SUSTAINABLE PATHWAYS 2

Reflection on model development and process; understanding success criteria for councils

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Published by Ecological Economics Research New Zealand
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Private Bag 11 222
Palmerston North
New Zealand

ISBN: 978-0-9876532-5-3 (Print)

ISBN: 978-0-9876532-4-6 (Online)

Executive Summary

New simulation models are currently being developed under the Sustainable Pathways 2 (SP2) project. The models are being developed to fill a perceived gap in current model use – namely a lack of integrated and spatial modelling within councils in order to aid in long term and robust decision making processes.

This report fills a gap in the literature on assessment of the effectiveness of integrated spatial models. It highlights the paucity in development of assessment tools for evaluating information systems in general, despite their obvious importance. It is acknowledged that this may be due to the limited tangible or verifiable measures of success for integrated spatial models, particularly when longer term outcomes may indicate success. The need for defined success criteria and a way to evaluate the level of success of model use is important as inability to assess whether a model adds value has been identified as a barrier to model use (van den Belt et al, 2010).

The research methodology includes a literature review of existing approaches used to assess information systems, and the undertaking of semi-structured interviews with users/project partners of the SP2 Integrated Spatial Explorer (ISE) model based on the 'Updated DeLone and McLean Information System Success Model'.

The updated Delone and McLean (D&M) model of Information Systems Success (2003) was identified as a useful methodology for conceptualising the factors important for measuring and understanding model success. It uses six related variables; 'System Quality', 'Information Quality', 'Service Quality', 'Use/Intention to Use', 'User Satisfaction', and 'Net Benefits' (as shown in Figure 1 of this report) to evaluate success. A distinction is made between the 'critical success factors' and 'success criteria' for models. The first relates to the wider aspects that must be achieved to allow a model to succeed (the means to success), whereas the second is the ultimate desired outcome (the ends).

Single-issue models and simulations serve a useful purpose, but alone won't meet the needs for long-term sustainability and resilience. It is intended the SP2 models will complement existing models, as opposed to replacing them. Planning for resilience requires that an integrated approach is taken, and that a wide range of future scenarios be considered. For the ISE models to be informative wider participation in their use will be required.

Based on the literature review and subsequent interviews, this research suggests that particular attention be paid to the establishment of specific criteria to measure the 'success' of the ISE models judged against the following three core aspects of their use:

1. Does the model promote **systems thinking**? – Do the decision makers within councils base their decisions on a more integrated and holistic model of reality?
2. Does the model promote **futures thinking**? – Is more weight given to the longer-term challenges and are a broader range of options and scenarios for the future considered?
3. Does the model promote **participation and collaboration**? – Are more stakeholders included in the planning process, thus contributing to a more democratic and transparent decision making process?

These questions link to the sixth variable of the DeLone and McLean model (with specific reference to the Net Benefits) through which the somewhat intangible success criteria of model use are assessed.

Consideration was given as to **how** the critical success factors and the success criteria of the ISE model are best measured. Given there are few tangible or verifiable measures that can be used to gauge long term outcomes (such as headline indicators or annual prediction accuracy) a user questionnaire was employed to subjectively evaluate success. For future use a draft questionnaire was developed, with questions grouped under the six success variables of the DeLone and McLean model.

The challenge for understanding what constitutes success for the ISE models has two parts – clarifying its potential benefits to the councils, and then better understanding what will help to maximize those benefits.

While it is still early days to reflect on the impact of ISE models, this report is intended to primarily support the participating councils: Auckland Council, Waikato Regional Council, and Greater Wellington Regional Council.

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1. Background

This report has been commissioned and collaboratively written by Ecological Economics Research New Zealand at Massey University as a part of the six-year Sustainable Pathways 2 (SP2) research project, with support of the SP2 project members. The SP2 project is funded by the Ministry for Business, Innovation and Employment (MBIE - formally the Ministry of Science and Innovation) and runs from 2009 to 2015. It aims to bridge the science-policy interface by linking state-of-the-art research with policy development and progress the use of integrated spatial planning within councils.

The SP2 project has three parallel research streams:

1. Mediated Modelling, a participatory and consensus based approach to decision making (led by Ecological Economics Research New Zealand);
2. Spatial Based Modelling, to provide spatial decision support system models for the Auckland and Wellington regions (led by Market Economics Ltd.); and
3. Developing and integrating dynamic and spatial modelling tools into urban planning practice (led by Greater Wellington Regional Council, Waikato Regional Council and Auckland Council).

With approximately two thirds of the project now complete, the focus is on pausing to consider the lessons learned at this interim juncture, with the intention to improve process by taking valuable insights into the final stage of the project. This involves moving research findings towards the integration of the new models and processes into councils. If this is to happen successfully, councils will need to be able to demonstrate the benefits from model use, in order to justify the large financial and time investments needed to take ownership of the models. Furthermore, one of the milestones of the SP2 project (Milestone 1.3.5) 'requires reflective co-learning on Mediated Modelling (MM) and Spatial Decision Support Systems' (SDSS – now referred to as Integrated Scenarios Explorer or ISE). This report details elements of this reflective process.

Some reflection has already taken place, in particular following the Mediated Modelling workshops in Wellington and Auckland in 2011 and 2012. Mediated Modelling is defined as the process of building a model *with* rather than *for* stakeholders. Through a process of workshops stakeholders develop a system dynamics model that reflects their perception of issues (van den Belt, 2004). Pre- and post-modelling reports have been produced for both regions (van den Belt *et al.*, 2011a; van den Belt *et al.*, 2011b; van den Belt *et al.*, 2012a; van den Belt *et al.*, 2012b). These reports, along with further information about the project can be accessed on the SP2 website (www.sp2.org.nz).

The third research stream of SP2 as described above is led by councils, and further reflection will be required as the project draws to a close. This interim work aims to provide a base for councils to enhance the understanding of 'success criteria' for integrated modelling tools and processes, and ultimately for deciding how useful the modelling process has been for integrated spatial planning for the council.

2. Methodology and Research Questions

The SP2 project has been planned, designed and developed around the notion of 'action research'. Action research aims to incorporate elements of planning, action, observation and reflection (van den Belt et al., 2012). This sits alongside the aspirations of 'adaptive management' which also have a similar cycle of learning and adaptation, as opposed to a linear process of research. Reflection and envisioning are important steps in these processes. This research output is a reflection on the current use and development of new models (the ongoing action), so that future developments can be shaped and modified as needed.

With the above aims in mind, the following research questions have been formulated:

1. What are the broader and longer term changes taking place with regards to model use and development?
2. Do these changes require a re-evaluation of what constitutes benefit or success for model use and development?
3. By what criteria can the success or failure of the ISE models be judged, with regard to their use within the Auckland Council and Greater Wellington Regional Council?

The methodology for this research is a literature review and semi-structured interviews with members of the three councils involved in the SP2 project. The literature review focuses on articles relating to the success criteria by which model use and development can be judged.

Following this, a sample of core statements or questions was compiled to use in semi-structured interviews. This involved Auckland Council, Greater Wellington Regional Council, and Waikato Regional Council, who have developed their Waikato Integrated Spatial Explorer (WISE) model through the recent Creating Futures research programme. Interview questions focus on the benefits, decisions and use for models, as per the second and third research questions stated above.

Ten interviews were carried out, with at least three interviews taking place in each council. Interviewees were selected with the help of the lead project contact in each council for the SP2 project: one member of the SP2 project team, one or more technical modellers involved with spatial planning (ideally from the Technical Users Group for ISE/WISE), and one or more further members of the council who is involved in strategic decisions relating to the procurement, resourcing and development of models within the council.

The interviews contained both quantitative and qualitative aspects. A series of statements or questions were provided, with participants asked to rate their agreement (or disagreement) on a Likert Scale of '1' to '5'. Participants were then asked to elaborate on their answers, to elicit more detail. While it is acknowledged that ten responses do not provide conclusive or statistically relevant results, it provides insight on some of the issues put forward in this paper.

The final stage of the research aims to adapt the success criteria and propose a method for ongoing review of the ISE models in Auckland and Wellington, as well as WISE (Waikato Regional Council). A questionnaire will be proposed with a series of questions that, if used on a regular basis could provide 'real-time' feedback as to the current use, confidence and benefits of the ISE/WISE models.

3. Context for Model Use in Councils

3.1 Systems thinking, integration and sustainability

The first stage of reflection begins with an overview of the wider context the Sustainable Pathways 2 project operates in. Huge strides in science have occurred over past centuries based on the reductionist techniques of Descartes and other Enlightenment philosophers who advocated studying components as opposed to whole systems. After centuries of progress in this direction, there is a move towards systems thinking and complexity theory, in recognition that a system cannot be understood solely by studying its parts. Systems thinking focuses on identifying the interconnections between the parts of the system and synthesizing them into a holistic picture that provides better understanding of cause and effect (Meadows, 2008). Within the sustainability discourse, there has been a call for more integrated, holistic thinking working across disciplines to tackle the many environmental and social issues facing us today. For example, Donella Meadows worked for decades to promote a systems approach, stressing the benefits of finding the leverage points within a system, where actions can be most effective (Meadows, 1999; Meadows, 2008).

It is also increasingly acknowledged that we face a growing list of 'wicked' problems, ones of complex nature with no single solution and which are symptomatic of deeper problems. According to Bob Frame *"many existing technologies (e.g. cost–benefit analysis or environmental impact assessment) at the science–policy interface were developed to support decision-making in a world of infinite resources where rational decisions could be developed from relatively simple models of processes. While still perfectly adequate for specific purposes, many are insufficient for the complexities of contemporary society and its drive towards greater sustainability."* (Frame, 2009, p.189)

In New Zealand there is limited use of formal integrated modelling at the regional scale (van den Belt et al., 2010) and this plus the case for strengthening the interface between science and policy, provided justification for the goals of the SP2 project. Along with the move to promote more integrated, interdisciplinary and spatial modelling is the corresponding need to assess the effectiveness of such tools.

This report now looks at some of the trends and contextual changes that will impact on the use and effectiveness of integrated spatial models.

3.2 The continued growth of computing power and modelling potential

Rapid development in computing power and the way computers are utilized for decision support will continue. Development has passed through distinct eras; data processing, to the micro-computer era and on to the network era (Shim et al., 2002, p. 112). Processing speeds have grown exponentially since the 1960's – with Moore's Law predicting a doubling of power every 18 months. Computing power is also growing through the use of networking – for example grid computing, where multiple computers can work in parallel. As well as computing power, there has been a similar explosion in the amount of data available for input into models.

It is not only computers that are developing; it is their users too. Technological proficiency continues to increase (Shim et al., 2002, p. 121). Terms like 'Generation Y', 'Digital natives' and 'Millennials' are used to describe the young adults entering the workforce today – people who were born into a world with internet, laptops, mobile phones and many other technologies that help shape their distinct

characteristics and capabilities. They will be more sophisticated and tech-savvy and be more open to new ways of interacting with technology but will also demand more functionality.

Likewise, organisations will have to adapt to the increasing number of platforms for expressing views. Tools for virtual and collaborative decision making are becoming more common, as is the scope for decision making by diverse groups of networked individuals. Organisations will become more complex and more connected, yet must be increasingly agile and flexible (Ibid., pp. 113, 122). New Planning Support Systems (PSS) are also being developed to aid collaborative and participatory decision making (Geertman and Stillwell, 2004, p. 292).

3.3 The growing complexity and coverage of models

Spatial Planning has a relatively short history in New Zealand, with the Auckland Spatial Plan being the first of its kind, but follows a general global trend in this direction (Gardner-Hopkins and Fairgray, 2011). A survey of New Zealand's local authorities found there is limited use of truly integrated modelling, with complicated decisions often being left to softer, human-based forms of evaluation (van den Belt et al., 2010). Cost is one factor behind this, with smaller councils often not having the capacity to fund and resource large, complex models. The inability to assess whether the model adds value is another barrier to use (van den Belt et al., 2010).

Due to the large number and range of models available for use in New Zealand, a Decision Support System Directory has been created, including EERNZ staff, and a searchable web-based database is available through EnviroLink Tools (www.tools.envirolink.govt.nz). The goal is to facilitate knowledge transfer across regions, and work to remove or lower barriers to model use within councils.

Embedding new models into use and gaining confidence in their outputs remains a challenge. A targeted approach that builds on opportunities is one way to do this. Such an approach requires picking topics of high interest, involving people who have authority to make decisions and also involving those sceptical about models.

3.4 Modelling – Decision Support Systems versus Planning Support Systems

Planning support systems (PSS) can be defined as "an infrastructure that systematically introduces relevant (spatial) systematized knowledge to a specific process of related planning actions" (Brömmelstroet, 2010, p.13). Decision Support Systems (DSS) are computer technology solutions that can be used to support complex problem solving (Shim et al., 2002, p. 112). There are close parallels between the two, and the use of models fits within both. Modelling can have various uses within planning. The world around us is infinitely complex, so all humans form mental models to help order and make sense of the limitless information that is available to us (van den Belt et al., 2012, p. 5). Computer modelling is essentially an extension of our mental process, but one that can be demonstrated to and critiqued by others.

While there are clear similarities between DSS and PSS, it could be theorized that the future of modelling has a wider purpose than pure decision making. The outputs may not simply be in the form of a decision or outcome to aid in planning, but rather a tool to aid in thinking about and understanding what impacts a decision may have. There is also a clear link between politics and the use of PSS (Solomon, pers. comm. 18/2/2014). This moves it towards a broader type of integrated planning and associated decision support. Such a role requires a re-evaluation of the benefits of model use and requires development of knowledge and understanding of the wider (complex)

systems where decisions and planning take place. Subsequently, such a role for modelling requires a wider view of success criteria for model use, where benefits are far less concrete (as in a decision or number), and far more abstract (such as a more holistic understanding of the multiple impacts and leverage points within a system, and a longer term outlook in planning).

Geertman and Stillwell (2004) note an increasing number of Planning Support Systems in use around the world. There is, however, limited uptake in practice of the multitude of models available which is put down to a mismatch between the needs (or capability) of the planners and the provision from developers. Most PSS are also recent, often in early stages of development. (Ibid., pp. 294-295). While the SP2 project aims to develop the new models through collaboration with planners inside the councils to overcome this mismatch, they are in essence new PSS tools and complementary in the toolkit. The reality is that they often compete against or have a barrier to overcome compared to other single-issue, familiar and available tools. To do so successfully, they must fill a defined purpose and be able to demonstrate their worth.

Obstacles to successful implementation of integrated Land Use – Transport (LUT) Planning Support Systems have been evaluated by way of an industry survey in the Netherlands (Brömmelstroet, 2010, p.32). The lack of transparency was ranked highest of the listed problems. That is, the assumptions and calculating methods are not clearly defined. ISE/WISE development has aimed to include end-user feedback through the development process, which may help to mitigate this risk. All assumptions must still be made transparent for new users of ISE. The technical user's manuals (available at www.sp2.org.nz) which are updated regularly are one way to assist new users and provide transparency.

Other top bottlenecks in the Dutch study included low communication values, issues with user-friendliness and a lack of interaction. Issues such as cost and complexity, while not insignificant, did not rank as highly. Open questioning in the Dutch survey revealed conflicts of interest between different actors (land use planning versus transport planners) as a major barrier with the lack of a common language as another one. However, some positive experience were also observed, including "genuine interaction" and a "readiness to listen" leading to acceptable outcomes (Brömmelstroet, 2010, p.33). While these are observations from LUT alone, the level of integration for ISE is across a wider variety of disciplines, and it can be assumed that similar bottlenecks are likely. The establishment of a Technical User Group made up of staff from each council is an attempt to overcome some of the problems in this area.

4. Process for Model Use and Development

Earlier research has investigated model use within New Zealand. A number of valuable conclusions were drawn from this research regarding the characteristics of models used and barriers to model implementation. These will be important considerations when determining success criteria for ISE models. Four common characteristics were listed (van den Belt et al., 2010, p. 15):

1. Models have clearly demonstrable value, providing evidential support for specific issues;
2. Models used are generally produced externally, as opposed to developed in-house;
3. Models are constructed to use data captured for/by the model; and
4. Models usually produce a decision making output.

In the same research, potential barriers to model use were assessed. The most frequently cited barriers, listed in order of significance were (Ibid., p. 17-18)

1. Inability to assess whether the model adds value
2. The cost in monetary terms
3. The cost in time
4. Complicated nature and maintenance requirements of models
5. Lack of in-house capacity
6. Misunderstanding of the model's application
7. Lack of end-user involvement in building models

The first barrier on the list is central to this research. While costs are easier to ascertain, the benefits of model use may be difficult to quantify, hence the need for defined success criteria and a way to evaluate the level of success.

4.1 SWOT Analysis

A SWOT analysis (strengths, weaknesses, opportunities, threats) was completed by staff in the councils (Appendix 1). This acknowledged that the SP2 project models (both Mediated Modelling and ISE models) are 'new' models for the councils and embedding them within councils comes with notable challenges. For the ISE model development, mediated modelling became part of the process, to allow the ISE models to be shaped according to the needs of each region (van den Belt, 2012).

Reflections done by council staff in the SWOT analysis identified the following issues for consideration – Appendix 1 includes the full SWOT considerations by the councils:

- *Assumptions* – should be clearly documented, and able to be amended if required.
- *Complexity/alchemy* – this relates to the resources required for model upkeep. Investment in highly complex models may result in continued use when their validity is no longer ensured.
- *Communication* – models should be fit to demonstrate to non-experts, with the accepted risk that partial information may be selected to argue a particular case.
- *Resourcing* – there is concern regarding the lack of spare staff capacity making it difficult to embed new tools.
- *Models as Politics* – the use of models is more complicated than simulation or forecasts and decision support. Outputs and model use may be manipulated for political means.
- *Accuracy* – while models are never completely accurate, they must meet expectations and be explicit about the assumptions they are based on, and the level of accuracy that can be expected.
- *Evidence base* – Outputs need to be timely and fit for purpose so they can constitute an important component of an evidence base that can be used to inform decisions.

5. Success Criteria for Models

5.1 A model for evaluating success criteria

There are a multitude of factors that contribute to the success of a model. After extensive research through the 1980s, DeLone and McLean (1992) proposed a model of information system (IS) success in their influential paper. This has stood the test of time, becoming the top cited article in leading IS journals (Petter et al., 2013, p.10). In 2003, the authors reviewed their original model, making small changes. The Updated DeLone and McLean (D&M) IS Success Model remains a leading model for understanding and categorizing IS success. The model is shown in Figure 1 below.

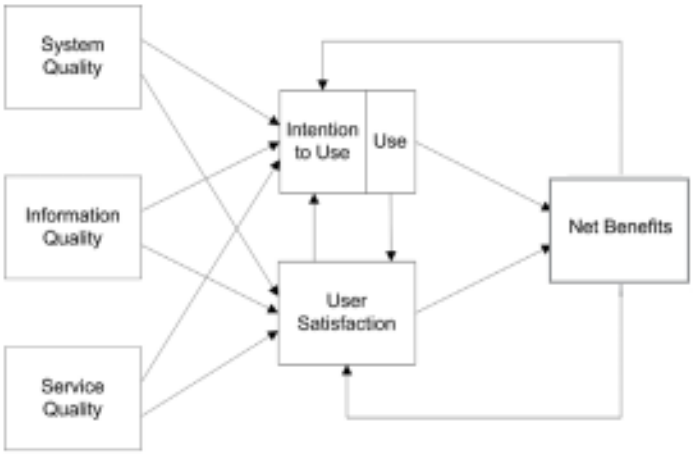

Figure 1: Updated D&M IS Success Model (Petter et al., 2013)

DeLone and McLean (D&M) (2003) concluded that IS success is a multi-dimensional construct, with no single measure. As well as multiple dimensions, there are also multiple determinants of what impacts on IS success (Petter et al., 2013, p. 38). Put simply, there are many dimensions to success, and there are many variables that affect those dimensions. The challenge for understanding what constitutes success for ISE/WISE has two parts – clarifying its potential benefits to the councils, and then better understanding what will help to maximize those benefits.

Figure 1 shows six interdependent success variables. They are (i) system quality, ii) information quality, iii) service quality, iv) use/intention to use, v) user satisfaction, and vi) net benefits. Each variable is comprised of various aspects and measures that can be assessed. Below are short descriptions of each taken from Petter et al. (2008; 2013):

1. **System Quality –** This is defined as the desirable aspects of a model, which are generally technical in nature. Measures can include ease of access and navigation, reliability, flexibility, functionality, ease of learning/intuitiveness, response time etc. System quality is tightly linked to user attitudes, experience and self-efficacy (Petter et al., 2013, p. 29-30).
2. **Information Quality –** This is the desirable aspects of the model outputs, such as figures, maps, diagrams, graphs, tables and data spreadsheets. Important measures relate to their accuracy, relevance, understand-ability, the relevance of the results when produced (i.e. timeliness), conciseness, completeness and usability. Their quality is naturally dependent on the quality of the inputs and design of the model.

3. **Service Quality –** This relates to the quality of support for model users, which could be internal or external to the organization. Measures include the responsiveness, accuracy, technical competency, empathy and reliability of the support. One of the reasons behind objective three of the SP2 project is to embed ownership within councils so the level of external support required from the primary developers is reduced.
4. **Use/Intention to Use –** Use and Intention to Use provide two related but different measures. Use can sometimes be measured directly (frequency of use/log-ins, amount of use/time), but can include less tangible measures too, such as purpose, innovation, appropriateness and nature of use. The Intention to Use criteria takes account of user attitudes towards future expectations for the model. Both are very dependent on aspects of management, such as communication of purpose and benefit, as well as allocation of time and resources (Ibid., p. 33).
5. **User Satisfaction –** The users overall satisfaction of the model. Whereas use may be a result of necessity, satisfaction is separate, but tightly linked to the other success variables. Satisfaction can be measured through a multi-attribute instrument.
6. **Net Benefits –** Defined as the extent to which a model contributes to the success of individuals, groups, organizations, industries, and nations. In the original D&M model, this was two components – Individual Impact and Organisational Impact. The measures could include improved decision making, improved productivity, cost savings, or improved consultation.

With 'User Satisfaction' a distinction needs to be made between types of users for ISE/WISE as what is important for success may differ. One group comprises of the technical users and on-going developers of ISE. These users will be most impacted by issues such as technical glitches or poor service support. Other users could include planners, policy developers or strategists, or even public interest groups. Output quality and communicability, timeliness and flexibility may be more important for these types of users. The interaction between users will contribute to the overall benefits from model use (Brömmelstroet, 2010). Using mediated modelling to develop a scoping model is a potential way to provide a useful interface between users and improve understanding of the task at hand.

While all the above variables will in part determine whether the SP2 models are used, it is the Net Benefits emphasizing the intangible benefits, that are of prime (but not exclusive) interest to this study. Will the introduction of ISE/WISE into councils lead to improvements in the overall processes and decisions of councils? Can the ability to explore a wider range of future scenarios better prepare councils for more robust planning and decision making? If so how can better/improved outcomes be quantified and demonstrated? These are some of the issues that were explored through interviews with members of the councils.

5.2 Project Excellence Model®

The Project Excellence Model® (PEM) is another model more focused towards traditional project management. The PEM distinguishes between *result areas* (success criteria) and *organizational areas* (critical success factors) (Westerveld, 2003). The *result areas* deal with the 'what', whereas the *organizational areas* are concerned with the 'how'. While the overall SP2 project could perhaps be assessed by this means (as a project), it appears less suitable for measuring the success and benefits of the models themselves. However, useful insights can still be gained from looking at the PEM

model, because SP2 is unique as a collaborative research project where research users work closely together with research provider to understand both 'what' and 'how'.

Of the six result areas (success criteria), one is for traditional project goals (budget, schedule, quality) whereas the remaining five are judged by the appreciation of varying stakeholders including users, personnel, clients and other partners and parties. The six organizational areas include issues such as resourcing, policy and strategy, stakeholder management, project management and elements of leadership and personnel.

The distinction between success criteria and critical success factors can be used for comparison with the D&M model. Using this terminology, the left-hand elements in Figure 1 are the critical success factors – the 'how' benefits and success will be achieved. On the right – most notably the net benefits, but also in use and user satisfaction – are the success criteria. The net benefits or success criteria of the SP2 models are in the benefits to individuals and organizations that the models hope to achieve.

6. Interviews with Councils

As outlined in the methodology section, interviews were undertaken with council staff involved in ISE/WISE modelling. This was aimed at assessing opinions of those currently using the models (to varying extents), and gaining further insight into the net benefits of the models. In total, 10 interviews were held between the 12-19 of September 2013; three with Auckland Council, three with Waikato Regional Council, three with Greater Wellington Regional Council, and one with an external consultant who has been active in the development of WISE and other related projects. However, as this study is focused on assessing the views of councils, the answers from the consultant have been excluded from the analysis of results below, and used only for general observations and insights.

A list of questions was developed for the semi-structured interviews, and from this list, four key questions were selected. These were then written in the form of a statement, with interviewees asked to rate their agreement from '1' (strongly disagree) to '5' (strongly agree). These provided the starting point and basis for follow-up questions and discussion where the participants could give reasons for their opinions.

6.1 Core Questions

Quantitative results and discussion about each of the four questions is provided below. This is followed by further insights that came out of the interview process, that are not covered by the four main questions.

Question 1

"The ISE/WISE models serve a purpose within councils that are not filled by the models and processes previously/currently used."

This question aimed to assess whether these models are filling a gap within the current spread of models used, and investigate what some of the core benefits might be. There was a wide spread of answers, from 'disagree' to 'strongly agree' for this statement (although no one was neutral). The majority of respondents however, either 'agreed' (three) or 'strongly agreed' (four). The mean value

for the responses was 4.0. Figure 2:- Response breakdown for Question 1' below shows the breakdown of responses on the Likert scale for the first question.

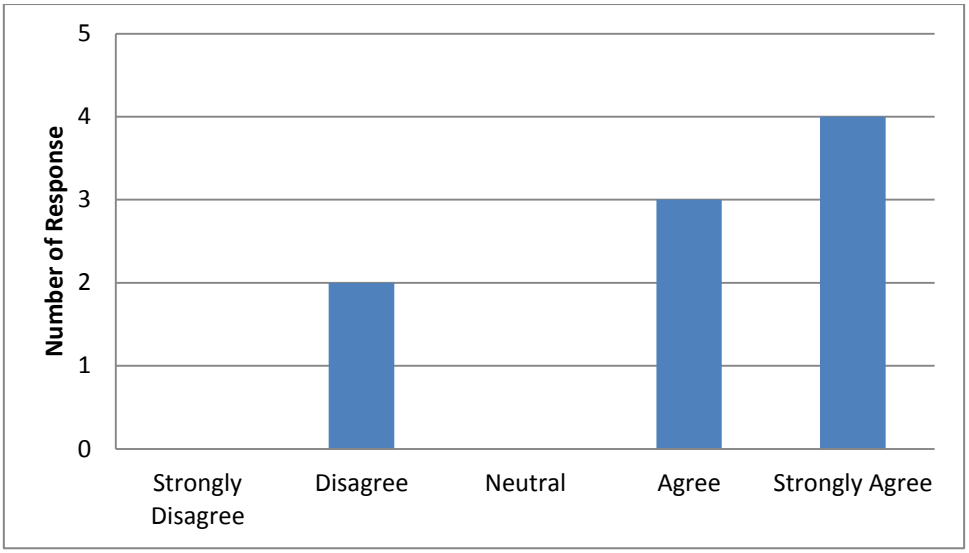

Figure 2:- Response breakdown for Question 1

Two participants disagreed. The first felt that there are many other existing models that *could* be used within councils. In their opinion, there are multiple different quantitative and qualitative models, from dynamic to static. However, that is not to say they are used fully and effectively. This view highlights the so-called *implementation gap,* that it is not so much the lack of models available, but the lack of appropriate use within the councils of such models. The second respondent stated that they didn't yet know what role it would fill (a sentiment even shared by some who agreed with the statement). This respondent felt the promise of the model is being somewhat over-sold, and that it was less suitable for the particular council/region in question.

There were many points raised to support those who agreed with the statement. Integration was the most commonly cited role compared to other models, being referred to by most respondents. Other main reasons given for agreement referred to its potential for envisioning further into the future and a broader set of scenarios (exploring 'what if's), its spatial aspects and level of detail in visualization and its potential for collaboration and education.

The fact that most participants feel it fills a gap in the current use of models is a promising sign. Obviously the model is in an early stage of development, and its potential is separate from how it is currently used. It was apparent to the interviewer that the barriers to its uptake were recognised as significant and a lot of work needed[1] to get to the stage where ISE/WISE actually fills gaps.

Question 2

"The use of simulation models is becoming increasingly necessary for the functioning of the council."

This question hoped to shed further light on the evolution of model use within councils and get a better understanding of the ways in which models are being used. Again, the majority of respondents were in agreement. However, while the mean response was the same as for question 1 (4.0), there

[1] The interviews were conducted before a series of workshops with Territorial Authorities in Wellington and users in Auckland Council had taken place. Such workshops have taken place in 2014.

was a bigger convergence on agreement, with fewer saying they strongly agree. Figure 3 shows the number of responses in each category. As can be seen, there was no one who disagreed with the statement, but two 'neutral' responses.

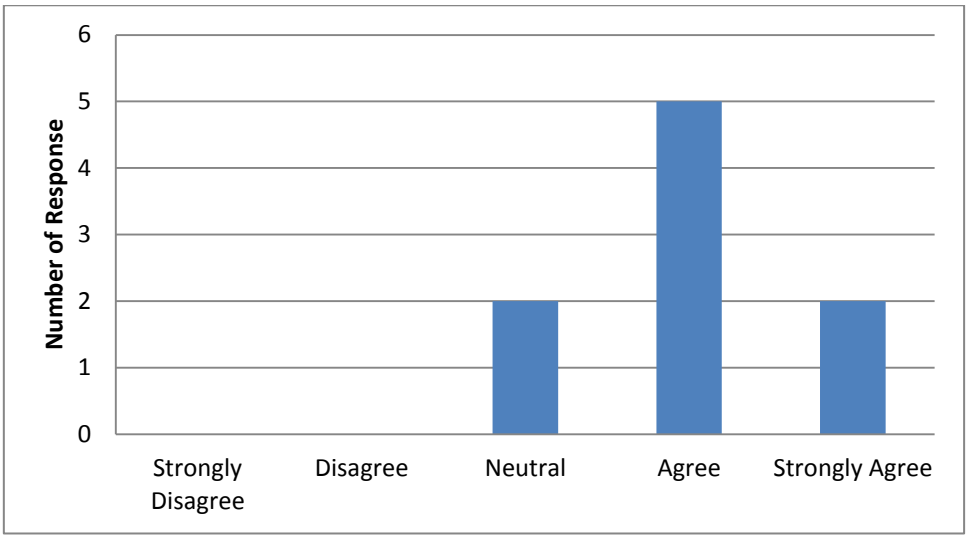

Figure 3: Response breakdown for Question 2

One comment that came up several times was that the word 'necessary' doesn't accurately describe the situation. There is a difference between whether they are useful tools versus being necessary in the strict sense. Some felt that the range of tools was developing and improving, but that does not mean they are more critical to councils. Another of the neutral responses said it was scale dependent – so sometime yes, and sometimes no.

Of those who strongly agreed with the statement, reference was made to the changing context, for example the need to demonstrate available land supply to meet Auckland's growth, or on the fact that change is happening faster and faster. This leads to a need for longer term thinking, and also the need to consider a wider range of scenarios. Predicting trends from past experience may become increasingly unreliable. One responded also thought simulation models were necessary not just for planning, but for education and for changing mind-sets, which also relates to question three below.

Question 3

"The process of modelling can lead to valuable insights for those involved. Put another way, some benefits from modelling are derived during the process as well as from the final result/output."

This question aimed to investigate where the benefits of modelling derive from, how much benefit and insight comes from the process of using models, and how the ISE/WISE models may fit in with regard to that. Of the four lead questions, this one garnered the strongest agreement. More than half of the respondents strongly agreed, with the remaining all still 'agreeing'. The mean response for this question was 4.6.

The number of responses along the Likert scale is shown for the statement in Figure 4 below.

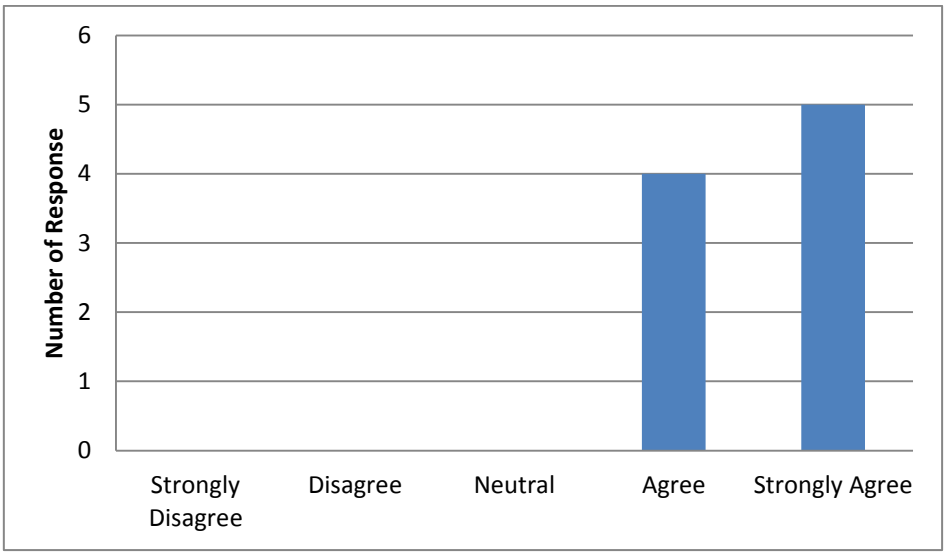

Figure 4: Response breakdown for Question 3

This does not help identify where the true breakdown between process and output lies. Putting a value on this would be difficult, and clearly it would vary from model to model. However, some opinions from the participants were proffered.

There were a number of different ways of describing process benefits which makes it difficult to categorise the responses given. Two interviewees distinguished between the process of developing the model (science/research based) versus the process of using the model (scenarios based). The technical modellers often pointed to the need to understand and explain why something was happening, which gave insights into the assumptions behind the model and the sensitivity of different aspects.

With ISE/WISE in particular, several respondents felt this statement was especially true. This could be because of its integrated nature, and also in the way that it facilitated dialogue between different users, which could mitigate risk of conflict or misunderstanding. Likewise, being integrated meant learning beyond traditional fields of expertise was necessary – for example transport modellers learning more about the economic assumptions/components within the model. Another aspect was the iterative nature of the model, where it is hoped that new scenarios will lead to new questions being asked.

In trying to assess what this would mean for how ISE/WISE was used, interviewees were less certain. It is an open question as to who in council will be using ISE/WISE, and whether or not technical users will be using it more in group settings compared with other models. Likewise, there is uncertainty as to how the outputs can be communicated, without defined headline indicators. Communication is made increasingly difficult when individual Territorial Authorities request information on their area alone and not just over the entire region.

If more benefits are derived during the process, it brings into question how the relationship between the technical users and other planners or strategists must develop. There will be more need for collaboration, and better communication between them. There may be more demand on the

modellers to also act as 'teachers', and be able to take some lead in running scenarios and explaining the relationships. These functions may be hard for people less aware of how the model is built to carry out.

Question 4

"A regular council initiated survey could provide useful insight into the success of SP2 models within the council."

This final statement aimed to discuss the possibility of using a survey of ISE/WISE users to assess progress and benefits according to the D&M model described earlier. A draft questionnaire was described or presented as an example, to provide further clarification as to the intention of the question (Appendix 2).

Again, responses were mostly in agreement, although there were a number of qualifying remarks. A third of respondents were neutral, while four agreed and two strongly agreed (Figure 5).

The central theme of the qualifying remarks could be summarized as this: it would be useful in principle, but more difficult in practice. Several people indicated they thought it would be more beneficial in the future if use of the model expands, or that it was still too early in the developmental process to be useful. A related issue was the small number of people involved in ISE/WISE, and with varying degrees of knowledge with regard to it. There are also different types of users, from technical to non-technical users, who may have different contact and experience with the model, meaning the responses of the interviewees are provided from various perspectives.

Two similar alternative suggestions were offered – one that the same framework is used as a basis for discussions in a group as a way to discuss problems and future developments. Another was that it is used by the regional 'champion' of the models, who can likewise use it to assess progress. These suggestions were a response to the concern that a regular survey may add administrative burden or time pressures, when there will likely be a scarcity of time for actually using the model.

The number of responses for each category is shown in Figure 5. Responses ranged from neutral to strongly agree, with a mean value of 3.9.

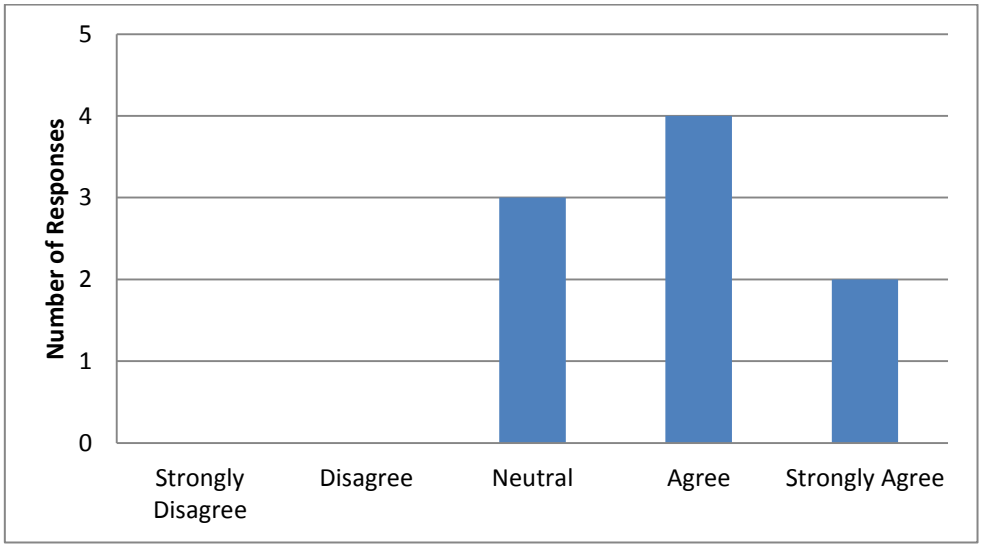

Figure 5: Response breakdown for Question 4

Interestingly, it was brought to the interviewer's attention that a very similar method was used under the name of Project Model Excellence in the Wellington Regional Council between 2006 and 2009.[2] This was set up "to identify and implement the elements that make up a successful modelling process" (GWRC, 2009). It seems that it may have covered all models used within the council as opposed to an individual model, although the focus may have been on the transport model. The tracker used seven 'foundations' which each contained a number of sub-components. The foundations were as follows: 'High Quality Models', 'High Quality Validation', 'High Quality Operators', 'Quality Suppliers', 'Quality Assurance Process', 'Organisational Champion' and 'Stakeholder Satisfaction'. The measures were rated on a 2-monthly basis, with a stakeholder survey done annually. The foundations and sub-components were all also weighted according to perceived importance, with their score adjusted accordingly.

The monitoring process was ultimately discontinued at the end of 2009. This was the result of staff changes – in essence, the losing of a 'champion' who drove the Project Model Excellence process. This highlights the importance of individuals in driving initiatives within organisations such as the councils in question. However, it is also reassuring to see that such a similar approach to that proposed within this study has been undertaken before.

6.2 Additional Points of Interest from the Interviews

Various points were discussed or raised that don't directly relate to the above questions, but that may be of interest to the overall study.

Whereas there were no noticeable trend variations between the regions in the above answers, some topics were often discussed by one region and not others. The topic of spatial planning differed for each region. Auckland has been required to prepare a spatial plan, now near completion. ISE was not ready to assist in the preparation of this, and it may be some time before it will be revisited. In Waikato, there is some consideration to developing a spatial plan, whereas in Wellington it seems very unlikely to come about without changes to the current territorial boundaries. There seems to be little expectation that the process could succeed in gaining agreement between the Territorial Authorities across the region.

In Waikato, various respondents talked about the hope of having a second version of WISE, a 'WISE 101' version. (In fact, one respondent in Auckland also had a similar idea, apparently without knowing about Waikato's discussion on the topic). The reasoning behind this is that it could make it more accessible for non-technical users to explore scenarios, but with less control over how many variables could be adjusted. Such a version could even be web-based, making it easily available to members of the public. The concern was that the current, more technical version could still put people off using it. While it is considered user-friendly for what it is, there is still a lot to learn and understand. A simplified version could prevent people being put off by the complexity and coverage.

This would obviously be a trade-off. The more the model is simplified, the less accurately it represents reality. It could, however, help develop the rough scenarios, and lead to requests for more detailed modelling to be done with the full version. A qualification here is that more detailed

[2] Despite the extreme similarities in name to the Project Excellence Model described earlier, it appears that the two are not directly related. Attempts were made to contact the staff member who has since changed jobs, but unfortunately this person was away on long-term leave.

modelling does not always achieve greater accuracy (Klosterman 2012). A second trade off highlighted by another participant is between speed and accuracy. Depending on how the model may be used, if it is too slow to run a scenario, this may make collaborative scenario exploration difficult – if there is too much time waiting for the result. This is less of an issue if the technical user is given a task to investigate and pass back results at a later date – but the benefit of learning during the process is somewhat lost in this case.

Various interviewees were asked if the SP2 models could supersede any existing models, and the prevailing viewpoint is that it couldn't. There is little chance for example that the component models would be left aside and replaced with ISE/WISE, even if the same model is incorporated into it. Clearly then, embedding the new models will be challenging, as it requires an additional investment in time and money. Furthermore, if these models are used predominantly for earlier stages of vision or scenarios development, they risk being seen as a luxury with less immediate deadlines and therefore being put as a second priority to other models.

7. Measuring Success – A Survey Proposal

7.1 User information satisfaction surveys

An influential paper published by Ives et al. (1983) focused on the user as a means to evaluate overall success of information systems. They reasoned that User Information Satisfaction (UIS) "*provides a meaningful 'surrogate' for the critical but unmeasurable result of an information system"* (Ibid, p.785). This was an early attempt to apply user surveys to assess success. It was a precursor to the D&M model and elements from the Ives et al. paper can be traced in the newer model, although they are left somewhat uncategorized.

User satisfaction has continued to be used pervasively as a measure of information system success following the development of the D&M model (Doll et al., 2004, p. 228). User information instruments have been developed for a range of different environments, measuring different aspects and fitness for purpose. Ives et al. (1983) somewhat naively hoped for the development of a standardized UIS instrument (which would allow comparisons across organizations and information systems) but such a standard measure or survey has proven elusive. They did, however, recognize the benefits of customization, clarity to the users, and ability to tailor for items of particular interest (Ibid., p. 791).

Why would a User Information Satisfaction measure be useful? The most dominant measure of assessment in today's world is an economic comparison of benefits and costs – the benefit cost ratio (BCR). In practice with model use the components of this may not be easy to determine. This could be because costs and benefits may be difficult to recognize and convert into monetary value, or because some systems are used in an unstructured and ad hoc fashion, where sufficient data records may not be kept to evaluate its full benefit (Ives et al., 1983, pp. 785-786). With a growing need for adaptive management as a way to deal with the 'wicked' problems that we now face, objectively measuring the true benefits and costs would appear to be increasingly difficult. Benefits and costs change with each adaptation to a new situation. The fact that learning occurs through process, which is especially so for WISE/ISE (as discussed above), the use of user satisfaction surveys remains a good option for measuring the more subjective aspects of success.

Looking back to the D&M model shown in Figure 1, it is the user that is placed in the centre of the D&M model diagram. The user is the most connected point in the model. On the left, the more technical aspects of IS success will impact on user satisfaction and intention to use, while the net benefits for the organization are naturally dependent on the system actually being put to use. It therefore seems plausible that a user questionnaire can be a worthwhile point of analysis for the wider success (current and forecasted) for a model.

During the early stages of development of WISE, the importance of working with end-users was recognized. Workshops were held, where participants were given a short questionnaire to complete (van Delden, 2010). This was designed to gain feedback on the perceived usefulness, usability and complexity of WISE. While the questionnaire used during those workshops was far shorter, the principle in use is much the same as is proposed here. It is based on the idea that gauging end-user opinions on the model is useful in evaluating its effectiveness and identifying points for improvement.

7.2 Developing a questionnaire – points for consideration

While the interviews (question 4) indicated that a survey or questionnaire could be of use to councils, there are some issues that must be considered which may shape the development of a questionnaire. These can relate to the practicalities of undertaking and evaluating a survey, as well as the relative importance of the various variables of IS success, which in turn are very dependent on the goals of the system. As any survey will be tailored for the particular model in question, the focus here will be on the ISE/WISE model, as it was for the interviews with councils.

7.2.1 Tailoring for ISE/WISE

The most important point to consider lies in the question of what the ISE/WISE raison d'être really is. Geertman and Stillwell (2004) describe the diversity of the PSS in use – in the aims, capabilities, content, structure and technology. The success criteria must relate to its overall purpose and goals (relating to the need to assess the wider benefits and costs). However, the benefits for each model will be unique, and in the case of ISE, arguably more diverse and wide ranging while also sometimes less tangible.

In the later part of WISE development, core aims for the model were listed as: (Huser et al., 2009, p. 2370):

1. Inform Strategic Planning
2. Communicate and inform stakeholders and community
3. Identify links between economy, environment and society, expose trade-offs and enable win-win situations
4. Enhance local government capability and capacity

Its purpose was also described in the same paper in a similar (but different) manner as given below: (Huser et al, 2009, p. 2372)

1. Provide a better understanding of society, the economy and the environment… and how these are connected (systems approach).
2. Explore future scenarios of change and development, including examining the consequences of individual or collective actions over time and space on those systems.

3. Develop and review regional policies by examining future scenarios, evaluating trade-offs and identifying possible thresholds or limits.

Returning to the D&M model, it will be the model variable of 'Net Benefits' where these issues must be especially considered. There can of course still be aspects of this included in the other variables. Also worth considering is where and how the costs for ISE can be assessed. While not all users may feel they have full knowledge of the wider benefits and costs, well designed questions should provide valuable insight into the success of ISE in relation to its goals, or at least stimulate further questioning. If the perceived benefits are lower than previously rated for example, it could be that ISE is not reaching its stated goals, or it could simply be that new users are involved, and the wider intentions and benefits have not been well communicated to them.

Many important issues for models have already been identified by the SWOT analysis as described above (and Appendix 1). Each of these issues must also be included within the questionnaire. Issues may fit across multiple variables. For example, accuracy may be part of system quality (is the model design robust), as well as in information quality relating to the outputs. The important thing is to take account of the issues previously identified as being important for ISE/WISE.

7.2.2 Standardisation through time

While the questionnaire can be tailored to meet the specific issues for ISE/WISE, it is intended that the same questionnaire be used through time to allow trends to show, and comparisons to be made, with previous results. Therefore, the aim is to develop a survey that will still be relevant in five or ten years. Therefore, questions should avoid issues that may be relevant in early stages of development only, as they would be out of date for later surveys. Consideration must be given to what issues may arise over the long term, as the models become established but may still evolve in their use.

7.2.3 Weighting and composite indicator

It is inevitable that some issues, variables or individual questions will be thought more important than others. Perhaps the quality of the model outputs is more important than the speed of response from technical support for example, or the net benefits may be considered more important than the intention to use. A system of weighting could be considered for each variable, or even a composite indicator for overall performance, although this may simply hide the insights that could be found in individual responses. Alternatively, a 'spider' diagram may be a better way of representing results for each component.

7.2.4 Forum for undertaking surveys

How would a user questionnaire be undertaken in practice? Possibilities could include physical mail out to a selected group, in-person evaluations at suitable events or meetings, or the use of online surveys through email and utilizing web-based survey platforms. With no certainty about long term external funding for councils, this would best be achieved from within councils, however, as the interviews indicated there are concerns about the practicalities, or the risk of additional administration for an already busy staff. Responsibility for the process would ideally need to be attached to a job description as opposed to an individual, to avoid disruption from staff turnover.

7.2.5 Length and detail

There exists an inevitable trade-off between the detail of a questionnaire and the likelihood and willingness of those surveyed to complete the form. Surveys that require too much time struggle to get a high response rate. Yet if it is shortened, potentially useful insights may be lost as to why or why not the model is succeeding. In developing this survey, a longer list of questions will be proposed, with the list then to be shortened depending on the perceived relevance of each, until the list of questions is a suitable length.

7.2.6 The scale and the measurement factor

Subjective scales can run across various opposing adjective pairs, such as agree-disagree, important-unimportant, easy-hard, satisfied-unsatisfied, high-low. Using many different attributes can become confusing or risk questions being misinterpreted. For this reason, the questionnaire will use a consistent scale where answers will always range from strongly disagree to strongly agree. The range of numbers is also important. At this stage, a one to five scale seems sufficient. Whether to include a 'not applicable' option has also been considered. Its inclusion risks people shying away from giving answers if they are not 'sure' of their knowledge. However, it is suggested to include because in some cases, it may not be possible for all respondents to answer.

7.3 Draft Questionnaire – questions to evaluate success

Keeping the above points of consideration in mind, a list of questions has been proposed, under six sections corresponding to the six variables of the D&M IS Success Model. The list is not considered 'final' – if it is to be used over coming years, further discussion should be held to ensure that the most important aspects will be surveyed. It could also be shortened if questions are seen as less pertinent or are doubling up. However, it provides a fairly comprehensive starting point.

The draft questionnaire can be seen in Appendix 2. The rating scales have been omitted for this report version, but would follow each statement on a suggested scale of one to five. In total, 36 questions have been included.

8. Conclusion

This study reflects on the development of the SP2 models and investigates what the success criteria are, and how these can be measured. Literature on the topic confirms that, despite numerous studies, there is no clear agreement on what determines the success of a model (or information system), and what exactly that elusive 'success' factor really is (Petter et al. 2008).

Furthermore, while certain generic factors may influence the success of models, the objectives will vary from model to model. The goals and objectives for the SP2 models (and its research approach) are notably different from the models traditionally used by councils within New Zealand. Traditional models tend to be single-issue, where model outputs can be validated and compared with direct observation. Measuring the benefits from integrated and collaborative modelling on multiple issues and multiple scales is far more difficult. That does not, however, mean that the benefits are not real (and part of the development process). In short, the goals of this study have been to find a way to consider, frame and start assessing these benefits.

One possible way of assessing 'success' could be the extent to which a model adds to the knowledge base. This measure can only be gauged in retrospect and if a system is put in place to record model use at the outset.

Information has been sought from existing literature and also through interviews with councils. To conclude this study, we return to the initial research questions, and thus summarise the findings. The three research questions are discussed in turn below.

What are the broader and longer term changes taking place with regards to model use and development?

There is a continually changing context for model use and development, reflected in the saying that the only thing constant in life is change. This is nothing new. What may be different, a view reflected in at least two interviews, is that we may be in a period of more rapid change, where planning for the future may not be so straight forward as it has been in the past.

Several trends were identified. Modelling capabilities continue to grow, particularly as a result of the growth in computing power, technology and innovation, but also in the number of people that use them. The younger generations have grown up in a hyper connected world, where new opportunities are opening up for online collaboration, collaborative model development and collaborative decision making. Organisations must also adjust to be able to continually adapt to change, meaning some of the traditional hierarchies in decision making are being replaced by more collaborative and dynamic decision making processes.

Increased computing power allows also for increased complexity in models. Where fully integrated modelling across multiple disciplines would have been difficult in the past, it is increasingly considered possible and necessary. Integration of Land Use and Transportation appears to be an area where this is quickly evolving. However, research has shown that more complicated models do not necessarily result in more accurate predictions (Klosterman 2012).

The rise of 'wicked' problems with no clear problem or solution means that interdisciplinary collaboration and adaptive management are becoming increasingly important. A lack of formal integrated modelling has been noted within councils in New Zealand (van den Belt et al., 2010). This requires a shift from 'complicated' to 'complex' models. Whereas complicated models assemble many essential parts governed by different rules, complex models are geared to understand how many interacting parts respond to simple rules and thereby displaying emergent properties of a system. Such distinctions for integration, as well as processes that allow for continual adaptation, will be necessary if the challenges of long term sustainability are to be met.

Do these changes require a re-evaluation of what constitutes benefit or success for model use and development?

The interviews demonstrated that the process of model use and development is an important component of the benefits. This is especially so for the SP2 models, where many of the benefits are thought to derive from the process itself. Mediated modelling allows end-user input as a way of narrowing the gap between users and developers. Systems thinking is promoted through exploring a broader range of scenarios in an integrated manner with the ISE models (van den Belt and Forgie, 2014).

If greater collaboration across a wider number of issues is required to meet the challenges being faced, then model use which facilitates or encourages such collaboration should be promoted. Planning support systems should no longer be thought of as decision makers. They can aid the decision making process, but they cannot replace the process. They are rather a tool to facilitate more robust decision making processes.

As the insights and learning process from model use becomes a larger part of the benefit, pure numerical predictions or data outputs are relegated in importance. The benefits move from hard and tangible, towards soft and intangible.

By what criteria can the success or failure of the ISE models be judged, with regard to their use within the Auckland Council and Greater Wellington Regional Council?

Measuring intangible benefits is never an easy process. Just as we use models to simplify reality as a way to make it understandable, we need a model to help us understand and categorise important aspects for model success.

This study identified the updated Delone and Mclean model of Information Systems Success (2003) as a useful model for conceptualising the factors that are important for measuring and understanding success. The updated D&M model uses six related variable, as shown in Figure 1 of this report. The sixth variable, the 'Net Benefits' is where the somewhat intangible success criteria of model use are assessed.

It is clear that a key requirement for 'success' of a model is in its use. If it is not being used, it is not going to provide ongoing benefit to the individual or organisation. Use and intention to use will provide a useful pointer towards whether the Net Benefits are being realised. They are not however equivalent. While obtaining benefits requires that a model is being used, using a model does not ensure a positive outcome. If a model is flat out wrong or misleading, it could be used to the overall detriment of an organisation.

A distinction was also made between 'success criteria' and 'critical success factors'. The critical success factors are represented on the left of Figure 1. This may be the quality of service and support for the model and model users, the quality of the input data available, usability of the model and so forth, as well as the organisational support and backing by way of staff time and financial resources.

It is in the Net Benefits where the real success or failure of a model can be judged. Each model will serve its own purpose, and each organisation will have specific needs. For ISE to be successful, it must provide benefit to the Auckland Council and Greater Wellington Regional Council. To benefit the organisation, it must aid the councils in meeting its wider goals. Sound planning for the long term benefit of the region requires good decision making based on a sound understanding of reality – a complex system with many unknowns.

Other models are already used within the councils. These are often relied on to make accurate predictions for one component of council planning. Such models can more easily be judged according to the accuracy of these predictions. As the interview process indicated, ISE is unlikely to be used to replace other models, and its purpose, while still rather undefined, is different. It is not to predict but to inform, and specifically in relation to the wicked problems that cannot be solved in the traditional sense. If they are to be informative, then wider participation in their use will be required.

With these reflections in mind, it is suggested here that the specific criteria to be established to measure the 'success' of the ISE models be judged against the following three core aspects of their use.

1. Does the model promote **systems thinking**? – Do the decision makers within councils base their decisions on a more integrated and holistic model of reality?
2. Does the model promote **futures thinking**? – Is more weight given to the longer-term challenges and are a broader range of options and scenarios for the future considered?
3. Does the model promote **participation and collaboration**? – Are more stakeholders included in the planning process, thus contributing to a more democratic and transparent decision making process?

The Net Benefits measure naturally requires benefits to be compared with costs. Costs for model development are far easier to ascertain and have not been considered here in detail, but can certainly be significant. Ultimately it must be decided whether the benefits derived justify the investment made, or whether similar outcomes can be achieved through alternative approaches.

Identifying what factors might hinder the success of SP2 models, and measuring the level of benefits obtained through the use of the models remains a difficult task. This study proposed a user questionnaire for making this assessment. Though this is a subjective measure of success, users are likely to have the best judgement as to the impacts a model is having, on them as individuals and on the organisation as a whole. Through a list of questions categorised under the six variables of the D&M model, it is hoped these factors could be better understood. A first draft of the questionnaire is suggested in Appendix 1. However, if this method were to be adopted, a more collaborative assessment of what factors are most critical is recommended, and the list of questions could be revised accordingly.

In summary, if the use of ISE leads to better informed individuals, making better decisions, based on a better understanding of reality, then it could be called a success. Sound decision making will require more cooperation between experts of different fields, which in turn will require a more collaborative modelling process.

9. Acknowledgements

The authors would like to thank Dr Catherine Murray (M.E) who peer reviewed this report and one other anonymous reviewer. The funding provided (MAUX0906) for the Sustainable Pathways 2 (SP2) project by the Ministry for Science, Business and Innovation is also gratefully acknowledged.

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Appendix 1 - SWOT analysis done by councils (2012)

Introduction

The Auckland and Wellington Regional Councils utilise a range of models in their work. These models range significantly in their operational complexity, working assumptions and spatial and temporal inputs and outputs.

The various models occupy different spaces within the councils; some are integral to decision making processes such as the financial models underpinning the Long Term Plan whereas others provide outputs which inform broader policy and strategy discussions.

The SP2 project will provide both participating councils with 'new' models. These include the mediated models that focus on bringing together stakeholder's perceptions regarding 1) quality of life in the Auckland region, 2) urban intensification in the Auckland region', 3) freshwater management in the Auckland region, 4) growth challenges in the Wellington region and 5) dynamic genuine progress indicators in the Wellington region. The spatially explicit ISE models include applied case studies on 1) Land use and economic impacts associated with protecting indigenous vegetation in the Wellington region; 2) Transport impacts associated with major road transport infrastructure investment; 3) Land use and economic implications of a district or regional plan zoning rule change; 4) Demographic change in the Wellington region; 5) Economic implications of Wellington Airport's runway expansion plans to cater for larger aircrafts; 6) Development of a major convention centre; 7) Land use impacts associated with Wellington City Council's Economic Development Strategy 'Broad-based diversification', and; 8) 'Government Austerity' scenarios. In addition, the challenges of interlinking the MM and ISE models are being documented.

Reflections on the state of modelling practice are required. This report provides an overview of the existing models utilised by these two councils by adopting a strengths, weakness, opportunities and threats framework. These reflections, of two council staff, subsequently inform a discussion about how the mediated modelling and spatial dynamics model to be produced as part of the SP2 project can embedded within the participating councils.

What are models?

The local government environment is characterised by complexity. It covers diverse public interests, statutory responsibilities, political influence, employment of large number of people and a wide range of duties. They are responsible for making decisions by considering the four well-beings and to consider the needs of current and future generations. Models are one approach that we can employ to understand our environment.

Models are simplified versions of reality that selectively focus attention on some aspects of complexity by setting boundaries. Because no model can incorporate the infinite complexity of our environment, we have to recognise that models will by definition be wrong. As Box and Draper state "All models are wrong; some models are useful'' (Box and Draper, 1987:424).

Existing modelling practice

Like all large organisations, a range of models are utilised in council. Each will have a specific purpose and function. The table below provides a snapshot of models utilised currently. It is not exhaustive and in particular it lacks the models used for financial planning.

Model	Description	Key information
Wellington		
Population, Household and Labour Force Projection Model	Provides demographic projections for the region at a variety of scales (Census Area Unit level up to regional). Excel based.	Developed and maintained by external people.
Regional Economic Input/Output Model	Outlines possible trajectories for regional economy and industry sectors. Used in regional economic planning and policy development. Excel based.	Input/Output model for 57 industries. Externally developed in 1996. Not currently in use.
Sustainable Yield Model (SYM)	Planning tool for assessing bulk water supply system reliability to compare against our one in fifty year shortfall standard. Based on WATHNET software. Enhanced by NIWA. Key output is the annual shortfall probability	Statistical network linear programming tool. Uses Monte Carlo simulation to determine the annual shortfall probability. Uses 115 year dataset of demand and river flows derived from climate records.
Hutt Aquifer Model (HAM2)	Groundwater model for water resource planning. Used to calibrate the SYM.	Finite difference hydrogeological model
Wellington Transport Strategy Model (WTSM)	Forecasts future transport demand (by mode) based on changes in landuse, transport costs, and transport infrastructure assumptions. EMME based.	Developed externally but managed in-house. Used to assess the long-term impacts of changes in transport policies.
Auckland		
Capacity for Growth Model	Determines level of capacity for all parcels and titles in Auckland region. Has changeable parameters. FME based.	Developed externally. Capacity information used for Spatial Plan reporting. Data incorporated into growth futures model.
Auckland Residential Growth Futures Model	Provides population, Household and dwellings by Mesh Block to 2051. Excel based.	Developed externally. Provides non-financial forecasting assumptions for Long Term Plan. Outputs used as denominator in Development Contributions Policy.
LUTEI	Transport and land use integration model.	
Development Contributions model	Uses CAPEX data and growth information to calculate per unit charge for new residential and business growth. Excel based.	Developed internally. Model underpins Development Contribution charges in existing Long Term Plan. Updated every 3 years.
Stormwater models	Stormwater flows and infrastructure capacity	

Modelling SWOT

Based on the above table what are some of the issues emerging for the models in the two Councils?

Assumptions: modelling assumptions have to be well documented. This is particularly important as the efficacy of model outputs in practice is dependent on the assumptions representing the understanding of the modeller of the underlying system. Many of the aforementioned Auckland models and the transport models have clear documentation which includes assumptions and limitations. Good documentation is a strength and is facilitative of good communication.

Models where assumptions can be amended based on the decision maker's view of change are desirable. Such models are more likely to have buy-in compared to those where assumptions are fixed and/ or where they are 'unrealistic'. Auckland growth model allows users to change demand (e.g. amount of population growth) and supply (e.g. locations where growth may occur) assumptions easily. This is a strength. Opportunity should be for more models to have changeable parameters. It follows that models that are too complex to use, understand and explain may limit their utility.

Complexity/ alchemy: Discussions of complexity highlight the differences between the uses of, so called 'complex' and 'simple' models (see Klosterman, 2012). Complex models are often large and expensive systems requiring significant resourcing to develop, maintain and refine. In particular the human capital required to run complex models can be difficult (and expensive) to source and to retain. Complex models, such as Auckland's Land Use Transport Integration Model or Wellingtons Sustainable Yield Model are capable of representing interconnected relationships and feedback loops. However the complexity of developing these complex models can means they "continue to be used for extended time periods, even though they may be obsolete and their core assumptions may be faulty" (Ascher, 1981: 262; Bankes, 1993:436 – 440).

Simple models by contrast often include less variables and more linear framings thereby requiring less resourcing. However in doing so, simple models may oversimplify the issue that they seek to model and "may introduce large specification errors by failing to represent adequately the processes that comprise the system being modelled" (Klosterman, 2012:2). Balance between simplicity/ complexity and ease of use is a key consideration for all models. No hard and fast rules.

Communication: Model outputs have to be timely, easily communicable to non-experts and fit for purpose. To be timely, communicable and fit for purpose, is to suggest that model outputs constitute an important component of an evidence base, where evidence is "information selected from the available stock and introduced at a specific point in the argument in order to persuade a particular audience of the truth or falsity of a statement" (Wolf, p. 66). Transport models are complex and can take up to two weeks to run, QA results etc…but this needs to be balanced against their purpose and function.

Resourcing: The modelling landscape within both AC and WRC is saturated. All council activities have models and other tools they use in their day-to-day work. Indeed, some activities such as transportation and storm water will use more than one model depending on the issue and scale of analysis (both temporal and spatial). The threat is that this saturated landscape makes it a problem to embed new tools. In this context, the introduction of new models will inevitably compete with existing resources. Models already embedded in existing day to day practice have momentum and shifting to other models is not always easy. This inertia creates challenges and highlights the need for sustained and ongoing processes for embedding new models into existing structures. There is also a need to assess when a model becomes obsolete.

Many of the above models rely on external expertise for their ongoing maintenance and development. Depending on the complexity of the model, updating can be very expensive and time consuming exercise (e.g. hundreds of thousands to update transport data in model).

Models as politics: Models are about information, acts and assumptions (Couclelis, 2005). Planning is about interpretations, values and politics. Additional technical means may contribute to the identification of problems and their solutions; yet these are inevitably political in nature. Modellers, as Couclelis (2005) notes "will have to accept that the role of science in planning is much more complex and subtle than generating alternative model forecasts and expecting decision makers to act on these" (p. 1368). Model results should therefore be considered a necessary, but not sufficient, components to decision making. Therefore the opportunity is to create and use models that facilitate thinking and reflection which in turn means involving end users in their construction to mitigate against "black box" criticisms.

Accuracy: Debates around models and modelling outputs, inevitably focus on their accuracy. In his discussion on agent based modelling, Green (2012) distinguished between predicative accuracy and process accuracy. In a modelling environment predictive accuracy can be taken to mean the ability to "consistently reproduce historical events" (p. 2) yet for decision makers this is often the extent to which the observed model outputs match their perceptions about the future (or perhaps more accurately their future desires). No model however is capable of predicting the future; they are necessarily wrong as they always simplify reality. The point though is in managing expectations about with the model does and does not do, how it works and what it is telling us based on the assumptions upon which it is built.

Issues for SP2

Given the above analysis, what lessons can be drawn to inform the mediated modelling and spatial dynamics models?

Firstly models that allow for general use, that are not too complex and that are transparent are preferable. The mediated modelling process with its discursive and collaborative process offers opportunities for ensuring transparency and, hopefully, buy in.

Secondly the underlying assumptions for both models need to be made clear. The spatial model has a range of assumptions about how land use change may occur given a series of planning requirements, economic conditions and other assumptions; and each of these is in turn is based on assumptions. The assumptions within the mediated models are likely to emerge and be documented through the process which is good.

Thirdly, given the large numbers of existing models, a strategic approach needs to be applied when embedding these within both AC and WRC. A targeted approach that builds on opportunities is required. That is picking topics of high interest, involve people who have authority to make decisions and involve those who are sceptical about models[3].

Fourthly, the models have to have owners. The Spatial Model is easy to find a home for but the mediated modelling is arguably a thinking framework applicable to all parts of the Councils. Therefore we need to think carefully about the process to embed systems thinking and systems dynamics.

References in SWOT

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[3] Relates to literature about involving end users.

Appendix 2 – ISE/WISE User Survey

Please indicate your agreement to the following list of statements, to help us assess the current and future success of ISE. The scale runs from '1' (strongly disagree) to '5' (strongly agree).

(Strongly Disagree)	(Disagree)	(Neutral)	(Agree)	(Strongly Agree)	(Not Applicable)
1	2	3	4	5	N/A

Success Variable A: System Quality

A.1 The ISE model is user friendly and intuitive.

A.2 The model is reliable and free from frustrating glitches or errors.

A.3 The overall model design is a fair and believable simplification of reality.

A.4 The model has sufficient flexibility to allow users to adjust parameters and assumptions to be able to explore many different scenarios.

A.5 The level of detail and complexity in the model is too high, making it difficult to determine whether the model gives accurate results.

A.6 Too many simplifications have been made for the model to accurately reflect reality.

A.7 The speed or response time of the model is sufficient.

Success Variable B: Information Quality

B.1 The assumptions and simplifications in the design (linkages, feedbacks, data sources etc) of the model are well understood and clearly communicated when the ISE model is used.

B.2 The input data available for the model is of sufficient quantity and accuracy so that the outputs can be considered reliable.

B.3 Input data is regularly updated with the latest data available.

B.4 Model outputs are presented in a clear and understandable way.

B.5 Outputs are understandable to non-experts and useful for communication or consultation.

B.6 The outputs available are relevant to the scenarios being investigated.

Success Variable C: Service Quality

C.1 There are good user manuals available which are easy to access and understand.

C.2 Within our council, there are various people who understand the model, and who can provide help on most day-to-day issues on the use of ISE.

C.3 I have sufficient time to keep up-to date about the latest developments, innovations and potential for use of ISE.

C.4 There is a good support network outside our council that I can request help from when needed, and that help would likely be timely and accurate.

C.5 This council would be willing and able to offer support and advice should other councils wish to develop their own ISE models.

Success Variable D: System Use/Intention to Use

D.1 Our council has regularly used ISE over the time period since the last evaluation survey.

D.2 We have been innovative with our use of ISE, trialing new scenarios and/or new alterations to the design of the model.

D.3 The model has been used in a collaborative way, with multiple staff or stakeholders (more so than for other models used within council).

D.4 The way we have used ISE is appropriate for the wider goals of the council and the opportunities that ISE presents.

D.5 The use of the model has been neutral and has not been used to demonstrate a desired outcome for the purpose of politics.

D.6 I expect that our council will be using ISE more regularly in the coming year than we have in the past year.

D.7 There is at least one champion within this council who actively promotes its use.

Success Variable E: User Satisfaction

E.1 Overall, I am satisfied with the ISE model, and feel that it provides a genuine benefit to the council.

E.2 I would like to see ISE used more regularly within our council.

Success Variable F: Net Benefits

F.1 The ISE models have helped individuals within councils gain a better understanding of the issues that concern them.

F.2 The ISE model has helped to encourage interdisciplinary cooperation between different divisions of the council.

F.3 Model use has helped identify the current status or gaps in data, knowledge or information available for the model, allowing prioritization for future effort.

F.4 The use of ISE has contributed to better decision making within councils.

F.5 The model has allowed for better stakeholder engagement, communication and consultation.

F.6 By integrating the environmental, social and economic aspects, future challenges are better foreseen, leading to more robust long-term planning.

F.7 The use of ISE has enhanced local government capability and capacity.

F.8 The ISE model has allowed for future scenarios to be investigated that would otherwise not have been considered.

F.9 The benefits from using ISE justify the costs (including allocated staff time).