised of combinations of only one, simple construct (a causal connection between two variables), meaning that key stakeholders and end-users may readily contribute to modelling sessions. As noted earlier, CLD models are generally implemented in the stock-flow form favoured by the more popular SD software packages. This increases complexity but it also enables the specification of critical concepts such as delays, queues, events and major environmental perturbations (e.g. the impacts of SARS or the recent, dramatic increase in global oil prices).

At the same time, the more variables a problem has, the more difficult it is to solve. In fact, problem difficulty tends to increase exponentially with the number of variables. Thus, (seemingly) simple systems can rapidly become very complex – and even our gentle introductory example above should leave little doubt that, in tourism, we are dealing with a very complex system.

Nevertheless, systems thinking researchers have found that, even in extremely complex SD models, certain patterns recur time and again. In addition, such patterns are often associated with specific types of system behaviour and this, in turn, can sometimes alert us to tread warily in our decision making. In the SD literature, these generic patterns are referred to as *system archetypes* (Maani and Cavana, 2000; Bellinger, 1999) and a thorough understanding of these improves our ability to both: i) understand how systems work; and, perhaps more importantly, to: ii) comprehend and interpret the consequences of our decisions. There are eight generally-acknowledged basic SD archetypes, first identified by the 'System Dynamics Group' at MIT. The TEPS model contains a number of these classic archetypes and we investigate four of these further in the remainder of this section (in 4.1 to 4.4 inclusive).

4.1 The *Fixes that Fail* System Archetype

The *fixes that fail* archetype is a generic instance of a fairly simple (but common) problem, where a fix designed to alleviate some problem (real or perceived) results in unintended consequences. These consequences counteract the intended fix, with the result that no real progress towards a fundamental solution is made.

In our TEPS example, we look at a case where the user plays the role of a prospective hotel/motel operator intending to set up in a rural region: i) where there is not much available in the way of good tourism and hospitality (T&H) staff; and ii) where the user intends to compensate for this through intensive (and ongoing) training. To investigate the consequences of this, the user is invited to: set

Region to *Rural; HR Quality* to *Poor;* and, finally, run the simulation several times alternating the *Training Commitment* parameter between *Significant* and *All out.* Typical results of this exercise are illustrated in Figure 2.

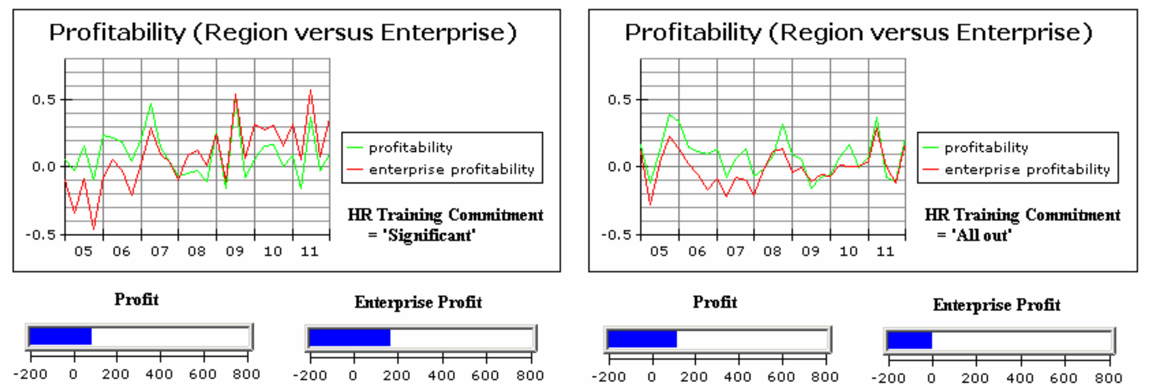

Figure 2: *Typical outputs from running the TEPS 'fixes that fail' archetype example.*

In general, simulations with a significant training commitment outperform those where the parameter is set to 'all out'. In particular, with the former, enterprise profits (i.e. profits for the user's hotel/motel) outperform the average profit performance for the region while, with the latter, the reverse is generally true. So, what has occurred here: i.e if 'significant' training produces goods results, would it not be reasonable to expect that more training should produce even better results?

In fact, this is a typical case of the 'fixes that fail' systems archetype and our specific case is illustrated in the CLD presented in Figure 3. Essentially, the user (playing the part of the prospective operator) knows that there are only relatively poor T&H staff to draw on and, consequently, commits to a major training program. After some delay, this development program improves the quality of staff and, in turn, this improves enterprise profit – assuming (as we do) that the net benefit outweighs the program's costs.

However, if too much is spent on training (with training commitment set to 'All out'), an unintended consequence may eventuate: specifically, staff have been trained to a point where their skills are much sought after and our user's enterprise will begin to lose them because of: i) poaching by local competitors; and ii) the attraction of better jobs in other (perhaps, more attractive) regions. Essentially, our user has borne all of the costs of the staff development program and reaped few of the benefits: by going 'all out' with staff training our user has, in fact, gone too far! Thus, as indicated in Figure 3, 'staff losses' is the unintended consequence that has foiled our user's attempt to cope with his/her problem in this 'fixes that fail' system archetype instance.

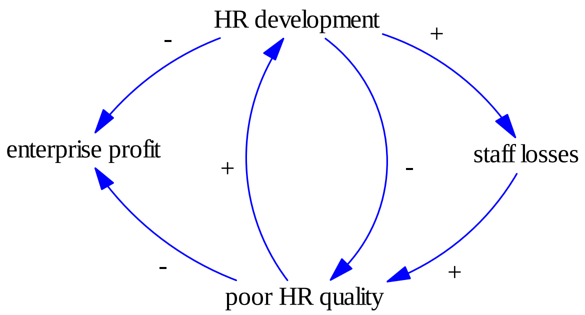

Figure 3: *'Fixes that Fail' archetype – unintended consequences of staff training.*

4.2 The *Shifting the Burden* System Archetype

With the *shifting the burden* archetype, problem symptoms are addressed in lieu of more fundamental solutions. Generally, this occurs because symptoms can often be dealt with more quickly, conveniently and cheaply than the underlying problem. This is similar to the 'solution by oversight' concept within the *garbage can* organizational decision-making model of Cohen, March and Olsen (1972), where 'non-problems' are tackled (at the expense of real ones).

This time, we look at an example of a motel in a coastal region, where commitment to environment despoilment mitigation has been minimal. As a result, region attractiveness (and, with it, enterprise profitability) have been declining over time. To arrest this decline, regional authorities have initiated a series of marketing campaigns. To investigate this example the user sets: *Region* to *Coastal; Marketing Boost* to *On;* and *Environment Commitment* to *Minimal* or *Nil.* An output from a simulation run is illustrated in Figure 4.

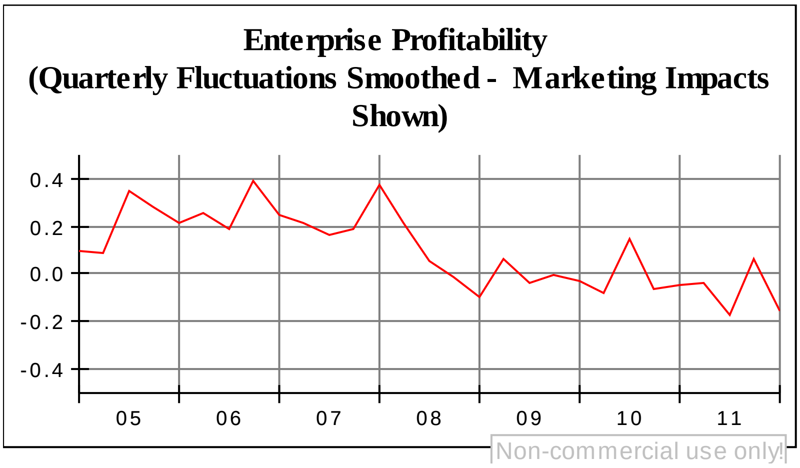

Figure 4: *A typical output from the 'shifting the burden' archetype example.*

Here, the enterprise profitability graph has been smoothed to eliminate seasonal fluctuations and we can see that each marketing campaign leads to a short-term improvement followed by a return to the longer-term downward trend.

The CLD representation for this example is illustrated in Figure 5. The essence of this archetype is that many (if not most) of us have a tendency to ignore long-term solutions to fundamental problems in favour of quick fixes. Thus, the regional marketing campaigns produce good results initially but the overall enterprise profitability downward trend still remains: the reason being that short-term benefits have produced an unfortunate reliance on marketing campaigns and, as a consequence, key regional stakeholders perceive less need to address the fundamental problem of the environment.

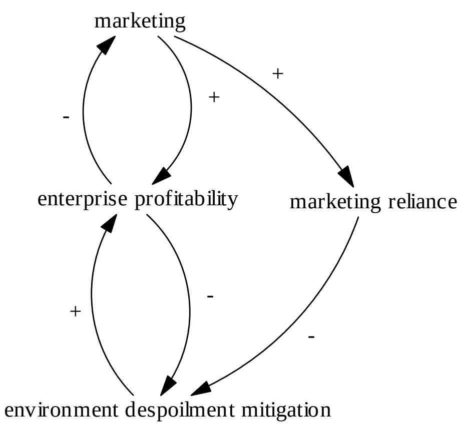

Figure 5: *'Shifting the Burden' archetype – an over-reliance on marketing.*

This is analogous to a person with an anxiety disorder. That is, if sedatives are prescribed, he may get some short-term relief but this also increases his dependence on the prescribed drugs – and, at the same time, decreases his immediate need to seek a solution to the underlying problem. The end result is that he gets more and more dependent on the short-term fix but no better (Karlins and Andrews, 1973).

4.3 The *Limits to Growth* System Archetype

The basic *limits to growth* structure consists of a 'reinforcing' (or growth) loop which, after a period, is neutralized by the action of a 'balancing' loop.

In this case, our user plays the part of a motel operator established in a region where the overall level of profits has been low and the quality of T&H staff within the region is fairly poor. Rather than undertake a staff development program, our user decides to try and lift profits through more intensive marketing. To see what might happen here, we initialize the simulator's control panel as follows: set *HR Quality* to *Poor; Training Commitment* to *Minimal;* and *Marketing Commitment* to *Significant* or *All out.* Graphical output from a typical simulation run with these settings is displayed in Figure 6.

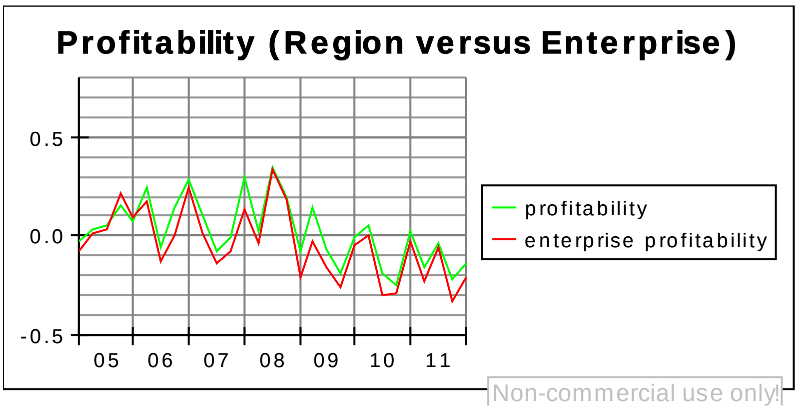

Figure 6: *Sample output from the TEPS 'limits to growth' archetype example.*

Again, as with the 'shifting the burden' archetype, we can see that each marketing campaign results in a short-term improvement. Also, our profitability seems to improve a little – at least, for a while. The overall trend, however, is not good and it is probably fair to suggest that the strategy (of emphasizing marketing at the expense of staff development) has not been a great success. In fact, what is occurring here is that the poor quality of the available staff is acting as a growth (and profit) inhibitor. This is illustrated in the CLD representation of the example, presented in Figure 7.

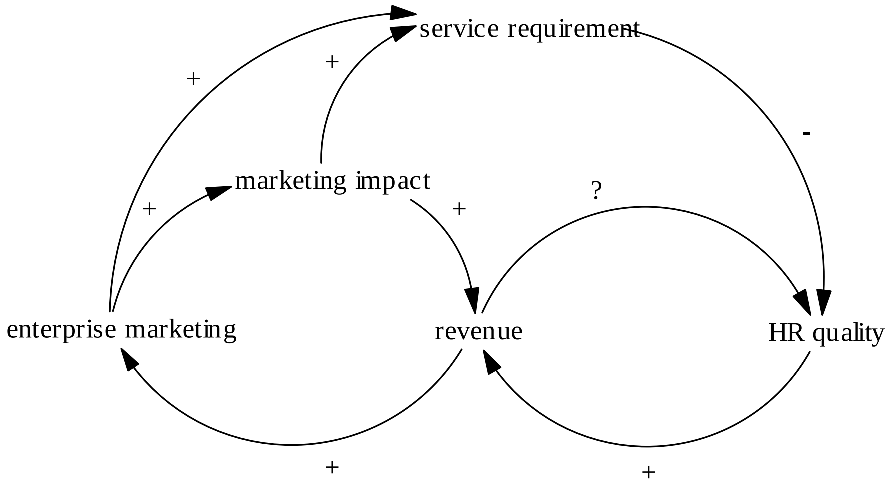

Figure 7: *'Limits to Growth' archetype – HR quality limits the impact of marketing initiatives.*

In the lower part of Figure 7, we have two 'virtuous' (or reinforcing) loops. Here, the more marketing we do, the greater its impact and this increases our revenue. The more revenue we have, the more we are (potentially) able to spend on HR development and, thus, improve the quality of our staff. However, we have chosen not to do this and, so our staff quality remains poor. At the top of the diagram though, we can see that the impact of our marketing results in greater demands for service. In turn, this will further worsen our already poor HR quality and, as with the 'fixes that fail' archetype (see Section 4.1), this will eventually have an adverse effect on revenue. In short, all the money that has been spent on marketing has been wasted because the poor quality of our staff limits our ability to satisfy the extra customers we have attracted.

4.4 The *Niagara Effect* System Archetype

The *Niagara effect* is typically concerned with a situation where some fundamentally important activity is neglected for an extended period and where problems are masked by some compensating activity (or activities). Inevitably though, a day of reckoning arrives and, when it does, the descent into chaos is often rapid and very painful. By this time, the underlying problems may be so bad that recovery is impossible. Stakeholders may be left wondering how things have degenerated so quickly.

This time, we assume that our user plays the part of a motel operator where basic maintenance activities have been neglected for an extended period. This has resulted in a great many customer complaints but, for the most part, front-desk and other employees have been very effective in containing customer anger (e.g. by quick fixes, work-arounds and through a generally sympathetic – and empathetic - manner in dealing with customers). To investigate this example, the user sets: *HR Quality* to *Good; HR Training* to *Average;* and *Maintenance and Development Commitment* to *Little* or *Nil.* Typical output is illustrated in Figure 8.

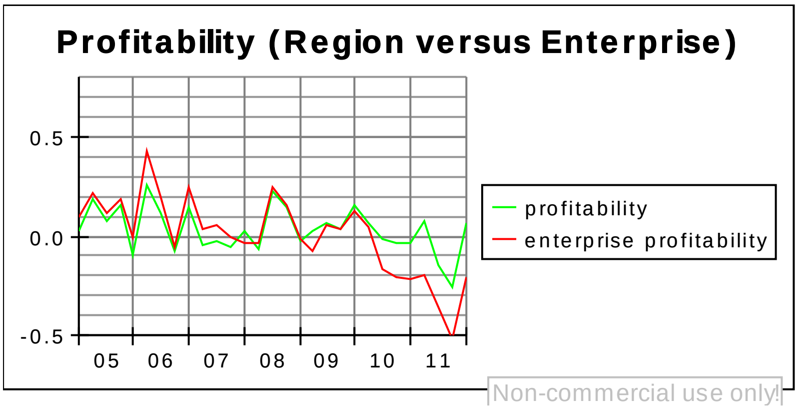

Figure 8: *Output from the 'Niagara effect' archetype example simulation.*

In this case, enterprise profits trend slightly downwards through the first part of the simulation and then drop away alarmingly. Also, our particular enterprise begins to perform considerably worse than the region average. The relevant CLD is presented in Figure 9.

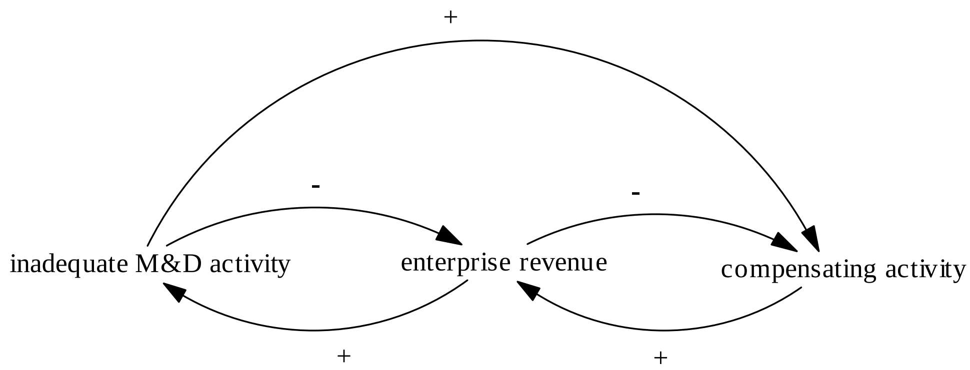

Figure 9: *The 'Niagara effect' archetype – the point of no return!*

As illustrated in Figure 9, inadequate maintenance and development (M&D) activity will eventually result in revenue losses. However, in the short-term, our motel's very-able workforce manage to contain these losses through compensating activity (as described above). However, this may only reinforce our operator's view that he may continue to skimp on M&D. Eventually though, it all gets too much, employees are no longer able to cope and customers: i) don't return; and ii) tell their families and friends not to bother staying with us. That is, we have reached the point of no return and fallen over the edge (hence the archetype name, the 'Niagara effect').

5. Model Validation

To a large extent, the learning aspect (as exemplified by the SD archetypes presented in the previous section) has probably been the primary inspiration for our work. Nevertheless, the fact that our simulator is capable of producing graphs of projected *Enterprise Profitability, HR Quality, Regional Enterprise Competition, Region Attractiveness, Environment Quality* and more is intended to act as the trigger that might prompt our targeted users to interact with the model in the first place. Thus, it seems essential that our principal outputs should be 'sensible' – to the extent that we must be able to convince the average user that our projections are reasonable. Consequently, the model and its implementation as TEPS must be *validated* and this is being accomplished via the following 2-stage approach:

- **Desk checking:** the model's predictive accuracy is currently being tested against historical data, employing the type of approach detailed by Georgantzas (2003). Here, *coefficient of determination* and other measures are used to compare TEPS's behaviour against the actual data. A difficulty here is that, for completeness, a very large number of test scenarios need to be generated. Thus, to keep the initial task manageable, key model parameters have been constrained to values characteristic of the single region in which field-testing is being carried out.

- **Field-testing:** negotiations are currently underway with a Queensland-based tourism authority concerning field-testing TEPS within their region. Testing protocols and other arrangements have yet to be finalized but it likely that some preliminary results will be available by December 2006.

SD models are notoriously difficult to validate (Richardson and Pugh, 1981). As noted by Forrester and Senge (1980: 209-210), there is no single test which might be employed to validate a SD model but, rather, confidence in the model accumulates gradually as it passes more tests and as new points of correspondence between the model and empirical reality are identified. Maani and Cavana (2000: 69-70), drawing on the work of Coyle (1983: 362), describe this process as consisting of:

- *Verification tests* – which focus on the equivalence between the *structure* and *parameters* of the real system and the model;

- *Validation tests* – which are concerned with demonstrating the correspondence between the *behaviour* of the real system and the model; and

- *Legitimation tests* – which determine whether the model is in accord with any generally-accepted system rules.

Essentially, the aim of validation is to *"show that there is nothing in the model that is not in the real system and nothing significant in the real system that is not in the model"* (Maani and Cavana, 2000: 69). An excellent example of how much of this can be accomplished through desk checking has been provided by Georgantzas (2003) where statistical measures, such as *coefficient of determination* and *Theil's Inequality Statistics (TIS)* (Theil, 1966), were employed to compare the predictive results of a SD model focused on various key measures of the performance of Cyprus hotels against actual data (over a 40 year period). Similarly, we have subjected our own model to similar tests, concentrating on measures such as *occupancy, room nights occupied (RNO)* and *average revenue per room night occupied (AvRevPerRNO).* An example of one of our desk checking outputs is presented in Figure 10. This shows actual versus predicted *AvRevPerRNO* for the region on which we based our *Major Gateway* generic region type.

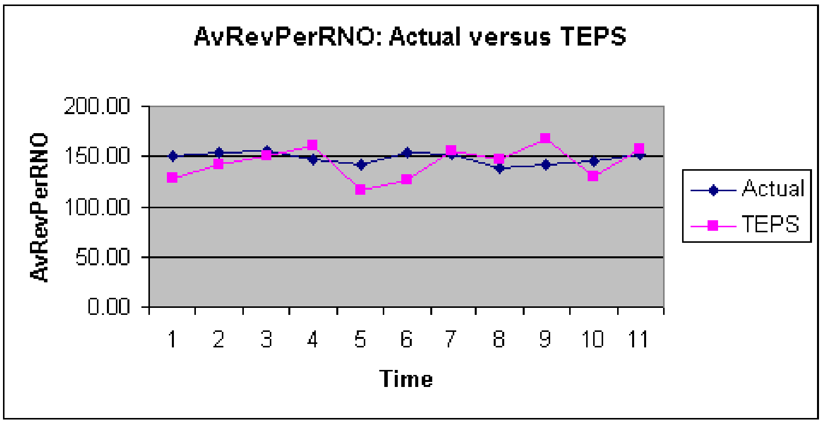

Figure 10: *Model validation – actual versus TEPS results for AvRevPerRNO.*

The basis of Theil's approach is that the *mean square error (MSE)* is divided into three components: i) *bias (U^m);* ii) *unequal variation (U^s);* and iii) *unequal co-variation (U^c).* The sum of all three components equals one and, briefly, a large U^m indicates a potentially serious systemic error and, to a somewhat lesser extent, this applies to U^s as well. If U^c is large though, most of the error is unsystematic and, as noted by Sterman (2000: 877): *"a model should not be faulted for failing to match the random component of the data"*. The TIS results for our example are presented in Figure 11 and, while they indicate that TEPS behaviour provides a reasonable approximation to reality (in this case anyway), there is significant room for improvement: specifically, the variance in our model is considerably greater than that of the actual data. In fact, this can be readily observed through a visual examination of the trend lines in Figure 10. The TIS results, however, are useful in that they quantify the extent of the various error types.

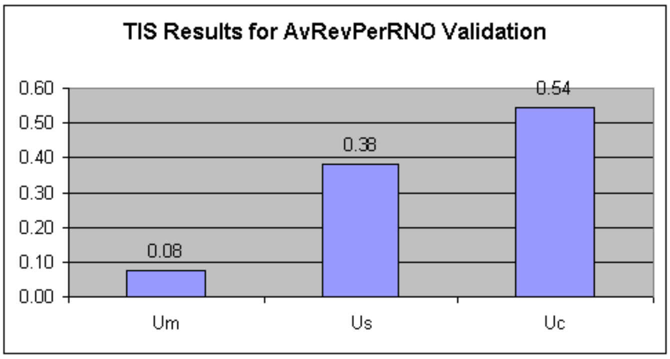

Figure 11: *TIS breakdown of the Figure 10 AvRevPerRNO trend lines.*

At the time this paper was being prepared, much of the initial desk checking phase had been completed and, while some fine-tuning was still required, the model was judged as being sufficiently mature that the next stage of validation could commence: i.e. field-testing. To this end, negotiations were underway with a New South Wales (Australia) - based tourism authority concerning field-testing TEPS within their region. Testing protocols and other arrangements were in the process of being finalized and it likely that some preliminary results will be available by end-December 2006.

6. Conclusion

We have detailed the development and use of a tourism enterprise planning simulator (TEPS) based largely upon SD constructs and tools. The motivation for our work and particular approach was: i) the need for improved access to useful business planning tools among SMTE operators; and ii) the fact that SD copes well with domains that are rapidly-changing and, in addition, can be classified as 'messy' (Vennix, 1996: 9-41).

Few would argue that the tourism landscape is evolving at an express (indeed, some might say *terrifying)* pace and issues that need to be considered when developing tourism enterprises are certainly messy (according to the criteria listed earlier). For example, Buhalis (2000) nominates the number of different stakeholders, stakeholder relationships and goals, contradictions between these goals, and difficulties in maintaining an acceptable and sustainable balance between the interests of stakeholders, natural resources and development activity as major problems that must be confronted in destination marketing and management – and tourism enterprises cannot be established in isolation from destination-level considerations. Thus, it is absolutely imperative that prospective owner/operators of SMTEs have a thorough understanding of these complexities. TEPS and, more specifically, its system archetypes introduced in this paper, are designed to enhance this understanding and learning.

Acknowledgement

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