A Micro-Simulation Model Of The Juvenile Justice System In Queensland

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EXTENDED ABSTRACT

The operation of criminal justice systems (broadly the police, the courts and corrections) is a complex and expensive process. Management of these systems depends on some knowledge of the long-term and cross-system impacts of policy changes across the system. Simulation models are valuable tools in the administration of criminal justice systems, providing the ability to project the relative effects of changes to policies based on current system information.

Presented in this paper is a summary of the development of the Queensland Juvenile Justice Simulation Model (QJJSM). QJJSM is a micro simulation model that simulates the progress of individual young offenders through their juvenile offending careers.

Historically, simulation models of justice systems have often quickly fallen into disuse. This has primarily occurred due to the over-complexity of the models, resulting in models that are difficult to maintain and that the user base of justice policy makers have found difficult to use and understand. With this in mind, the development of the QJJSM focussed on producing a simple, clearly defined model with an intuitive user-interface. Furthermore, the model was designed to rely only on data that was already available from current administrative systems, ensuring that the maintenance of model parameters was not a difficult task.

The QJJSM is a parsimonious model that simulates the initiation of new offenders, the commission of specific offences, the decision of the youth court, and reoffending behaviour In addition, three leverage points are included. These leverage points allow the user to add crime prevention, diversion and post-court intervention programs to the base system and explore their medium-term impacts. The model's schema is presented in Figure 1.

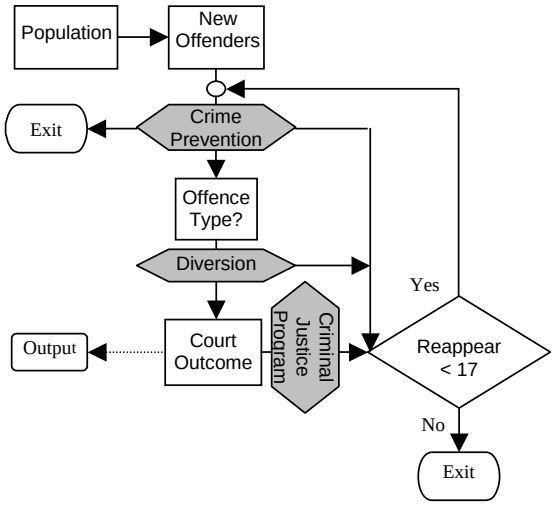

Figure 1. QJJSM schema with leverage points

An example of the model's use is presented in the paper. The example simulates the implementation of an early-intervention crime prevention program in North and Far North Queensland. The program is aimed at all young people aged between five and ten and is successful at preventing 12% of prospective offenders. The results of this program over ten years are presented, highlighting the lag between the program's commencement and the effect flowing through to the juvenile justice system as well as the differential impact on Indigenous and non-Indigenous offenders due to the locations targeted. The example scenario also provides estimates of the financial impact of the program.

The model presented is already in use in the Queensland juvenile justice system and it is expected that its success will enable the development of further justice system simulation models.

1. INTRODUCTION

This paper examines the use of simulation models in criminal justice systems. The criminal justice system is generally understood to refer to the government (and non-government) agencies that deal with crime and criminals. Thus, the criminal justice system broadly encompasses: crime-prevention, policing, the court system and corrections (including both incarceration and community-based supervision). Planning and management of this system (e.g. estimating prison requirements, measuring the impact of policing changes, examining alternative sentencing options etc) is necessary to ensure that the limited resources available are put to the best possible use.

There has recently been a range of significant technical advances in policy impact analysis and the development of theoretical and policy simulation models. Models are being used across government and non-government organisations to assist in decision-making. Modelling is used extensively in engineering, management, and even human services areas such as health and education. Despite this trend, applications of this technology within the criminal justice system are only beginning to be explored due to the complexity of the systems and the lack of suitable data (see Lind et. al. 2001). Unlike other disciplines, the traditional training of the policy analyst and professional decision maker within the criminal justice system involves little or no exposure to disciplines (such as statistics, operations research, programming) routinely included in the training of economists, engineers, and physical scientists. Consequently, there has been no development of a professional culture conducive to the use of models and simulations in decision-making.

Nevertheless, there is increasing awareness of the benefits that could result from policy simulation modelling of the criminal justice system. The development of such models allows for the simulation of proposed practice, policy, and legislative changes, providing decision-makers with information pertaining to the short-term and long-term consequences of any such changes. Simulation scenarios ask the 'what if' questions. They are like mini experiments that identify the downstream impact on the system of a proposed change if everything else was held constant. Of course, systems are extremely dynamic and models do not and cannot predict the future. Rather, models provide predictions on the basis of past trends and take into account what is known about a particular system. As such, policy simulation modelling provides decision makers with additional information that assist them in making rational decisions on the optimal use of scarce resources.

When justice system simulation models have been developed, they have often been overly complex and it has often proven difficult to engage policy makers with the technology and to maintain the models over time. This has led to a number of models that have taken substantial effort to build falling quickly into disuse and obsolescence. This paper describes a parsimonious micro-simulation model of the juvenile justice system in Queensland, briefly outlines the methods that have been used to ensure policy makers utilise the model and presents an example scenario to demonstrate the usefulness of the model.

2. SIMULATION MODELLING IN CRIMINAL JUSTICE

Over the last four decades a range of criminal justice models have been developed. Unfortunately, many of these models remain undocumented as much of the literature in this area is in the form of in-house government reports and unpublished documentation. This section provides a brief history of simulation modelling in a criminal justice context. A more detailed review of this field is available in Stewart et. al. (2004).

Simulation modelling of the criminal justice system developed during the 1970s primarily in the U.S.A. (e.g. Stollmack 1973) as the need for evidence-based planning for court and correction systems was recognised. This original work focussed on simple "stock and flow" models that allowed the effect of minimal system changes to be examined. Throughout the 1980s justice system modelling increased in sophistication, with JUSSIM and JUSSIM 2 (Blumstein, 1980) modelling the flow of individual cases through the system. These models also incorporated information on the underlying population structure and attempted to model reoffending behaviour. These models, along with similar work in the United Kingdom (Morgan, 1985) were hampered by the level of detail they attempted to incorporate. While increases in model complexity provide a wider range of policy options that can be explored, they also necessitate a greater range of data and depend on a larger number of assumptions. Data dependencies were particularly problematic for the JUSSIM models with Blumstein (1980) noting that few jurisdictions collected the necessary data to make use of JUSSIM.

More recent attempts to model the justice system in the United Kingdom rectified some of the

problems of the earlier attempts and The Flows and Costs model was widely used for almost a decade (Henderson, 2003). However, the model was not generally accepted outside of the Home Office and has recently been superseded by a micro-simulation model of the U.K. justice system that is more flexible and dependent on less data (Henderson, 2003). In the United States, criminal justice modelling has also moved towards micro-simulation with the National Council of Crime and Delinquency developing PROPHET, a flexible micro-simulation tool primarily used to project prison populations that is currently in use in over 30 American states (Austin et. al. 1992).

In Australia, most modelling work has been conducted within Government and little has been published. Lind et. al. (2001) discuss the development of a detailed model of the New South Wales justice system that was highly complex, dependent on a vast amount of data and subsequently costly to maintain and infrequently used by the non-technical policy makers that were its target audience. This model was subsequently replaced by a much simpler stock and flow model.

Lind et. al. (2001) provide an overview of the reasons behind the difficulties inherent in developing simulation models of the justice system, particularly emphasising the exhaustive data requirements of many models and the difficulty of engaging non-quantitative policy analysts with technical computer-based models. Furthermore, Lind et. al. offer a framework for developing criminal justice models that will be accessible to decision makers and relatively simple to maintain. In particular, Lind et. al. emphasise the need to: develop the simplest model capable of the desired analysis; design the model so that the parameters necessary can be largely obtained from existing data sources; and make the model as user-friendly as possible (Lind et. al., 2001).

3. QUEENSLAND JUVENILE JUSTICE SIMULATION MODEL

The model described in this paper attempts to simulate the passage of offenders through the juvenile justice system in Queensland. This system is managed by the Department of Communities and deals with offenders who have committed offences between the ages of 10 and 16.

3.1. Purpose of QJJSM

The majority of simulation models developed in justice system settings have focussed on the prediction of prisoner numbers over time. However, an analysis of youth detention numbers in Queensland highlighted the volatile nature of the detention system. Between 1997/98 and 2003/04 the average detention population decreased by 32% without any substantial changes to offending numbers, legislation or policy. Instead, this change was affected largely by internal practices (e.g. ensuring parole was provided as soon as legally possible) that, due to their informality and the resulting lack of available data, are almost impossible to model. This, combined with the small numbers of young people detained in Queensland (an average of 99 in 2003/04), meant that a model designed to predict detainee numbers into the future was almost doomed to failure.

Instead, the QJJSM was developed to provide a tool for policy makers and legislators to estimate the *relative* impact of prospective changes to the system in the medium-term. Thus, the model was designed to assess 'what-if' type questions, with the underlying assumption that, apart from the system change being modelled, the only changes to the juvenile justice system relate to demographic changes. Therefore, the focus of the model is on a comparison over time between the baseline situation (i.e. the current system) and the proposed changes to the system. An example of this will be provided in Section 4 of this paper.

3.2. Type of model

The QJJSM model was developed in conjunction with stakeholders from a range of Queensland Government Departments and it became clear that these stakeholders were interested in a model that incorporated both the way individuals moved through the system and the broad numbers of young people at various points in the system (e.g. in detention). Of the two main types of model that had been developed in other jurisdictions (stock and flow; micro-simulation), only micro-simulation models allow the simulation of individual offenders. Therefore, a micro-simulation model was the most appropriate model structure, allowing sophisticated models of individual behaviour as well as aggregated outputs.

3.3. Broad schema

Using the framework described by Lind et. al. (2001), the QJJSM was based upon the simplest possible schema of the juvenile justice system in Queensland (Figure 1). The model simulates: the initiation of new offenders, the commission of offences, the court decision-making process and the reoffending behaviour of offenders.

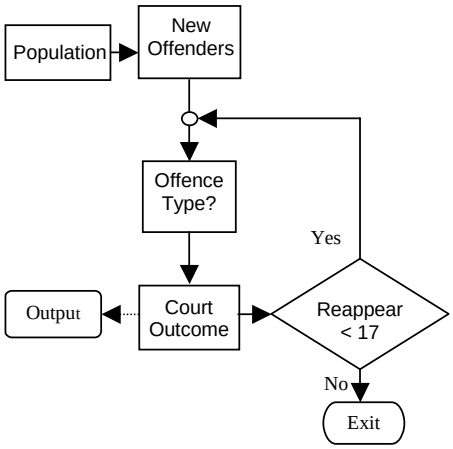

Figure 1. QJJSM schema

This level of simplicity had a number of benefits. Firstly, it captured the crucial components of both the system behaviour (court outcomes and supervision) and the individual offender behaviour (initiation, desistance and reoffending) required. Secondly, the model's simple structure made it easy to explain to policy makers and thus avoided alienating the model's user base through over-complexity. Finally, the structure of the final schema ensured that the data required to parameterise the model were readily available in administrative datasets maintained by the Queensland Department of Communities.

Three 'leverage points' were added to the schema to model the points within the system where policy changes can be implemented: crime prevention, pre-court diversion and post-court intervention (see Figure 2). Specific examples of these leverage points will be discussed in Section 4.1. System leverage points are components of the juvenile justice model where the implementation of a program, policy or legislative change may result in a reduction in offending.

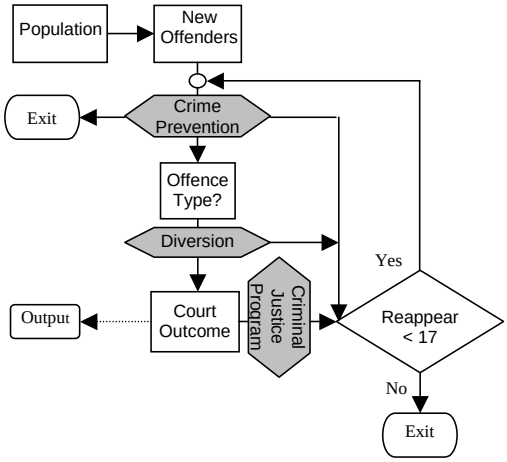

Figure 2. QJJSM schema with leverage points

3.4. Building the model

The QJJSM was constructed in the proprietary micro-simulation package Extend. Extend is a flexible and easy to use package that allows the construction of simulation models using a wide array of pre-defined 'blocks'. Thus, the vast majority of model functionality could be implemented simply by adding and manipulating task-specific blocks. Extend also allowed for the implementation of a built in database with a dynamic link to Microsoft Excel, providing a method for automatically maintaining and updating the model parameters as more recent data became available. Extend also allows users to develop their own blocks using its proprietary programming language, enabling the development of user-friendly blocks to implement the system's leverage points. These blocks allow the user to specify the details of their prospective program or policy using a clear, well-organized user interface.

The model developed in Extend was constructed according to the schema already presented. Thus, new offenders (items in the micro-simulation model) enter the system from the general population. Demographics (age, sex, Indigenous status and region) are assigned to offenders based on analysis of the administrative data provided by the Department of Communities. Offenders are assigned an offence type based on the offence types committed by their demographic group in real appearance data (e.g. 32% of non-Indigenous male appearances will be for theft and related offences) and are given a court outcome (based on number of prior appearances, type of offence and gender). Following the court outcome, offenders either reappear before the age of seventeen (offenders move into the adult system once they have turned seventeen) or leave the system. Those who reappear return to the first section of the model and are assigned a new offence when their next appearance occurs.

A vast amount of data and a wide range of statistical analyses underlie the workings of the QJJSM. The model is based around administrative data collected by the Department of Communities and incorporates population projections developed by the Australia Bureau of Statistics. These data were analysed to develop offending rates, offence probabilities, sentencing models and models of reoffending and desistance. Separate analyses were conducted for each stage of the system and included a series of logistic regression models for the court decision and survival analysis for reoffending. The details of the model's parameter estimation will not be explored in this paper, but

interested readers can refer to Stewart et. al. (2004) for a detailed technical report.

4. USING QJJSM

For the QJJSM to be useful for comparative policy analysis, it is necessary to provide mechanisms through which the user can implement their proposed changes to the system. These mechanisms take the form of leverage points, briefly discussed in Section 3.3.

4.1. Leverage Points

The three leverage points included in the QJJSM are crime prevention, pre-court diversion and post-court intervention. These leverage points are based on the broad crime prevention literature (e.g. Farrington 1994) and were developed in consultation with policy makers and potential model users. The three leverage points were implemented as custom blocks in Extend. All leverage points allow programs to be targeted at specific sub-groups of offenders based on their gender, Indigenous status, type of offence, offending history, age and region.

Crime Prevention

Crime prevention in QJJSM works in one of two main ways: developmental crime prevention and situational crime prevention. Developmental crime prevention strategies attempt to provide assistance to at risk children *prior* to their initiation into offending (e.g. through parenting and primary school-based programs). Therefore, when successful, developmental crime prevention programs prevent a young person who would otherwise have commenced an offending career from ever initiating. Therefore in the model, a successful early intervention program will intercept a new offender before their first offence and will exit them from the system preventing both their first offence and all subsequent offending.

Contrastingly, situational crime prevention stops only one specific offence from taking place. Situational crime prevention depends on reducing the opportunity and increasing the risk (to the offender) of offending and therefore does not have a long-term impact on a young person's offending behaviour, but can prevent specific offences from taking place. These programs generally rely on target-hardening measures (such as improved security).

Pre-court Diversion

Pre-court diversion programs take place after an offence has been committed but before the young offender has been through the court process. These programs attempt to reduce the likelihood of a young person reoffending by processing their offence in a less formal way (e.g. a community conference) and there is evidence that offenders diverted in this way have a reduced likelihood of reoffending (Trimboli, 2000). Therefore in the model, a young offender who is eligible for a pre-court diversion does not go through the court process, instead proceeding to the reoffending decision with a reduced likelihood of reoffending.

Post-court Intervention

Post-court interventions are strategies either mandated by the sentencing magistrate or implemented by the Department of Communities as part of a supervision or detention order. They include a wide range of interventions aimed at reducing the likelihood of an offender reappearing in the system. These include educational, employment and rehabilitation programs. Thus, in the model an offender will commit an offence, go through the court process and, if subject to a post-court program, will subsequently have a reduced likelihood of reoffending.

4.2. Policy Analysis with QJJSM

The primary purpose of the QJJSM is the analysis of proposed changes to policies in the juvenile justice system. The model does not aim to predict precisely what will happen in the future as there are too many influential factors that cannot be modelled accurately (e.g. "law and order" political campaigns). Instead, the model provides a baseline set of data assuming that the current system behaviour will remain stable over the time period modelled, with only the underlying demographics changing. This baseline model provides a set of standard output that can be used for comparison with proposed system changes.

Once the baseline results have been recorded, the user can include one or more prospective programs at the leverage points. The model is then re-run with the proposed programs included and the relative reduction in traffic through the juvenile justice system can be examined. Due to the nature of micro-simulation models, the results of the modelling exercise can be broken down by any number of factors. For example, the user can broadly explore the overall reduction in court appearances or can examine the reduction in detention orders given to, for example, Indigenous females over each year of the program.

Furthermore, the model allows some simple cost-benefit analysis by incorporating the costs incurred by the Department of Communities (the cost of court appearances and supervision of detention and community-based orders) under each scenario.

4.3. Modelling an Early-Intervention Program with QJJSM

As an example of the QJJSM's use, we model a family-based counselling program aimed at five to ten year olds commencing in 2001. As such, this program is targeting young people who have yet to have any contact with the juvenile justice system (as only young people aged between 10 and 16 are dealt with by the juvenile justice system). A meta-analysis of evaluated family-based intervention programs demonstrated that a 12% reduction in the initiation of juvenile offending could be achieved (Farrington, 1994). Consequently, we assume that this program in the QJJSM will prevent 12% of generated new offenders from commencing an offending career. We assume that this program will be implemented in North Queensland and Far North Queensland.

The effect of this program on the overall number of court appearances for Indigenous and Non-Indigenous young people can be seen in Figure 3. The impact of the program is minimal between 2001 and 2007. The program is aimed at five to ten year olds and, as most young offenders do not initiate offending until their late adolescence, it will take at least five years for the majority of the oldest children to commence juvenile offending. It appears that the program has an earlier impact on Indigenous offending, which is consistent with the trend towards earlier commencement of offending for this group. By 2011, the simulation of this program estimates a reduction of 6.5% in the number of court appearances by Indigenous offenders across the Queensland juvenile justice system and a reduction of 1.7% in court appearances by non-Indigenous offenders. This differential effect is due to the high proportion of Indigenous offenders in the regions selected for this program.

The model also provides estimated costs. These costs do not include program-related costs and only reflect the impact on the Department of Communities. The model estimates that the family-based program in two regions would reduce court and supervision costs by around $10M over the ten years modelled with an average saving of approximately $2.5M per year by 2011.

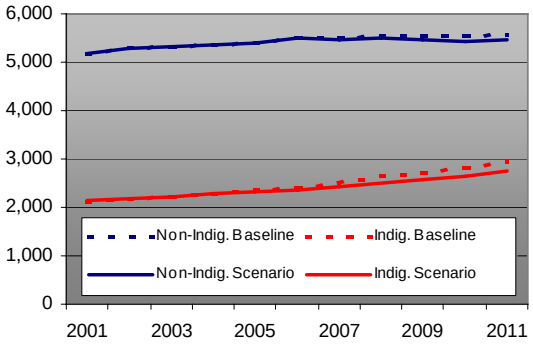

Figure 3. Simulation output – total court appearances (baseline and prevention program)

This example highlights that the benefits resulting from programs targeted at pre-adolescents can take a number of years to have an effect and that a program of this type can have a substantial impact on the juvenile justice system.

4.4. Sensitivity analysis

The aforementioned scenario was replicated with five different values of program efficacy (8%, 10%, 12%, 14% and 16%) to assess how sensitive the model results were to varying assumptions of efficacy. The results of these replications in 2011 are presented in Table 1.

Model settings	Appearances (2011)	Saving (2011)
Baseline	8,490	n.a.
Scenario (8%)	8,440	$0.7M
Scenario (10%)	8,390	$1.5M
Scenario (12%)	8,321	$2.5M
Scenario (14%)	8,207	$4.2M
Scenario (16%)	8,126	$5.4M

Table 1. Sensitivity of model results to changes in early intervention program efficacy

These results highlight the importance of a reasonable estimation of program efficacy, with reductions in total youth court traffic varying between 0.6% and 4.3% when efficacy is changed between 8% and 16%. In terms of costs, this variation in efficacy results in savings between $0.7M and $5.4M per year by 2011.

Estimates of the efficacy of proposed new programs are generally based around similar programs that have been evaluated in different jurisdictions. Unfortunately, well-conducted

evaluation studies of crime prevention, diversion and post-court programs in Australian settings are the exception rather than the rule and evaluations of overseas-run programs will not necessarily reflect the impact that these programs would have in Australia (Stewart, 2004). With these limitations in mind, standard use of the model involves providing results for at least 'best-case', 'worst-case' and 'most-likely' values of program efficacy.

5. ENSURING THE LONGEVITY OF THE QJJSM

It is clear that modelling of criminal justice systems is potentially of great use to both policy-makers and researchers. However, it is evident that despite the large effort spent developing justice models, they have not often been taken up by decision makers and have repeatedly fallen into obsolescence. This paper has presented a simulation model of the Queensland Juvenile Justice System that attempts to provide a user-friendly, easily maintainable tool that can be readily incorporated into policy analysis and decision-making.

The QJJSM has been developed with a strong focus on usability. In particular, the level of detail modelled in the QJJSM has been restricted to key decision points and attributes so that the modelling process can be easily explained to the (generally non-technical) prospective users. Furthermore, the development of the model in a graphical simulation package (Extend) has resulted in an intuitive interface that policy-makers can quickly become familiar with. This assisted in overcoming the resistance amongst criminal justice practitioners to quantitative decision support tools and has led to a wide range of Queensland Government policy-makers supporting the use of QJJSM for policy assessment, with the model already providing projections for one major Cabinet submission.

In addition to ensuring that the QJJSM was taken up by users, it was necessary to ensure that the model was easily maintainable. This meant that the QJJSM was built so that it required only existing Department of Communities administrative data and did not need any additional data collection. Due to the ease of linking Extend with Excel, it was also possible to develop a series of macros based on a standard data extraction that recalculate the model parameters at the end of each financial year. These steps have ensured that the model has been maintained efficiently and accurately reflects the most recent trends in the Queensland Juvenile Justice System.

6. CONCLUSIONS

The model presented in this paper is a parsimonious and easily maintainable tool that allows policy makers to analyse the medium-term consequences of juvenile justice policies before they are implemented. The model has been developed after careful examination of previous modelling efforts in criminal justice and is designed to engage with non-technical users. The QJJSM has already been used by the Department of Communities to assess the impacts of substantial changes to the juvenile justice system and it is expected that the model will become an integral component of policy and planning in the Queensland Juvenile Justice system.

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