A SIMULATION OF CASE MANAGEMENT OPERATIONS AT THE WORKERS' COMPENSATION BOARD - A DECISION SUPPORT TOOL FOR HUMAN RESOURCE ALLOCATION -

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Abstract

The challenges in human resource allocation drive the present project. Conducted at an office of the Workers' Compensation Board of British Columbia (the WCB), the project aims at developing a simulation model of claim management operations to facilitate decision-making in resource allocation. In this context, resource allocation refers to the alignment of staff to claims. The components of the problem include the number of staff required and the types of staff required, given targeted system performance.

The volume of claims, the profile of claims, the Workers Compensation Act, the board's business guidelines and the board's operational targets all influence staffing requirement. It is far from straightforward to answer the following questions: what is the optimal level of staffing? What is the right mix of skills? And what is the proper alignment of staff with claims? How will the system perform given a certain staffing level? How will change in the profile of incoming claims influence staffing requirement?

A discrete-event simulation model was developed as a decision support tool in this project. The model was used to evaluate several resource allocation scenarios. Simulation showed that timeliness measures such as time to decision and time to closure would improve with additional resources, but the improvement was not drastic. At the staffing level of 14, compared to the current level of 12, time to decision for unadjudicated claims would reduce by 6%. Simulation further showed that specialization of staff by claim type might have a negative impact on system performance measures, because economics of scale were compromised. Finally, simulation showed that if Site Visits, a required procedure for adjudicating claims related to Activity-Related Soft Tissue Diseases, could be conducted by dedicated personnel, time to decision for these claims might reduce by as high as 60%.

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I. Introduction

A. Context and Motivation

This project was conducted as part of a large-scale initiative of the Workers' Compensation Board of British Columbia to review multiple facets of its business. Since 1995, the board has undergone significant changes in technology, business process, and organizational structure. The changes have enabled the board to significantly improve the service rate for some types of claims – mainly simple and straightforward claims. However, similar magnitude of improvement has not been achieved for complex claims. More importantly, the average claim cost of complex claims has increased significantly in 1998 and 1999. Such a phenomenon has prompted a large-scale initiative at the board to review multiple facets of its business.

B. Project Objective

The challenge that drives this project is human resource allocation. In this paper, resource allocation refers to the alignment of staff to claims. The components of the problem include the number of staff required and the types of staff required, given targeted system performances.

A simulation model of the Case Management[1] process was developed as a decision support tool for human resource allocation. The model was based on the operation of the case management office in Surrey (also referred to as the Surrey Service Delivery Location, or the Surrey SDL). Description of the case management process and how it differs from regular claim processing can be found in Chapter II. This project is part of a large initiative to review resource allocation and the claim management practices across all business units and offices of the Compensation Division. The ultimate goal of the initiative is to determine how to optimally allocate human resources to handle claims.

Several factors led us to choose simulation as the approach of the study. First, the board recognizes the need to understand the dynamics of all phases of the claims management process. Naturally, one can not forgo developing a thorough understanding of the underlying business process before constructing a simulation model. Secondly, the implementation of the E-File system in late 1997 made available some of the data on workflow that did not previously exist. With E-File, the data system now captures not just actuarial information but some information on the business process, such as the date on which a certain activity is performed on a claim. Analysis of the data from the E-File system for the purpose of building the simulation model would provide insight to the problem of resource allocation. Finally, the board is interested in a tool that is flexible as

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[1] The practice of case management at different offices across the province may vary. To be exact, the case management model practiced at the Surrey office, where our study takes place, is sometimes referred to as the hybrid case management model. However, for simplicity we will use the term case management to refer to the operation of the Surrey office.

opposed to problem-specific. A simulation model enables scenario analysis and can be modified relatively easily when necessary.

C. Project Focus

Our focus is Case Management. case management is one of the three business units of the compensation division of the Workers' Compensation Board. We chose the case management as the area of study because this is where costly claims converge. It is an area where the business process diverges significantly from straightforward claim application processing. Though business protocols exist, offices of Case Management, called Service Delivery Locations (SDLs), may have very different practices. Increasing the understanding about the actual business practices of SDLs is one of the goals of the large initiative under which this project operates.

D. Other Approaches to Resource Allocation Problems

The problem of human resource allocation is not new. Vandergraft (1983) applied a fluid flow model in the context of claims processing to determine the number of workers required at each workstation of a claim processing office. In the study, each workstation is in charge of reviewing one part of a claim application. A similar study was done using integer programming to determine the optimal number of workers for each workstation of a social welfare office represented by a closed queuing network (Lewis et al. 1998.) These studies, however, concern resource allocation problems of a very different nature from the problem in hand. Mainly, the staff in the case management is not organized by workstation. The claims in case management are complex claims that may remain in the system for months and sometimes years. Frequent transfer of claims from one case manager to another is undesirable as the "setup" time for he or she to review a claim file and get familiar with it is high.

Athanassopoulos (1998) addressed a resource allocation problem in the provision of public services. Data Envelopment Analysis and goal programming are combined to determine the number of staff that should be allocated to each office. The model links benchmarking with resource allocation. The problem of resource allocation is examined at a "macro level," in contrast with studies that were conducted at the process level, the "micro level." Such an approach is a potential area of research and may help determine the overall staffing level for each of the 17 offices of the board across the province.

II. Background

A. Case management in Context

In British Columbia, workers' compensation insurance is provided and administered by a crown corporation - the Workers' Compensation Board of British Columbia. The services provided by the board can be divided into two areas. One area of service consists of processing forms, making eligibility decisions, and administering compensation. In this regard, the board operates like a regular insurance company. The other area consists of planning and monitoring clinical recovery and vocational rehabilitation programs. This line of services resembles that of a healthcare organization. We refer to the first area of services as claim processing and the second area of services as claim management.

To process and manage over 170,000 claims received each year, the board has approximately 1300 highly skilled personnel in the Compensation and Rehabilitation Division alone. In the division, there are three major types of business units: the Call Center, the Entitlement Unit and the Service Delivery Locations. Each manages progressively more complex claims. There are currently 17 offices in the Case Management. Each office is referral to as a Service Delivery Location (SDL).

Diagram 1 illustrates the dependency between SDLs and the other business units. All claims go through the Call Center for initial processing. Claims that require special expertise are routed soon after arrival at the Call Center to the SDLs. In addition, some claims are routed to case management after they have been with the Call Center or the Entitlement Unit for a certain period of time when a certain criteria is met. Duration of wage loss is one of the criteria. After 35 days of wage loss, for example, claims are routed to case management for on-going management.

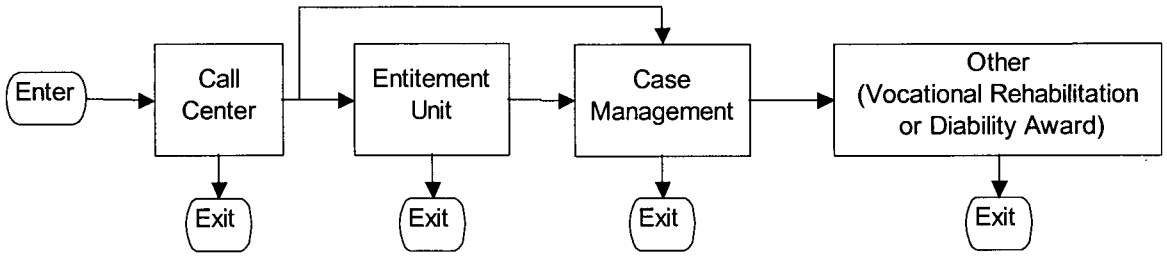

Diagram 1 The flow of claims between business units

Case management is where claim processing and claim management converge. Diagram 2 provides a functional view of Case Management. On one hand, claims that require special expertise in adjudication are reviewed at the Case Management. An example is claims with gradual onset of syndrome. These types of claims are not related to specific incidences of injury. For instance, a worker may file a claim caused by inappropriate working condition for a prolonged period of time. Such is the case of Activity-Related Soft Tissue Disorders (ASTDs), which includes Carpal Tunnel Syndrome. These

disorders may or may not be caused or aggravated by employment activities. Often, the staff at SDLs has to visit the worksite in conjunction with Occupational Therapist to assess the level risk of in the employment activities in causing such disorders. The difficulty in adjudicating such claims may be further aggravated by the protests of employers. Employers, who may be assessed of higher premiums because of increased number of claims, may disagree with the board's decision to accept claims that are not related to specific incidences.

On the other hand, case management encompasses not only claim processing but claim management. Other than making eligibility decisions and administrating payments, the staff at the case management offices, or Service Delivery Locations, plans and monitor rehabilitation programs and return-to-work progress of workers in conjunction with healthcare providers and occupational therapists. Proactive claim management is believed to increase the likelihood of returning workers to the work place and reduce claim costs.

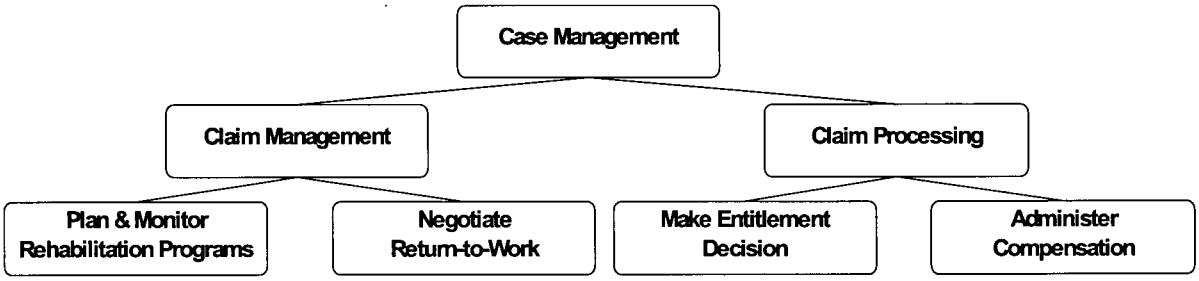

Diagram 2 Functional view of Case Management

B. Business Needs

The performance of compensation services can be assessed from three perspectives - service rate, costs, and quality. In terms of service rate, the goal of the board is to ensure the income continuity of injured workers by expediting claim processing. In 1998, the average number of calendar days from the date of disablement to the first short-term disability payment is 21 days. The goal is to improve the timeliness to within 17 days by year 2003.

The desire to improve timeliness, however, has to be balanced with the concern for rising operating costs. In addition, expedient decision-making has to be achieved without diminishing the appropriateness of decisions, which directly impact claim costs and quality of services. Quality of service is not explicitly taken into consideration, because there is no commonly agreed measure for quality available. Designing measures for quality is a potential area of research.

C. Current System Performance

In this study, the focal point is service rate and resource allocation. A major indictor for service rate is the time to the first entitlement decision. We refer to the interval between a claim's arrival at the Surrey SDL and the completion of an initial entitlement decision as time to decision. Note that some claims may require subsequent entitlement decisions. Examples are claims that initially request only health-care compensation and subsequently request wage loss compensation due to change in injury condition. However, we did not attempt to consider the timeliness for making subsequent decision due to data unavailability.

For example, for ASTD claims (see Chapter III.A Terminology) that arrive at the SDL between January 1999 and June 1999, the time to make the first entitlement decision is on average 39.4 days. The distribution varies widely from 0 day to 131 days (Figure 1). As shown in Figure 1, less than 30% of claims received initial entitlement decisions within 20 days at the Surrey SDL. In addition, the claims analyzed received initial decisions in 37 days on average, compared to the organization-wide average of 21 days and the board's target of 17 days. Although the lag of the SDL in timeliness performance may be mainly a result of the complexity of claims managed, analysis of this study provides some insight into the various factors causing the delay, and helps identify areas for improvement.

The other system performance measure used is the time from a claim's arrival to closure. The measure is used in validating the simulation model alone with the measure of timeliness.

Other measures of interest are the queuing time of claims that are waiting for a certain task, or procedure, to be performed on them. The WCB does not currently record these measures. Therefore, we did not attempt to validate the simulation model using these measures. However, these measures are also used in comparing scenarios in simulation for illustration purpose. The validity of these measures rendered by the simulation needs to be checked before using them for definite conclusions.

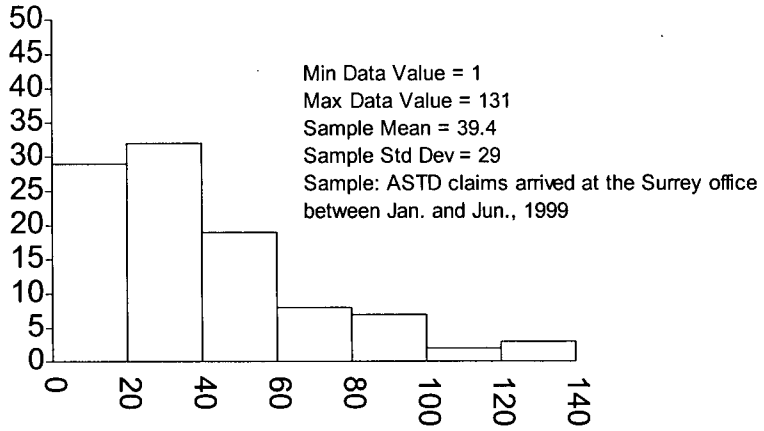

Figure 1 Time to decision distribution of ASTD claims

III. Simulation Model Formulation and Parameterization

This chapter summarizes the simulation model built in this study to assist decision-making. A summary of terminology used in this paper is first presented in Section A. A high level description of the case management process model is then presented in Section B. Sections C, D, and E highlight some modelling approaches adopted. Section F gives an overview of the simulation program structure. Section G summarizes some assumptions of the simulation model. Finally, parameters used in the baseline simulation model are available in Appendix B.

The simulation model is developed in ARENA, a simulation software package.

A. Terminology

Case manager (CM) and team assistant (TA)

The case managers and team assistants are the human resources modeled in this study. There are currently 12 case managers and 12 team assistants in the Surrey SDL. Each case manager is assisted by a team assistant. However, team assistants do not assist case managers on a full-time basis. About 40% of their time is allocated to other tasks. In the simulation, the availability of the time of team assistants is modeled accordingly.

Entitle or Adjudicate

These are two terms used interchangeably. They refer to the action taken to make eligibility decision on a claim and on the associated amount of compensation. All claims receive at least one entitlement decision, termed as the initial entitlement decision in this study. However, there may be multiple subsequent entitlement decisions on a claim. Claims that have not been entitled are referred to as "unadjudicated".

Close and Reactivate

To the staff of the board, a claim is never literally closed. Once registered, a claim's record remains in the system permanently. In addition, there is always a possibility that a claim may be *reactivated*, if the claimant experiences relapse of syndromes caused by the original injury. In practice, when all work needed to be done for a claim is completed, the staff executes an action called *close* on the E-File system, the information system that stores all relevant information of claims.

Time to Decision

Time to Decision is one of the performance measures used in this study. It measures the number of days between the arrival at the SDL of a claim and its initial entitlement decision.

Time to Closure

Time to Closure is one of the performance measures used in this study. It measures the number of days between the arrival at the SDL of a claim and its closure.

Caseload

Caseload of a case manager refers to the number of active claims managed by he or she at any given time.

Y and C Claims

Claims are stratified into two categories – Y and C. Y claims are in general Activity-Related Soft Tissue Disease (ASTD) claims. These claims are routed to the SDL from the Call Center as soon as they are identified (Diagram 1). They arrive at the SDL unadjudicated. An initial entitlement decision by a case manager is required for a Y claim. C claims in general are complex claims that have been with the Call Center or Entitlement Unit for some period of time but are routed to the SDL after meeting some criteria (Diagram 1).

Wage Loss Duration

When a claimant suffers from wage loss due to a compensable injury, he or she receives wage loss compensation. Wage loss duration refers to the total number of days of wage loss prior to the closure of a claim.

B. Service Delivery Location (SDL) Operations

case management Process

We modeled the case management process at an SDL as a four-stage process: Initial Review, Initial Entitlement, Return-To-Work Management and Closure. Table 1 describes the tasks that may be performed by the staff at each stage. Diagram 3 shows the flow of claims from one stage to another.

Table 1 Examples of tasks at each of the four stages of the case management process

Step	Major tasks
Initial Review	- Access whether a claim has been routed to the office correctly - Assign a claim to appropriate staff - Gather missing information
Initial Entitlement	- Review the history of a claim - Collect medical and employment information - Determine eligibility of compensation
Return-To-Work Management	- Approve and administer payments - Arrange necessary rehabilitation programs - Monitor claimants' recovery progress
Closure	- Close payments and perform action "close" in the E-File system - Route a claim to Vocational Rehabilitation Consultants or Disability Award Officers

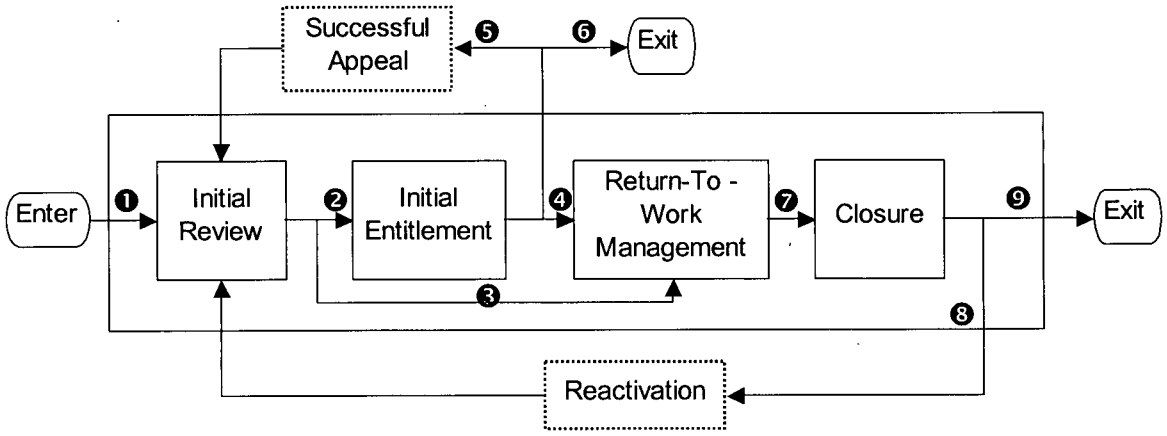

Diagram 3 High-level 4-stage process model of case management

A claim that enters an SDL may go through part or all of the four stages, depending on its type and status. The following describes the condition under which a claim takes a certain path. The numbers below refer to the labels of paths in Diagram 4.

❶ All claims go through the stage Initial Review.

❷,❸ After the stage Initial Review, a claim may take path ❷ or ❸. If the claim has not been entitled, it enters the stage Initial Entitlement via ❷ and awaits a primary entitlement decision on its eligibility for compensation. This type of claim accounts for approximately 20% of the claims routed into the Surrey SDL. Otherwise, the claim enters the stage Return-To-Work Management via ❸ because it has been accepted and requires on-going management.

❹,❺,❻A claim that is entitled at the SDL may be accepted and enters the stage Return-To-Work Management via ❹. Alternatively, it may be rejected. In this case, the claim may exit the system via ❻, or it may re-enter the system via ❺ if the claimant chooses to appeal and is successful in the endeavour.

❼ Depending on the claim type and on the progress of recovery, a claim stays in the stage Return-To-Work Management for a varied period of time, which can be as short as 0 day and as long as several years. After meeting some criteria, such as when the claimant returns to work or when the claimant reaches a stable health condition (Medical Plateau), the wage loss compensation for the claimant will be closed. The claim then enters the stage Closure via ❼.

❽, ❾ At the stage Closure, three things may happen to a claim. It may be closed without further action by any WCB staff, It may be routed to a Vocational Rehabilitation Consultant if employment training necessary[2]. Alternatively, it may be routed to the Disability Award office. Because the study focuses on the case management process, these three possibilities are modeled as closure identically. From the case managers' perspective, at the point of closure, a claim exits the system via ❾. Some claims, however, may be reactivated after closure. For example, a claimant may return to work for a week but is unable to continue working because of pain. If such the reopening request is accepted, the claim re-enters the system via ❽.

Although the majority of claims follow the flow delineated above, exceptions do exist. For example, sometimes a claim may be routed to an SDL inappropriately. Such a claim will be redirected to its proper destination after the Initial Review stage. Because such incidences are relatively infrequent, we do not attempt to capture these exceptions.

At the time of study, twelve case managers and team assistants composed four teams at the Surrey SDL. Each case manager is assigned a team assistant. However, team assistants do not assist case managers on a full-time basis. About 40% of their time is

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[2] Note that the interaction between Vocational Rehabilitation Consultants and case managers are simplified in the model. In reality, Vocational Rehabilitation Consultants may become involved in the case management Process in the stage Return-To-Work Management and play an advisory and consultative role.

allocated to other tasks. Each team consists of three case managers and team assistants. Each team is assigned to handle claims from a number of major employers.

When a claim arrives, the support staff at the Screen Desk (usually a team assistant) decides which case manager the claim should be routed to. If the claimant works for one of the major employers, then the claim is routed to a case manager within the team that is responsible for this employer. Usually, the Screen Desk employs a cyclic rule to assign claims to case managers. That is, within each team, a claim is routed to the case manager that has not been assigned a case for the longest time. There are exceptions to this rule. For example, when a claim is closely related to another claim that has been managed by a certain case manager, the claim may be routed to the same case manager. Such a situation exists when a claimant has multiple claims. We assume that claims are always routed cyclically.

Caseload and System Performance

The number of claims owned by a case manager is referred to as the caseload of the case manager. Depending on the claim type and the progress of recovery, a claim may remain in the system, or open, for as short as 0 day and as long as several years. At any given time, a case manager may "own" many open claims.

Caseload has a direct but mixed impact on system performance. On one hand, exceedingly high caseload results in lengthening queuing time. On the other hand, low caseload may results in low utilization of staff and undesirably higher administration and operational costs per claim. Long queuing time resulted from high caseload has two impacts. For one, client satisfaction naturally deteriorates. For the other, case managers are less likely to actively manage claims. It is a prevalent hypothesis at the board that active case management reduces the duration of wage loss, therefore the claim cost, while inactive case management increases it. However, one can also argue that if active case management accompanies reduced waiting period for eligible compensation, claim duration and frequency may increase. Bulter (1994) attempted to use waiting period as an explanatory variable for claim frequency and claim duration. The result showed that reduced waiting period increases claim frequency but reduces claim severity. However, the impact on claim duration is less than 0.3% for 10% decrease in waiting time.

The challenge of resource allocation is to maintain an appropriate caseload that achieves acceptable client service, lower claim cost, resource cost, and resource utilization. As the relationship between caseload and claim cost has not been established, however, we only consider the tradeoffs between client service, resource cost, and resource utilization in this study.

Diagram 4 presents a fictitious example that demonstrates the tradeoffs between client service and resource utilization. Increasing the caseload of the case manager in the example reduces the idle time of the case manager but also increase the waiting time for claim 1 and 3. Specifically, the entitlement decision of claim 4 was delayed, and the referral of claim 1 to a rehabilitation program is also delayed.

To achieve a balance between resource utilization and service, one needs to consider many factors simultaneously – such as the arrival rate of claims, the profile of claims, the case management process, the time required to complete tasks at each stage of the process, the uncontrollable delay that may occur during the process, and the capacity of the resources.

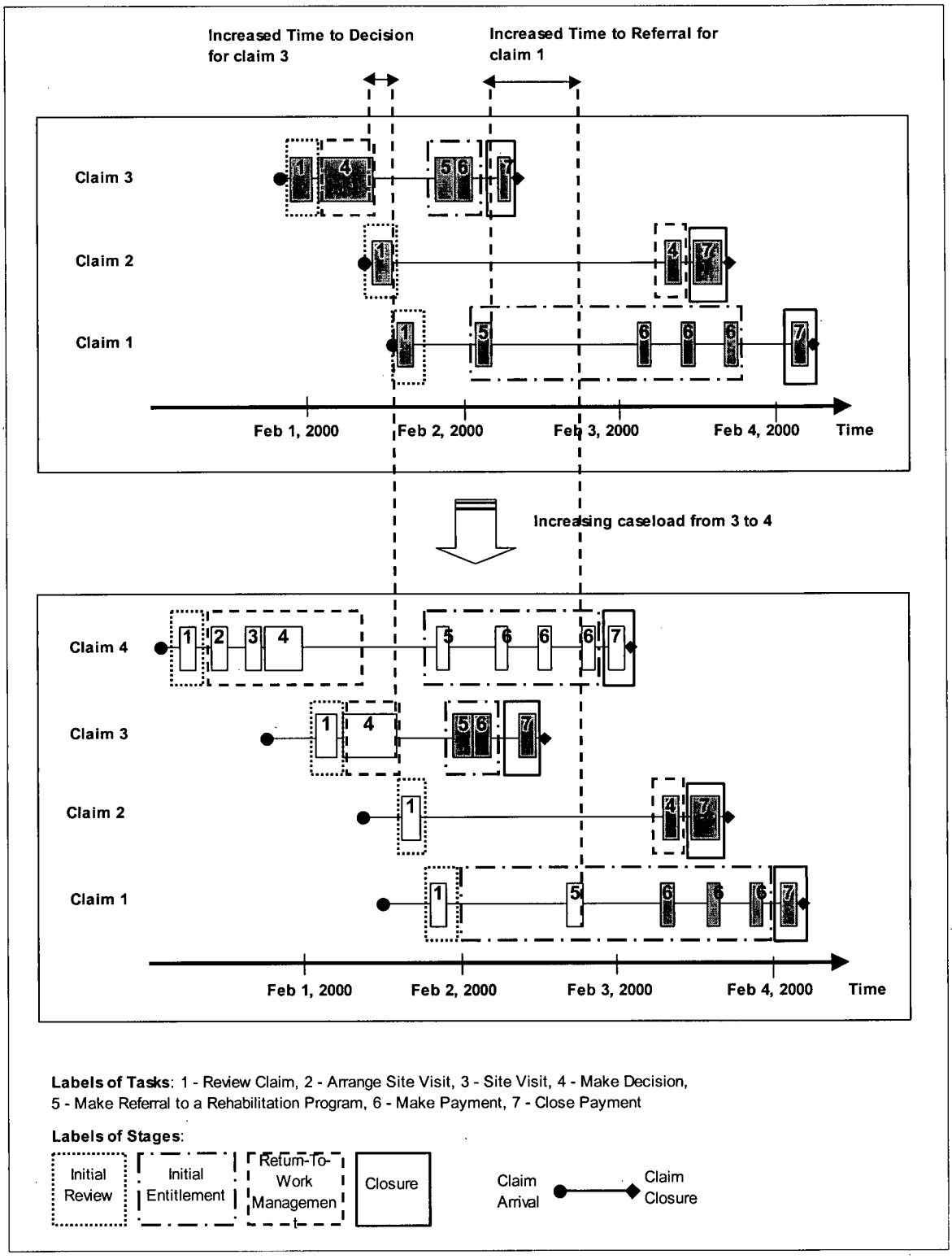

Diagram 4 Tradeoffs between resource utilization and service rates

C. Modeling Claim Inflow

The modeling approach of the claim inflow will be discussed below in two parts: the arrival process and the claim stratification.

Arrival Process

The following figure depicts the fluctuation of daily claim intake in 1999. The time series appears to be stationary around mean 13.8. Also, regression shows that there is no significant day-of-week effect. It appears that the volume of claim inflow in summer, particularly in July and August, was lower than other months in 1999. Longer time series, however, were not available to verify if there is month-of year seasonality. Analysis on the time series of claim inflow is presented in Appendix C.

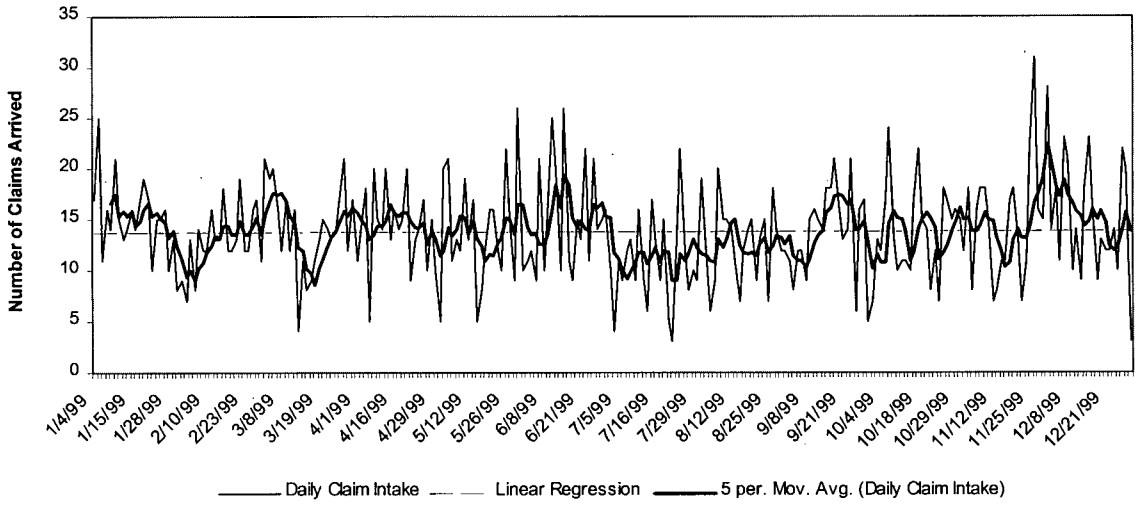

Figure 2 Daily claim intakes in 1999 (Non-workdays excluded)

The daily arrival rate of claims is estimated based on the data between January and November 1999. We were informed that the upstream business units worked overtime prior to Christmas of 1999 to clear some backlogs of claims and routed them to the SDL. To avoid bias, the data in December was excluded.

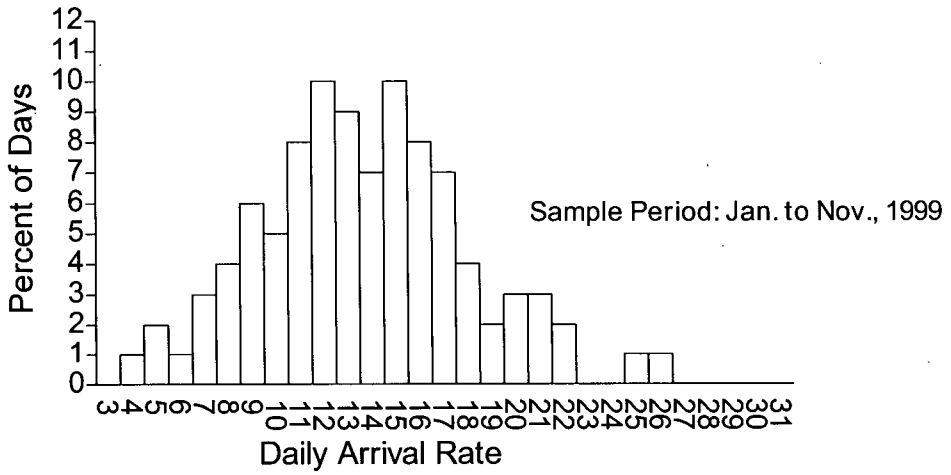

Figure 3 Distributions of daily intake

Figure 3 shows the distribution of volume of incoming claims during the period analyzed. Chi-square test shows that there is no strong evidence against the hypothesis that the daily arrival rate has a Poisson distribution (p-value >0.15).

Based on the above analysis, in the baseline simulation model, the arrival process of claims is modeled as a stationary Poisson process with daily rate of 13.8.

Claim Stratification

It is necessary to distinguish claim categories, because different categories require different services and may arrive at the SDL in different status, for example, adjudicated vs. unadjudicated. Each category of claim is referred to as a claim stratum.

The baseline simulation model is a two-stratum model – the C claim stratum and the Y claim stratum. The strata were defined in accordance of the claim prefix already defined in the information system of the WCB.

We assume that claims belong to the Y stratum are ASTD (Activity-Related Soft Tissue Diseases) claims that require initial adjudication. We further assume that a Site Visit and a report by an Occupational Therapist are required before a decision can be made.

We assume that claims from the C stratum are non-ASTD claims that entered the SDL adjudicated. A small proportion of the C claims are related to psychological disorders or highly serious injuries, such as brain injuries. The initial entitlement decisions for these claims are made by case managers. However, we did not model the process for managing these claims for two reasons. One, these claims account for only about 5% of the claims routed to the SDL in 1999. Two, the tasks required for managing these claims vary widely from one claim to another.

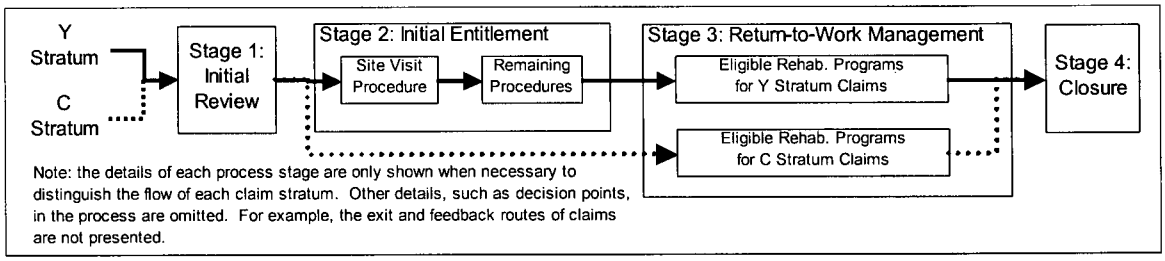

Diagram 5 Flow of claims from each stratum in the baseline simulation model

D. Modeling Claim Feedback

Claims may feedback into the SDL as a reactivated claim or an appellate return. The simulation model captures both routes of feedback.

Reactivation

Claims may be closed and reactivated. The sample proportion of claims being reactivated (18%) will be used as the probability of reactivation. In addition, the time between closure and reactivation will be drawn from a sample distribution.

Appellate Return

Claims that are disallowed by the case managers may feedback into the system if the claimants have successful appeals. These claim are called appellate returns. About 1.6% of the disallowed claims in the period analyzed became appellate returns.

E. Modeling External Delays

Examples of events or delays that are treated as external, outside the control of the SDL, include Medical Plateau, the time between referral to a rehabilitation program and its start, and the time between completing a Site Visit and obtaining a Site Visit report from an a third-party Occupational Therapist.

Delay in starting a rehabilitation program

After entitlement, a claim may be referred to a third-party provider for rehabilitation programs that supplement medical treatment programs sought by the claimant. After referral, the staff at the SDL will monitor the progress of the program and make decisions about the suitability of the claimant to return to work in conjunction with the third-party provider. The time between referral to a rehabilitation program and its start is modeled as an external delay.

Delay in obtaining a Site Visit report

The case managers need to conduct Site Visits in order to make initial entitlement decisions for some claims. After a work site visit, a Site Visit report will be completed by an independent occupational therapist. Such a report usually arrives one to two weeks after a Site Visit.

F. Simulation Model Formulation

The simulation model consists of five modules – the case management Process Module, the Random Inquiry Module, the Claim Profile Module, the Resource Module, and the Data Module. Organizing the simulation program into modules increases the flexibility of the model and allows us to modify the model easily. For example, with the Claim Profile Module, we can start by building a simple simulation model with only 2 types of claims and increase the level of claim categorization as necessary without modifying any other modules.

The heart of the simulation model is the case management Process Module. It is an expanded version of the high-level model shown in Diagram 3, and it captures the details of the process at a sufficient level that allows us to evaluate the scenarios of interest. The Random Inquiry Module simulates the phone inquiries generated by open claims. The Claim Profile Module creates new claims, assign parameters to claims, and change parameters of claims based on the claim status. The Resource Module controls the availability of the case managers and team assistants. Finally, the Data Module allows the user to input the parameters for all the other four modules. Diagram 6 presents the relationship of the five modules and the information flow between them. We describe each module in further details below.

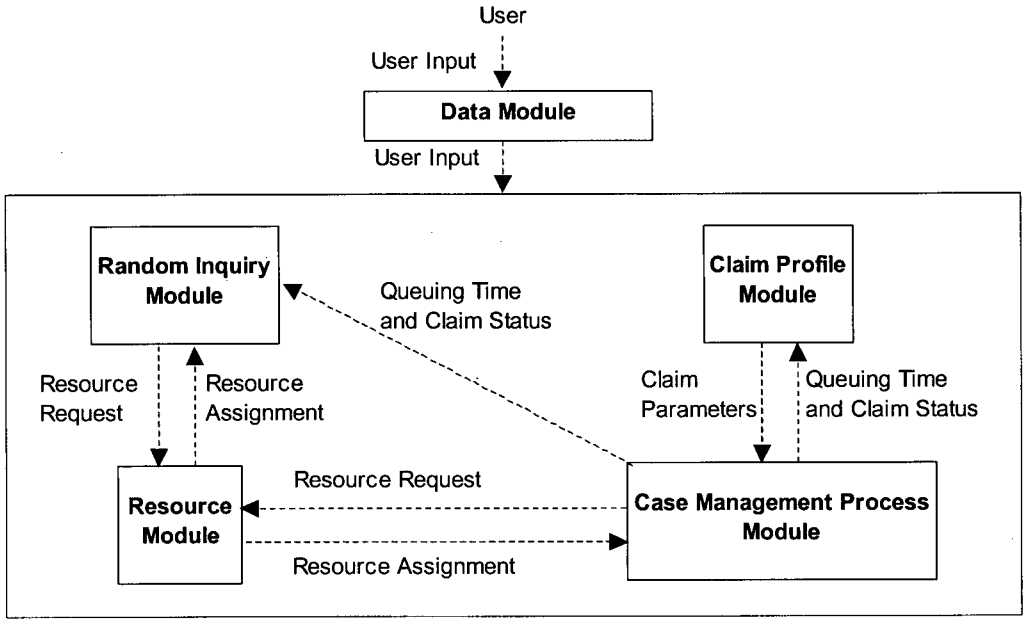

Diagram 6 case management simulation modules and inter-module information flow

case management Process Module

The case management Process Module routes a claim from one stage to another based on the type and status of the claim. Within each stage, a claim goes through sub-processes. Each sub-process is either a task, which is completed when the responsible staff is

available, or a delay that is beyond the control of the staff. A schematic view of the module is presented in Appendix A.

Random Inquiry Module

The Random Inquiry Module simulates the phone inquiries generated by open claims. Depending on the stage in which a claim is in, the frequency and purpose of inquiries differ. During the stage Initial Review and the stage Initial Entitlement, claimants or related parties may call their case managers inquiring about the entitlement decision before a decision has been made. During the stage Return-to-Work Management, the claimants may contact their case managers for a variety of reasons, for example, requesting an extension of therapy or requesting permission to take a leave from a rehabilitation program. Each case manager has his or her own style in handling these inquiries. Some case managers screen their phone calls and reply to their phone messages at their convenience, while others take phone calls as they come. However, in the simulation model it is assumed that these phone calls interrupt the case managers activities in hand and receive immediate attention from case managers when they arrive. The assumption was made because the gain in simplifying the model outweighs the gain in accuracy.

Claim Profile Module

The Claim Profile Module determines the type and the progress of a claim throughout the process. It creates new claims according to the arrival rate specified in the Data Module. After creating a new claim, it assigns parameters to the claim based on the type of the claim. Number of days of wage loss is one of the parameters assigned by the module to claims. By assigning wage loss days as a parameter, we are implicitly assuming that a claimant's wage loss duration is independent on what happens to his/her claim.

Resource Module

The resource controls the availability of the case managers and team assistants. This module simulates the vacation time and the regularly scheduled events such as weekly team meetings during which the staff is not available for managing claims.

Data Module

All parameters driving the simulation model are input to this module. The parameters required for simulation are described in Appendix B.

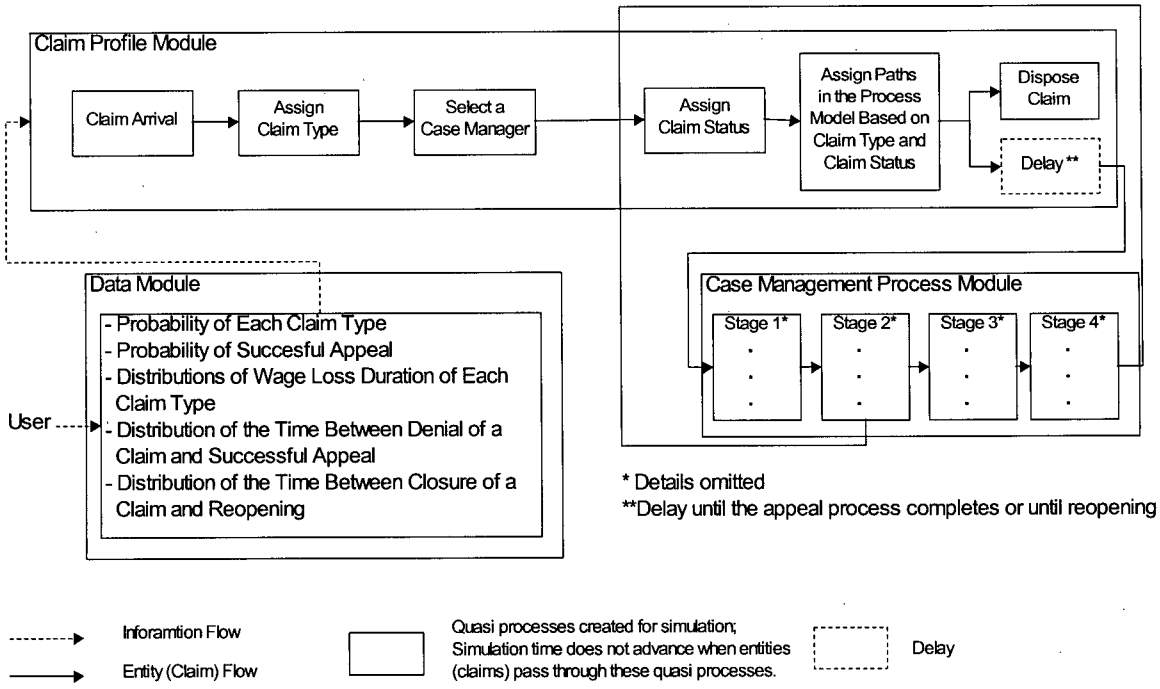

Diagram 7 Claim Profile Module and its interaction with other modules.

G. Model Assumptions

Several assumptions were made because data was insufficient or because it was necessary to simplify the model. The assumptions and their implications are described below.

1. The arrival process of claims into the Surrey SDL is Poisson and stationary.
2. The probability of a claimant filing an appeal and the probability of a claimant succeeding in appealing are independent of claim type and claim history.
3. The time that it takes to process an appeal is independent of claim type and history.
4. The probability of reactivation is independent of claim type and history.
5. The time to reactivation is independent of claim type.
6. Homogenous distributions of task times across staff with various lengths of experiences.
7. Wage loss duration is dependent on claim type but independent of what happens to a claim during the case management process. That is, the wage loss duration of a claimant is solely determined by the injury severity and treatment. It is not influenced by case managers or the case management process.
8. Case managers give top priority to phone call inquiries randomly generated.

For assumption 1, data on the arrival of claims in 1999 is used to determine the arrival process of claims into the Surrey SDL. Prior data was not used because the organization structure, and therefore the routing rules of claims, was extremely different from the current situation prior to the organizational change in late 1997. For the period analyzed, graphical tests appear to support assumption 1 that the arrival process is Poisson and stationary (see Appendix C). There appears to be a trend of increase in claim inflow. We are currently investigating whether the increase in claim inflow is a consequence of changes in routing policy or changes in external environment. The result of the investigation will help determine whether the trend will continue and whether it is necessary to model the claim arrival as a non-stationary Poisson process.

Assumptions 2 and 3 are made to simply the model. The impact of these assumptions was small because of the low volume of appellate returns that were routed to case managers for on-going management.

Assumptions 4 and 5 are made because there was not enough data available in the areas concerned. As described in the section Data Collection Methodology, reopening events are not accurately captured in the E-File system currently. As a result, the simulation model parameters associated with reopening were estimated based on the 100 E-File logs that we sampled.

Assumption 6 was due to considerations of labor relation. We have treated all information sources obtained in job-shadowing and interviews as anonymous. The task times observed or solicited during interviews were aggregated when estimating model parameters.

Assumption 7 was discussed in the section describing the Claim Profile Module. Quantifying the impact of case management on wage loss duration is a potential area of study that we have not investigated.

IV. Data Collection Methodology

The following data available in the information system of the board was analyzed to construct the simulation model. Data prior to 1998 was not available as the E-File system was implemented in late 1997.

- The available workflow data of the Surrey SDL captured by E-File during the period of 1998 and 1999.
- The actuarial data that captures some relevant claim information in the data warehouse of the WCB.

In addition, additional data was collected from the source described below to obtain data on workflow that was not available in the sources mentioned above:

- 100 samples of the E-File Log (a collection of memos written by the staff of the Surrey SDL regarding activities performed on each claim)

Finally, data regarding task time durations was collected in two ways:

- Interviews with the management and the staff of the Surrey SDL: subjective estimates of the task time were solicited. Specifically, we obtained during interviews the most likely task time for each task, as well as the minimum and the maximum.
- Job shadowing (direct observation): job shadowing was conducted at the Surrey office for a period of one week. We sat with a different case manager each day and observed his or her typical workday, while recording the task times. Data obtained from direct observation was used to cross-validate the subjective estimates gathered in interviews.

Although self-recording of task times by the staff may be an efficient way to collect more data in a shorter time, we decided not to adopt this data collection approach for the following reason. The data collection phase of this project (March and April, 2000) coincided with a special review in the office. We therefore decided to minimize the disruption on the operations and the demand on the staff's time during this period. However, sensitivity analysis was conducted to assess the impact of lacking accurate data on task time durations (Appendix D).

V. Simulation Model Validation

Diagram 8 illustrates the iterative procedure that we followed to validate the simulation model. We attempted to validate the model quantitatively whenever possible. Three system measures rendered by the simulation were compared with past observations. Due to lack of data, however, qualitative verification and validation of the model was necessary. We verified the process model and the simulation results with the management and the staff. In addition, we conducted job shadowing and reviewed a sample of event logs in the E-File system to verify the process model.

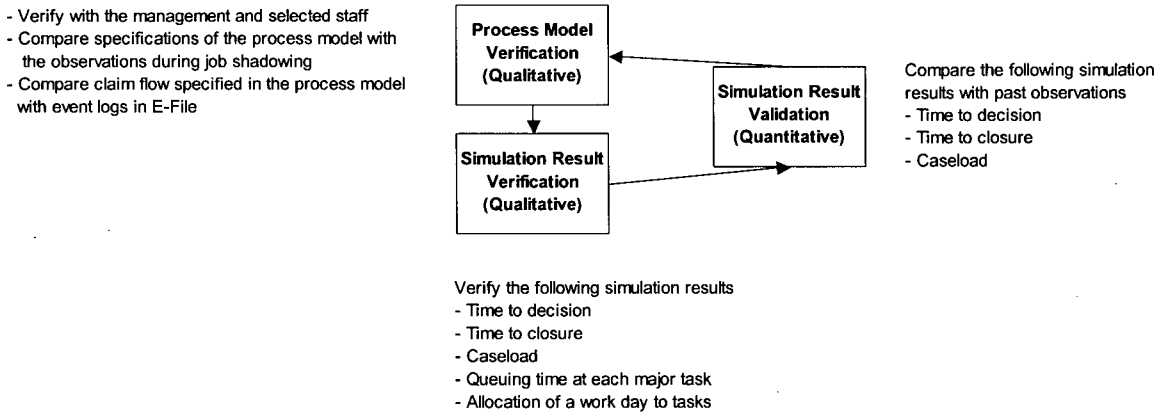

Diagram 8 Model validation procedure

A. Validation Results

Validation results of the two-stratum baseline model are presented in this section. Three system measures were used to quantitatively validate the simulation model – time to closure, time to decision, and caseload. Some examples of comparison between simulation and reality are provided at the end of this section.

Choosing an appropriate data sample to compare with the simulation results turned out to be a great challenge. On one hand, the simulation model is based on the current operation, which varies significantly from the operation prior to March 1999, before the Surrey office moved to its current location. Before the move, for example, case managers were stationed at the headquarters and did not conduct Site Visits. On the other hand, the sample of claims have to old enough, that is, arrive at the office early enough, to allow sufficient time for the claims to become adjudicated or closed. Whenever possible, we used a data sample that is more recent to compare with the simulation results.

The validation results are satisfactory. The distributions of the system measures are similar to reality in terms of average and shape of distributions. However, the simulation differ from reality in the following aspects:

- The caseloads are higher on average in reality than in the simulation.
  The average caseload in 1999 is higher than the average caseload in the steady state of simulation as shown in Figure 4. However, the surge in caseload near the end of 1999 may not be representative. The management of the Surrey SDL informed us that it was a result of overtime work by the Entitlement Unit prior to Christmas season.
- The spread of distributions is greater in reality than in the simulation.
  In reality, a small proportion of unusually claims may receive decision or close much faster or much slower than in simulation, which captures the general cases. For example, claims that receive only healthcare benefits are generally closed soon after arrival, compared to the overall (C and Y claims on aggregate) average day to closure of 79.8 days. For the other, a small proportion of C claims caused by serious injuries tend to last much longer because of extended wage loss duration.

It is possible to refine the simulation model by increasing the level of details captured in the simulation model. However, some issues in validation as described in the following section will remain.

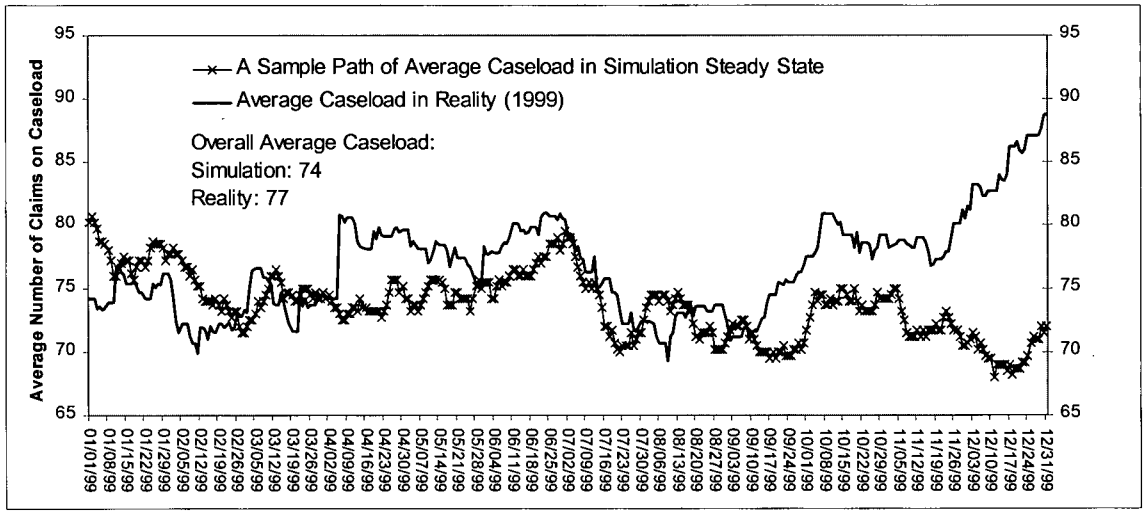

Figure 4 Caseload average rendered by simulation and observed in reality

Table 2 Comparison between simulation and reality

	Caseload	Time to Decision	Time to Closure (C claim)	Time to Closure (Y claim)
Reality (1999 Average)	77	39	87	59
Simulation Steady State (95% Confidence Interval)	74 ± 0.672	38.9 ± 1.04	89.1 ± 0.974	58.8 ± 1.39

B. Validation Issues

Validation of the simulation model was challenging for the following reasons:

1. Insufficient data

Two major categories of data drove the simulation model – the flow of claims and the distribution of the time required to complete each task. The E-File system provided some rudimentary ideas about the flow of claims. However, as the system was implemented in late 1997, we relied heavily on the data after mid-1998 to estimate parameters for the simulation model to avoid unrepresentative figures during and post implementation. As to the distributions of task times, there was no data available. We relied on subjective estimates and limited observations to establish parameters for the model.

2. Significant instability exists in the system during the time period under study.

From 1998 to early 1999, the WCB underwent significant organizational changes. Besides implementing an information system as described above, the organization redesigned its structure and decentralized some of its services. The impact of changes was systematic. Figure 5 shows the caseload on each case manager during 1998 and 1999. Redistribution of human resources during the reorganization caused claims to be transferred from one desk to another, as indicated by the sudden drops and surges of caseloads (CM2, CM8, and CM12 in Figure 5). When such events happened, case managers who received a group of claims would need to spend some time to familiarize himself or herself with the history of the claims. When necessary, the data affected by such events was excluded.

Note that the caseloads on the E-File system ramped up gradually from 1998 to early 1999. The reason is that only new claims registered after the implementation of the E-File system were included in the caseloads presented in Figure 5. Paper claims already in the system were not included in the caseloads. The caseloads presented were lower than the true caseloads until most paper claims had been closed.

3. Subjective aspects are not captured in the model.

The case management process is not completely standardized. Case managers rely on their judgment in processing and managing claims. For example, though in general priority is given to unadjudicated new claims, it is up to the case managers to decide which claims to give priority to on a given workday. Furthermore, the labor division between case managers and team assistants is not completely defined. Each case manager has his or her style in delegating tasks to the corresponding team assistant. Finally, subjective elements are also present in the data extracted from the E-File system. For example, in Figure 5 we see that the caseload of CM11 is consistently higher than most others between mid 1998 and 1999. The management of the Surrey SDL informed us that this case manager used to keep cases open longer than other case managers, usually waiting for the final documents of claims even when they might be technically

eligible for closure. The difference in personal style was one possible explanation for the higher caseload of CM11.

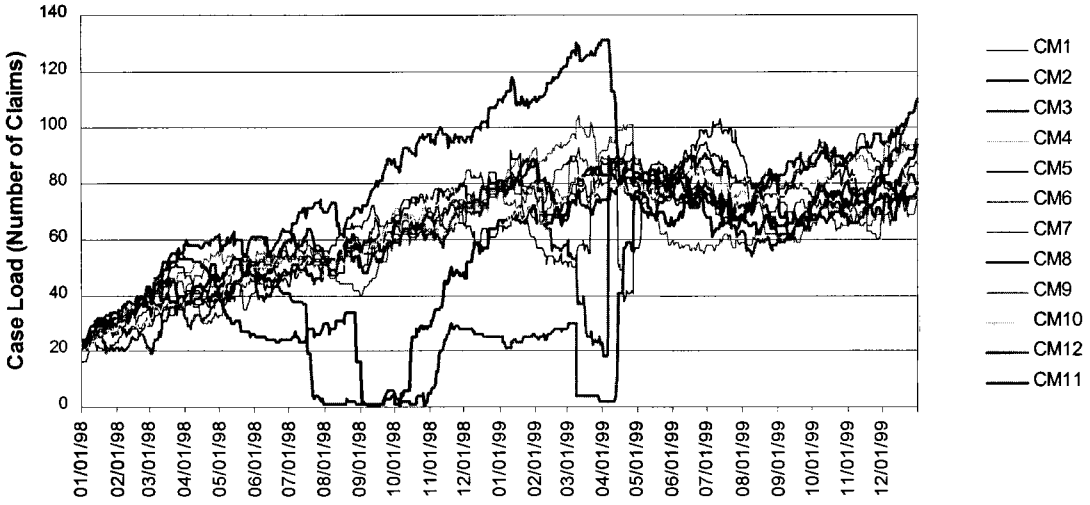

Figure 5 Caseloads of E-File claims of case managers in 1998 and 1999

(Each line correspond to a case manager)

VI. Scenario Analysis

Several scenarios are analyzed using the simulation model. The scenarios are chosen in consultation with the management of the Surrey SDL.

A. Scenario – Changing Staffing Level

We varied the staffing level of the office in the simulation model and assessed the tradeoffs between timeliness and staff utilization. The details of the simulation results are presented in Appendix E and Appendix F.

Figure 6 depicts the relationship between system performance and staffing level. Simulation showed that time to decision reduces by about 2.5 days with a staffing level of 14, compared to the current staffing level of 12. We define the adjusted time to decision as the total number of days to decision minus the average number of days of external delay incurred during the Site Visit procedure, which is on average 22.9 days based on the E-File logs for 50 Y claims that we sampled. The adjusted time to decision is on average 16 days in the baseline model, while the adjusted time to decision is on average 13.5 days at the staffing level of 14, which represents 15% improvement from the baseline simulation model. Note that timeliness is quite stable as the staffing level decreases from 11 and 12. However, it starts to deteriorate severely when the staffing level drops to 10. (Figure 6, top left and top right)

Further, as the staffing level increases, the average time from the arrival of a C claim to the stage 3 (Return-to-Work Management) reduces from 8 days to 6.6 days. The stage 3 is where case managers refer a claimant to rehabilitation programs and monitor his or her return-to-work progress (Figure 6, bottom left). The sooner a claim reaches this stage the earlier a case manager can take necessary measures to prevent any return-to-work issue.

There are trade-offs between resource utilization and system performances. As the staffing level increases, resource utilization decreases. The percent of time spent in the tasks captured in the model drops from about 92% to 83% as the staffing level increases from 12 to 14.

Based on the interviews with the case managers, 60 seems to be a good caseload level at which case managers feel that they can actively manage claims (Figure 6, bottom right). Based on the simulation results, such a caseload level can be achieved at the staffing level of 14.

We must emphasize, though, that the simulation model does not capture the human aspects of the system. In the simulation model, it is assumed that task time durations remain the same at various staffing levels. In reality, however, task time durations may change along with caseload. Variation in task time durations may also be correlated with variation in quality. Further, it is assumed in the simulation model that wage loss durations of claims do not vary with what happens to claims during the case management

process. In reality, more active case management due to higher staffing levels may change wage loss durations of claims, which in turn change the resource requirement of claims.

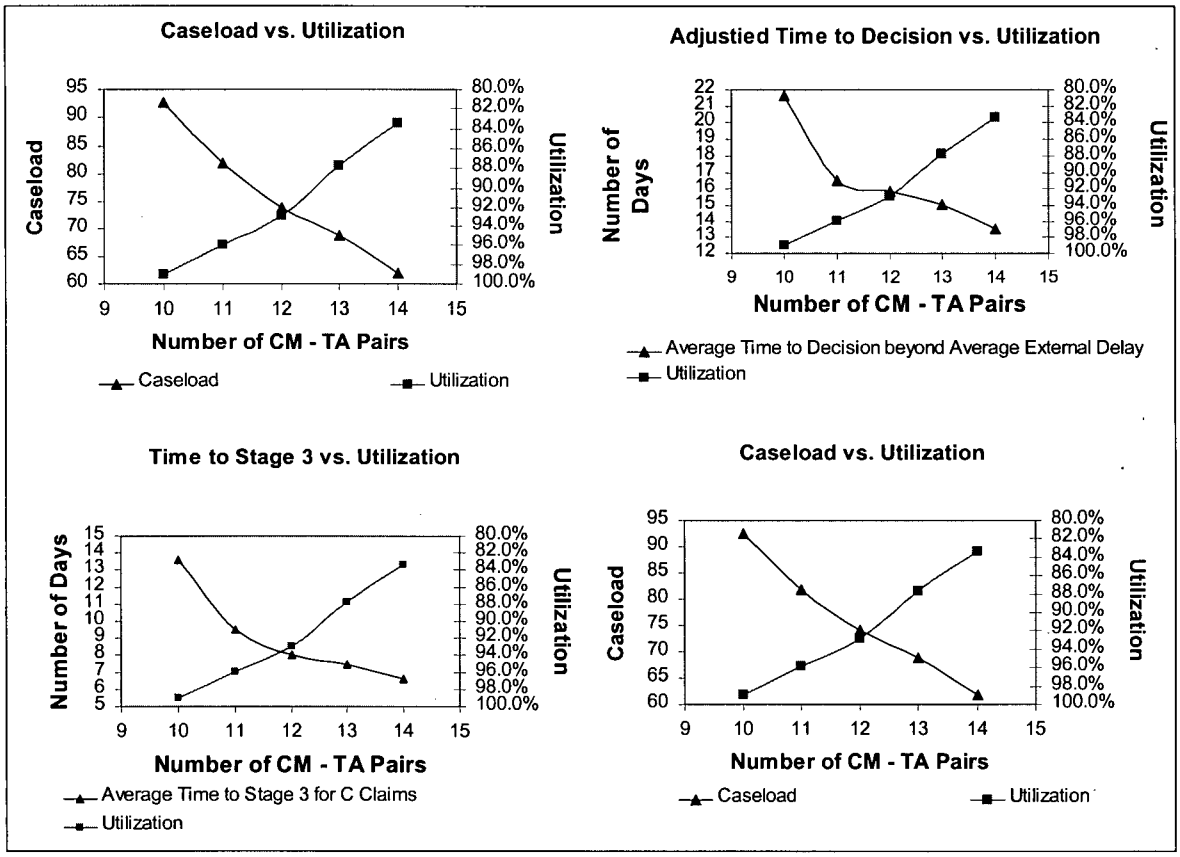

Figure 6 Simulation results - staffing levels and system performance measures

B. Scenario – Alternating Configurations of Teams

As described earlier in this paper, currently case managers are generalists who do not formally specialize by claim type. At the Surrey SDL, there are at present four teams, each with three Case Mangers and three team assistants. Each team is assigned to handle claims from 25 of the top 100 employers with the highest yearly volumes of claims. Therefore, if an incoming claim belongs to one of the top 100 employers, the claim is routed to the team responsible for this employer. Within each team, claims are assigned in a cyclic fashion. If a claim does not belong to any of the 100 employers, then it is not routed to any specific team and is routed in a cyclic fashion.

We evaluated the scenario of reorganizing teams. Teams of case managers are organized by claim stratum in this scenario. The rationale is that specialization may improve quality of services as the skills required for managing C and Y claims are different. On one hand, Y claims are mostly unadjudicated Activity-Related Soft Tissue Disease claims. These claims usually lack easily identifiable work-related incidences and have

lower expected wage loss duration in comparison to C claims. To management Y claims, the ability to investigate thoroughly and make decisions accurately and quickly is crucial. On the other hand, C claims are in general adjudicated claims. They are deemed complex because of long recovery periods or long wage loss durations. Issues in Return-to-Work may arise during a long period of recovery. Therefore, the skills require for managing these claims are more in the realm of negotiation, coordination, and consultation.

The following table summarizes the team configurations that were simulated. We refer to case managers that handle all Y claims as Type 1 and the case managers that do not handle Y claims as Type 2.

Table 3 Team configurations that were simulated

	Configuration I	Configuration II
Claims Assigned to Type 1 case managers	100% of Y claims	100% of Y claims and 5% of C claims
Claims Assigned to Type 2 case managers	100% of C claims	95% of C claims
Number of Type 1 case managers	3	3
Number of Type 2 case managers	9	9

The following tables summarize the simulation results. Details of the simulation results are available in Appendix F. Time to decision and time to closure under configuration 1 do not differ significantly from the baseline. Time to stage 3, however, deteriorated because fewer case managers are available to handle C claims. Under both configurations, discrepancy between utilization exists between the two types of case managers. The utilization rate of case managers responsible for only C claims is higher than those assigned Y claims. However, as the configuration moves toward "softer" specialization, such is the case of configuration II, the discrepancy is reduced.

Several other aspects not captured by the model need to be considered when evaluating this scenario. For example, using the current case assignment rule, the case management teams are expected to have a better relationship with the top 100 firms. This benefit may be retained in this scenario by allowing case managers to specialize by firm within each team. Around 50% of all claims came from the top 100 firms in 1999. The Y claims, mostly unadjudicated Activity-Related Soft Tissue Diseases, appear to be less concentrated than C claims. As shown on the left of Figure 7, 50% of the Y claims came from 20% of the firms with Y claims, while 50% of the C claims came from 10% of the firms with C claims. However, the number of firms with C claims is much larger, as shown on the right of Figure 7. To flag 50% of the claims and assign them to appropriate case managers in charge of the corresponding firms, case managers responsible for Y claims will be assigned about 60 firms, while case managers responsible for C claims will be assigned 135 firms. Under the alternative team configurations, if three case managers are to specialize in Y claims, each case manager responsible for Y claims will be

assigned 20 firms, while each case manager responsible for C claims will be assigned 15 firms, compared to about 8 firms in the baseline configuration.

Finally, workplace equality and staff preference are also important factors in designing team configurations. Under the two configurations that we simulated, the case managers assigned to handle Y claims have to spend around 30% of their day on the road to conduct Site Visits. Also, specialization may result in less variable work activities. Staff preference is one factor that should not be overlooked.

Table 4 System performance measures under alternative team configurations

		Team Configuration		
		Baseline	Configuration 1	Configuration 2
System Measures	Average Caseload (Number of Claims)	74.00	Type 1: 33.66; Type 2: 87.75	Type 1:47.02 ; Type 2: 81.83
	Average Time to Decision for Y claims (Days)	38.90	38.01	39.84
	Average Adjusted Time to Decision for Y claims (Day)	16.00	15.11	16.94
	Average Time to Closure for Y claims (Days)	58.80	58.94	60.18
	Average Time to Closure for C claims (Days)	89.10	90.37	89.65
	Average Time to Stage 3 for C claims (Days)	7.99	10.144	8.7
	Utilization of Case Managers	92%	Type 1: 74%; Type 2: 99%	Type 1: 84%; Type 2: 92%

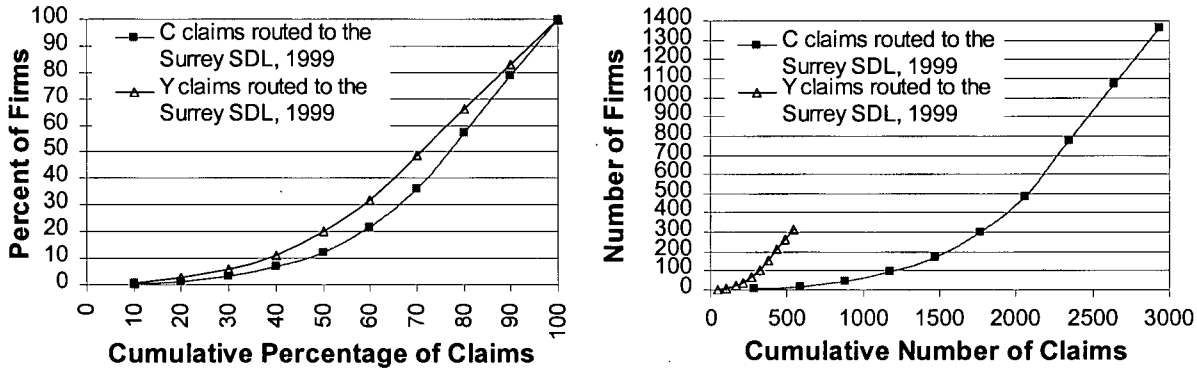

Figure 7 Concentration of claims
(Note: 10% of the C claims came from the top 5 firms and 10% of the Y claims came from the top 3 firms.)

C. Scenario – Dedicating Personnel for the Site Visit Procedure

We evaluated the scenario of hiring two Occupational Therapists in house, instead of contracting out the work. The Occupational Therapists are responsible for conducting Site Visits along with the case managers and writing up Site Visit reports, generally required for making initial entitlement decisions for Y claims. Currently, the average external delay incurred in arranging a Site Visit and receiving a Site Visit report is 22.9 days.

We assumed that the time it takes to complete a Site Visit report has a triangular distribution with 2 hours as the most likely value, 3 hours as the maximum, and 1 hour as the minimum. The simulation results showed that the total waiting time for a Site Visit and a Site Visit report is on average 3 days. Time to decision for Y claims is about 15 days on average in this scenario, compared to the baseline of 39 days. The two Occupational Therapists, however, are only 75% utilized.

Table 5 System measures under the scenario of dedicating personnel for Site Visits

		Baseline	Scenario: Dedicating 2 Occupational Therapists for Site Visits
System Measures	Average Caseload (Number of Claims)	74.00	71
	Average Time to Decision for Y claims (Days)	38.90	14.79
	Average Time to Closure for Y claims (Days)	58.80	42.65
	Average Time to Closure for C claims (Days)	89.10	87.63
	Average Time to Stage 3 for C claims (Days)	7.99	7.23
	Utilization of Case Managers	92%	90%

VII. Areas for Further Investigation

The model developed in the present study was based on the operations at the case management Service Delivery Location (SDL) of Surrey. Among the seventeen SDLs of the WCB in British Columbia, the Surrey SDL is one of the largest in terms of both resource availability and the Claim intake. Differences in case management practice, claim volume, and claim profile are likely to exist among the SDLs. Further investigation is necessary before generalizing the results of the present study.

Further, the present model focuses on the case management operations and treats upstream business units, the Call Center and the Entitlement Unit, as external. Designed as such, the model treats claim intake as given, while in reality both the B.C. work environment and the routing policy of the board influence the claim intake of the office. The model's utility is therefore limited to facilitate planning within the case management operations. Future study may incorporate the upstream business units into the model. Such a model may be used to determine resource allocation across the three business units under alternative routing policies.

One important area of future research is the impact of case management on wage loss duration. The initial phase of such research may involve establishing credible severity index of injuries that enable the board to estimate the expected wage loss duration more accurately in the early phase of a claim's life cycle. Then, it may be possible to compare claims with comparable severity index with various degree of active case management. Though a controlled experiment is not possible, one may take use of natural experiments for such research. For example, the staffing level in summer is significantly lower than winter in general because of vacation. Intuitively, claims accepted during the low-staffing months receive less active management than usual. It may be possible to isolate the impact of less active Case Management on wage loss durations, which is directly associated with claim costs. The result of such research will enable incorporating claim costs into the current simulation model.

Conclusion

A discrete-event simulation of case management operation was developed in this project. The model was based on the current operation of the Surrey office of the Workers' Compensation Board of British Columbia.

The challenges in human resource allocation drove the present project. Conducted at an office of the Workers' Compensation Board of British Columbia (the board), the project aimed at developing a simulation model of claim management operations to facilitate decision-making in resource allocation. In this context, resource allocation refers to the alignment of staff to claims. The components of the problem include the number of staff required and the types of staff required, given targeted system performances.

The case management operation was modeled as a four-stage process: Initial Review, Initial Entitlement, Return-To-Work Management and Closure. Claims are stratified into two types – C and Y claim stratum, based on the process routing rule. The validation results of the 2-stratum model were satisfactory. It is possible, however, to refine the model by increasing the level of claim stratification. This may be an area for future study.

Constructing the simulation model and validating it was a very challenging exercise for two reasons. For one, the case management process is by nature not a completely standardized process. For the other, the system being modeled was very unstable during the data period due to organizational restructuring, In addition, data challenges continued throughout the project. Insufficient data was available for estimating durations of task time and several types of external delay. In the case when sufficient data is available, such as wage loss duration, the challenge was to choose an appropriate sample of data. On one hand, sampling more recent claims enables us to estimate parameters closer to the current system condition. On the other hand, when the sampling period is too close to the cut-off date of the data, the sample becomes heavily biased. The closer the sampling period is to the cut-off of the data, which is the end of year 1999, the less claims in the sampling period are available for estimating parameters.

The simulation results provided insight into the relationship between system performances and staffing level. Timeliness measures may improve as the staffing level increases. However, the measures are not highly sensitive to increase in the staffing level. For example, to improve timeliness by three days, 14 case managers are required, compared to the current staffing level of 12. At the staffing level of 14, resource utilization is around 82%, compared to 94% in the baseline simulation model. Also, at this staffing level, the average caseload is 61, compared to 74 of the baseline simulation. Note that several other aspects have to be considered along with the simulation results. For one, task time durations may change as caseloads change. It is likely that case managers spend more time in making entitlement decisions and providing services with higher quality. This may have a mixed impact on the system. For one, increase in task time durations offsets the improvement in timeliness. For the other, active case

management may change the wage loss durations of claims, with which resource requirement varies.

Besides staffing level, alternative configurations of teams were evaluated. The simulation results showed that specialization of case managers by claim type has a mixed impact on system performances. Timeliness for making decisions for Y claims may improve slightly. However, timeliness for C claims may deteriorate. Again, aspects not captured in the model need to be considered. Potentially, specialization by claim type may enhance the quality and effectiveness of services.

Finally, simulation showed that time to decision may be dramatically reduced from 39 days to 15 days should two Occupational Therapists be hired in house to conduct Site Visits and write Site Visit reports. Such a scenario may be infeasible if Site Visit reports need to be written by impartial third parties. The simulation results nonetheless gave insight to the sensitivity of timeliness to external delay, and projected the magnitude of improvement on timeliness should external delay be reduced.

Future studies may focus on two areas – expanding the current simulation model or analyzing the impact of case management on wage loss durations. An expanded model that captures the whole claim processing system of the WCB, from Call Center, Entitlement Unit to the case management Service Delivery Location, will be useful in evaluating alternatives of claim routing rules and the impacts of each alternative to the whole system. Research on wage loss durations, however, is of fundamental importance. The result of such research will determine whether it is reasonable to assume that wage loss durations are independent of staff availability.

In conclusion, through the development of a discrete-event simulation model, we increased the understanding of the factors that impact the requirement of staffing. Further, the model serves as a tool that facilitates personnel planning, enables scenario testing, and helps the board to answer the questions about staffing with greater confidence.

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Appendix A Case management Process Module – A Schematic View

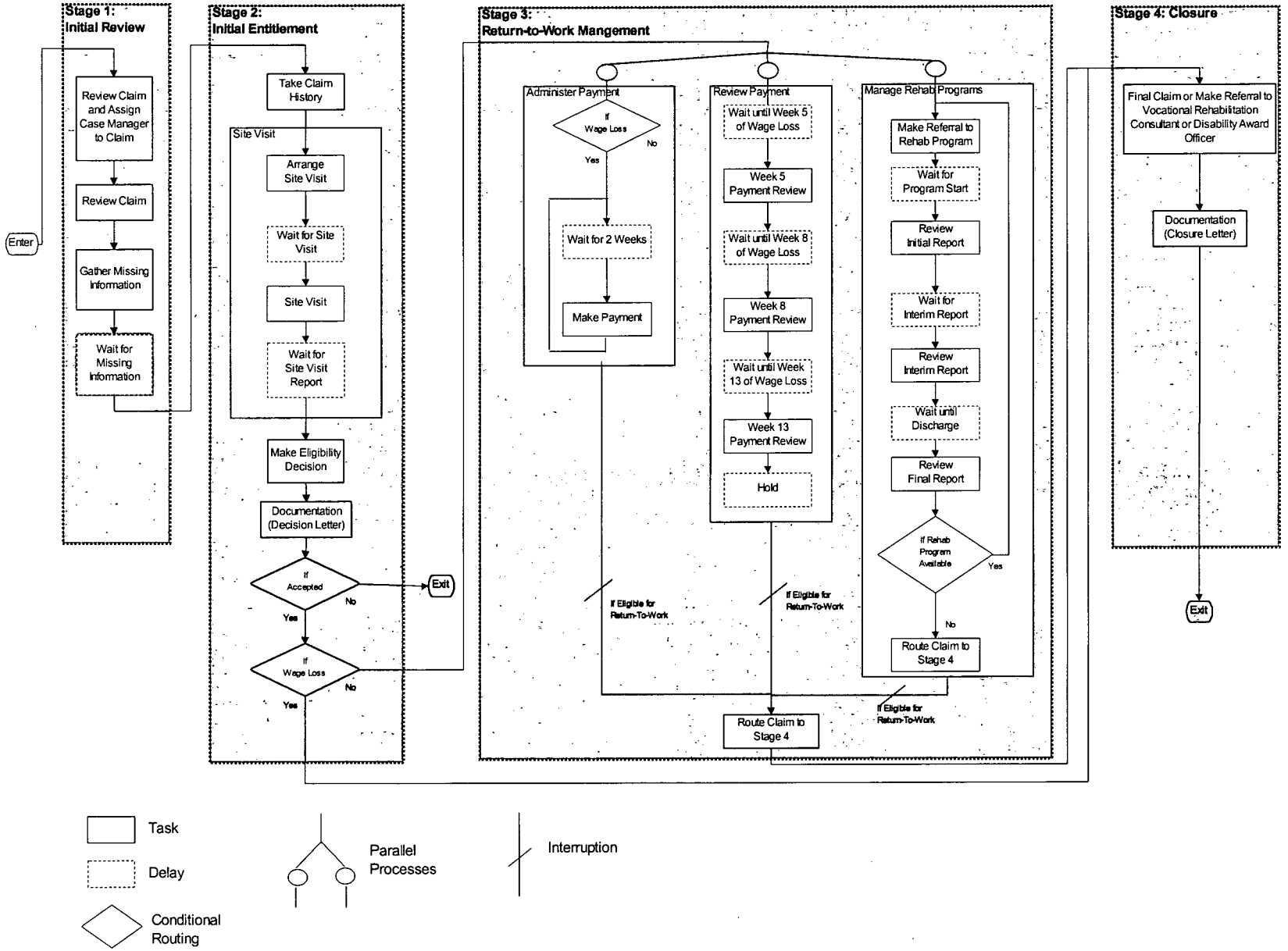

Diagram 9 Case management process module of the baseline simulation model

Appendix B Parameters of the Baseline Simulation Model

Table 6 Task time durations used in the baseline simulation model

Parameter Name	Description	Data Source	Distribution
Assign_CM	Time required to review routing decision and assign claim to case manager	Subjective estimation with adjustment [1]	Triangular (unit:min) ▪ Min=5 ▪ Most likely=10 ▪ Max=25
Review_Claim	Time required to review a claim upon arrival	Subjective estimation with adjustment [1]	Triangular (unit:min) ▪ Min=20 ▪ Most likely=30 ▪ Max=40
Gather_Info	Time required to gather missing claim forms through phone contacts	Subjective estimation with adjustment [1]	Triangular (unit:min) ▪ Min=10 ▪ Most likely=20 ▪ Max=30
Take_History	Time required to take a statement of work history and injury history	Subjective estimation with adjustment [1]	Triangular (unit:min) ▪ Min=30 ▪ Most likely=45 ▪ Max=60
Arrange_Visit	Time required to arrange a Site Visit	Subjective estimation with adjustment [1]	Triangular (unit:min) ▪ Min=5 ▪ Most likely=10 ▪ Max=20
Site_Visit	Time required to conduct a Site Visit, commute time included	Subjective estimation with adjustment [1]	Triangular (unit:min) ▪ Min=130 ▪ Most likely=160 ▪ Max=190
Initial_Entitlement (Non-Acceptance)	Time required to make the first entitlement decision including composing a decision letter for claims that receive non-acceptance decisions	Subjective estimation with adjustment [1]	Triangular (unit:min) ▪ Min=45 ▪ Most likely=60 ▪ Max=90
Initial_Entitlement (Acceptance)	Time required to make the first entitlement decision including composing a decision letter for claims that receive acceptance decisions	Subjective estimation with adjustment [1]	Triangular (unit:min) ▪ Min=15 ▪ Most likely=20 ▪ Max=30
Make_Payment	Time required to calculate and make payment	Subjective estimation with adjustment [1]	Triangular (unit:min) ▪ Min=2 ▪ Most likely=10 ▪ Max=20
Wage_Review	Time required to complete wage rate and payment review	Subjective estimation with adjustment [1]	Triangular (unit:min) ▪ Min=20 ▪ Most likely=30 ▪ Max=50
Rehab_Referal	Time required to make a referral to a rehabilitation program	Subjective estimation with adjustment [1]	Triangular (unit:min) ▪ Min=5 ▪ Most likely=10 ▪ Max=20
Report_Review	Time required to review reports from rehabilitation programs	Subjective estimation with adjustment [1]	Triangular (unit:min) ▪ Min=10 ▪ Most likely=20 ▪ Max=45

Close_Claim	Time required to finalize payment, close a claim, and composing closure letter or make disability award referral	Subjective estimation with adjustment [1]	Triangular (unit:min) ▪ Min=30 ▪ Most likely=45 ▪ Max=60
Respond_Inquiry	Time required to respond to the inquiry of claimants who called	Subjective estimation with adjustment [1]	Triangular (unit:min) ▪ Min=2 ▪ Most likely=5 ▪ Max=20
Handle_GRTW	Time required to handle issues arise during a Graduated Return to Work program	Subjective estimation with adjustment [1]	Triangular (unit:min) ▪ Min=10 ▪ Most likely=20 ▪ Max=30

Table 7 External delay time durations used in the baseline simulation model

Parameter Name	Description	Data Source	Distribution
Wait_Visit	Time between arranging site visit and visiting site	100 E-File Logs [2]	Gamma (unit:day) 0.5 + GAMM(6.09, 1.27,10) Sample Mean = 8.2 Sample Std Dev =7.8
Wait_ACES	Time between completing site visit and obtaining site visit report	100 E-File Logs [2]	Lognormal (unit:day) 0.5 + LOGN(15.4, 19.9) Sample Mean = 14.7 Sample Std Dev =13.2
Wait_Info	Time between requesting missing claim info and receiving it	Subjective estimation with adjustment [1]	Expo(3) (unit:day)
Wait_WCP	Time between completing referral to Work Conditioning Program and commencing it	Rehab. database; referrals made by Surrey in 1998 and 1999	Beta (unit:day) 274 * BETA(0.272, 12.7) Sample Mean = 5.75 Sample Std Dev =10.5
Wait_ORP	Time between completing referral to Occupation Rehabilitation Program and commencing it	Rehab. database; referrals made by Surrey in 1998 and 1999	Beta (unit:day) 195 * BETA(1.3, 17.6) Sample Mean = 12.6 Sample Std Dev= 13.1
Wait_Pain	Time between completing referral to Pain Program and commencing it	Rehab. database; referrals made by Surrey in 1998 and 1999	Beta (unit:day) 118 * BETA(0.83, 4.14) Sample Mean = 19.7 Sample Std Dev= 18
Wait_ASTD	Time between completing ASTD program (a rehab. program) referral and commencing it	Rehab. database; referrals made by Surrey in 1998 and 1999	Triangular (unit:day) ▪ Min=7 ▪ Most likely=35 ▪ Max=76
Wait_App	Time between closing a disallowed claim and receiving the Review Board decision	Jan. to June, 1998, workflow data from the CaRRs database and Review Board database	Triangular (unit:day) ▪ Min=115 ▪ Most likely=291 ▪ Max=466
Wait_React	Time between closure of disallowed claims and receipt of Review Board decision	Claims closed between Jul. and Dec.,1998	Weibull (unit:day) WEIB(67.2, 0.722) Sample Mean = 81.5 Sample Std Dev = 103

Table 8 Wage loss durations used in the baseline simulation model

Parameter Name	Description	Data Source	Distribution
WL_Y	Wage loss duration of Y claims accepted for wage loss compensation	New Y claims registered between Jul. and Dec., 1998 from the Data warehouse and CaRRs database	Weibull (unit:day) WEIB(37.8, 0.711) Sample Mean = 48 Sample Std Dev= 79.6
WL_C	Wage loss duration of C claims accepted for wage loss compensation	New C claims registered between Jul. and Dec., 1998 from the Data warehouse and CaRRs database	Exponential (unit:day) Expo(83) Sample Mean = 83 Sample Std Dev= 73.4

Table 9 Claim stratum probabilities used in the baseline simulation model

Parameter Name	Description	Data Source	Distribution
Prob_Y	Probability of an arrived claim belonging to the Y stratum	1999 workflow data from the CaRRs database	Constant 16%
Prob_C	Probability of an arrived claim belonging to the C stratum	1999 workflow data from the CaRRs database	Constant 84%

Table 10 Other probability parameters used in the baseline simulation model

Parameter Name	Description	Data Source	Distribution
Prob_React	Probability of an accepted claim returning the system through reactivation	Claims closed between Jul. and Dec.,1998	Constant 18%
Prob_App	Probability of a disallowed claim returning the system as an appellate return	Jan. to June, 1998, workflow data from the CaRRs database and appeal database	Constant 1.64%
Prob_Non-AC_Y	Probability of a Y claim that receive non-acceptance decision by a case manager during the first initial entitlement decision	Y claims arrived between Jan. and June, 1999, from the workflow data of CaRRs	Constant 20%
Prob_HC_Y	Probability of a Y claim being accepted for healthcare only by a case manager during the first initial entitlement decision	Y claims arrived at the SDL Jan. and June, 1999, from the workflow data of CaRRs	Constant 24%
Prob_AC_Y	Probability of a Y claim being accepted for wage loss by a case manager during the first initial entitlement decision	Y claims arrived between Jan. and June, 1999, from the workflow data of CaRRs	Constant 56%
Prob_HC_C	Probability of a C claim routed to the SDL with acceptance decision and outcome Healthcare Only	C claims arrived at the SDL between Jan. and June, 1998, from the data warehouse	Constant 5%
Prob_AC_C	Probability of a C claim routed to the SDL with acceptance decision and outcome non-healthcare only	C claims arrived at the SDL between Jan. and June, 1998, from the data warehouse	Constant 95%

Prob_Phone	Probability of an non-GRTW claimant calling to inquire about his/her claim	Subjective estimation with adjustment [1]	Constant 10%
Prob_GRTW Issue	Probability of an GRTW claimant calling for GRTW issues	Subjective estimation with adjustment [1]	Constant 15%
Prob_GRTW	Probability of a claimant on a GRTW program	100 E-File Logs [2]	Constant 20%

Note:

[1] Estimates from the management were solicited and compared with observations obtained during a one-week job shadowing. When significant difference between the management estimation and observation exists, discussion with the management and the case managers were made to adjust the subjective estimates.

[2] 100 E-File Logs, which contain memos written by case managers and team assistants, are sampled. Some parameters there were not available as fielded data in the E-File system of the board were obtained from this source.

Appendix C Claim Inflow

The time series of the aggregate daily claim inflow into the Surrey SDL exhibits noisy fluctuation around a mean that appears to be stationary (Figure 8).

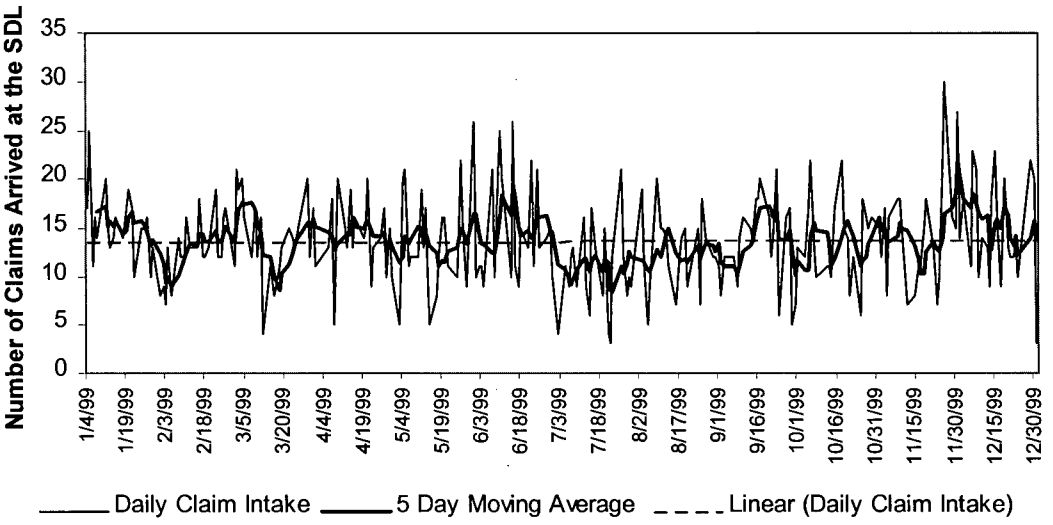

Figure 8 Inflow of claims in 1999

The autocorrelations of the time series of daily claim inflow exhibits no obvious pattern (Figure 9).

In addition, there was no significant day-of-week seasonality. Regression shows that day-of-week explains less than 2.5% of the variation in the volume of daily claim inflow.

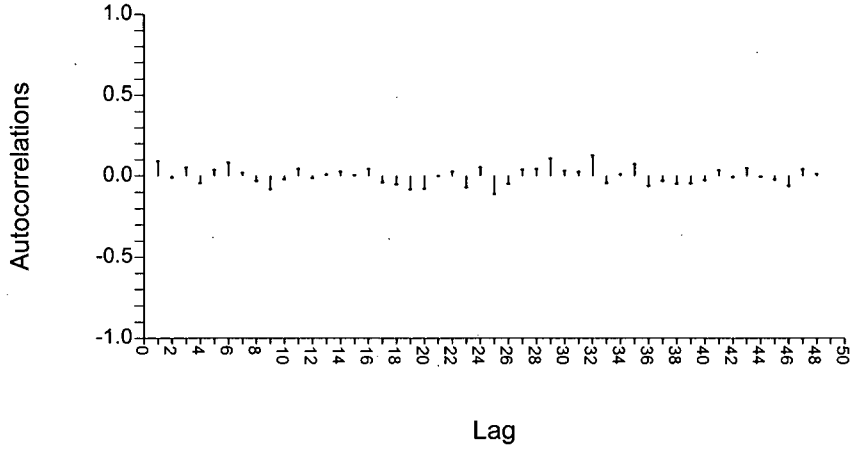

Figure 9 Autocorrelations of the time series of daily claim inflow

Appendix D Sensitivity Analysis

Here, we assess the sensitivity of the simulation model to the parameters of which the major data source was subjective estimates and job shadowing. The parameters were increased by 100% and decreased by 100% individually, and the resulted changes in system measures were recorded.

Overall, the system measures are not highly sensitive to the selected parameters. Increasing or decreasing the parameters by 100% results in less than 4% change in system measures on average. However, the model is relatively sensitive to the task time duration of reviewing rehabilitation reports. Increasing the task time duration of reviewing rehabilitation reports by 100% results in about 18.5% increase in time to decision for Y claims, and around 7.6% increase in other system measures. Although the task time duration of reviewing rehabilitation reports used in the current simulation model was verified by the management and the staff of the Surrey SDL, additional observations may be necessary to ensure accuracy of this particular task time duration. This has not been attempted in this study.

Table 11 Percent change of system measures due to 100% increase of parameters

		Task Time Duration Increased by 100%					
		Review Claim	Site Visit	Make Rehab. Referral	Reivew Rehab. Report	Close Claim	Make Entitlement Decision
System Measures	Average Caseload (Number of Claims)	3.86%	0.14%	-0.95%	7.61%	0.11%	4.61%
	Average Time to Decision for Y claims (Day)	9.49%	2.83%	1.44%	18.51%	0.82%	10.00%
	Average Time to Closure for Y claims (Day)	6.77%	2.82%	-0.80%	7.69%	2.11%	4.35%
	Average Time to Closure for C claims (Day)	2.67%	1.00%	-0.90%	6.92%	-1.20%	0.56%
	Utilization of Case Managers	7.61%	3.26%	4.35%	7.61%	0.00%	2.17%

Table 12 Percent change of system measures due to 100% decrease of parameters

		Task Time Duration Decreased by 100%					
		Review Claim	Site Visit	Make Rehab. Referral	Reivew Rehab. Report	Close Claim	Make Entitlement Decision
System Measures	Average Caseload (Number of Claims)	-0.18%	-1.42%	1.12%	-1.51%	0.41%	1.28%
	Average Time to Decision for Y claims (Day)	-0.18%	-3.80%	1.47%	-3.83%	0.41%	1.90%
	Average Time to Closure for Y claims (Day)	1.12%	1.22%	0.29%	-4.95%	-3.35%	-1.31%
	Average Time to Closure for C claims (Day)	-1.12%	-1.99%	1.57%	-1.30%	0.98%	0.84%
	Utilization of Case Managers	-3.26%	0.00%	-3.26%	-9.78%	1.09%	0.00%

Appendix E Simulation Results of 5 Staffing Levels

Note: GRTW stands for Graduated Return-to-Work. It is a program planned and monitored by case managers to help injured workers return to workplace gradually. Also, note that the average adjusted time to decision is defined as the number of days to decision beyond the average external delay incurred during the Site Visit procedure, 22.9 days.

Table 13 System measures of 5 staffing levels (simulation)

		Staffing Level (Number of CM-TA Pairs)				
		10	11	12	13	14
System Measures	Average Caseload (Number of Claims)	92.64	81.94	74.00	68.75	61.91
	Average Time to Decision for Y Claims (Day)	44.48	39.42	38.90	38.04	36.39
	Average Adjusted Time to Decision for Y Claims (Day)	21.58	16.52	16.00	15.15	13.49
	Average Time to Closure for Y Claims (Day)	65.00	59.48	58.80	58.52	56.47
	Average Time to Closure for C Claims (Day)	90.97	91.17	89.10	89.10	86.41
	Average Time to Stage 3 for C Claims (Day)	13.62	9.48	7.99	7.50	6.61

Table 14 Average time allocation of case managers at 5 staffing levels (simulation)

		Staffing Level (Number of CM-TA Pairs)				
		10	11	12	13	14
Activity Category	Close Claims	0.84%	0.69%	0.69%	0.85%	0.58%
	Conduct Site Visits	8.90%	7.80%	7.25%	6.58%	6.37%
	Handle GRTW Issues	9.06%	8.39%	7.16%	6.83%	5.52%
	Make Initial Entitlement Decisions	3.90%	3.51%	3.54%	3.07%	2.70%
	Make Referrals	5.07%	5.03%	4.97%	4.81%	4.76%
	Not Busy	1.02%	4.14%	8.18%	12.27%	16.56%
	Respond to Phone Inquiries	11.15%	11.20%	9.86%	9.14%	8.84%
	Review Claims	12.28%	10.82%	10.15%	9.60%	8.87%
	Review Rehabilitation Reports	24.09%	25.36%	25.94%	25.22%	24.48%
	Take Claim History	4.35%	3.80%	3.71%	3.35%	3.21%
	Team Meeting Preparation	7.56%	7.89%	7.72%	7.73%	7.78%
	Team Meetings	4.64%	4.74%	4.72%	4.84%	4.90%
	Wage Review	7.15%	6.64%	6.13%	5.72%	5.42%

Table 15 Average time allocation of team assistants at 5 staffing levels (simulation)

		Staffing Level (Number of CM-TA Pairs)				
		10	11	12	13	14
Activity Category	Arrange Site Visits	1.73%	1.52%	1.39%	1.27%	1.23%
	Assist Vocational Rehab. Consultants	48.25%	48.20%	48.62%	48.07%	48.34%
	Gather Information	11.08%	9.92%	8.76%	8.44%	7.92%
	Handle GRTW Issues	8.13%	7.67%	6.25%	6.08%	4.87%
	Make Payments	5.89%	5.96%	5.55%	5.27%	5.01%
	Not Busy	12.13%	13.65%	15.72%	16.69%	18.65%
	Team Meeting Preparation	6.63%	6.69%	6.69%	6.72%	6.67%
	Work at the Screen Desk	1.82%	1.97%	2.69%	3.07%	2.94%
	Team Meetings	4.34%	4.42%	4.33%	4.40%	4.37%

Appendix F Simulation Results of Alternative Team Configurations

Table 16 System performance measures under alternative team configurations

		Team Configuration		
		Baseline	Configuration 1	Configuration 2
System Measures	Average Caseload (Number of Claims)	74.00	Type 1: 33.66; Type 2: 87.75	Type 1:47.02 ; Type 2: 81.83
	Average Time to Decision for Y claims (Day)	38.90	38.01	39.84
	Average Adjusted Time to Decision for Y claims	16.00	15.11	16.94
	Average Time to Closure for Y claims (Day)	58.80	58.94	60.18
	Average Time to Closure for C claims (Day)	89.10	90.37	89.65
	Average Time to Stage 3 for C claims (Day)	7.99	10.144	8.7

Table 17 Allocation of time by case managers under alternative team configurations

		Configuration I		Configuration II	
		Type 1 Case Manager	Type 2 Case Manager	Type 1 Case Manager	Type 2 Case Manager
Activity Category	Close Claims	1.70%	0.42%	1.53%	0.40%
	Conduct Site Visits	30.31%	-	29.71%	-
	Handle GRTW Issues	-	10.35%	1.43%	7.67%
	Make Initial Entitlement Decisions	6.30%	2.14%	7.00%	1.96%
	Make Referrals	0.75%	6.29%	1.57%	6.26%
	Not Busy	27.48%	1.55%	16.73%	7.19%
	Respond to Phone Inquiries	3.05%	12.68%	4.40%	11.94%
	Review Claims	6.37%	11.52%	8.02%	10.81%
	Review Rehab. Reports	2.94%	32.10%	6.97%	31.86%
	Take Claim History	7.36%	2.31%	7.96%	2.02%
	Team Meeting	4.41%	4.81%	4.60%	4.83%
	Team Meeting Preparation	7.74%	7.79%	7.67%	7.83%
	Wage Review	1.59%	8.05%	2.40%	7.22%

Table 18 Allocation of time by team assistants under alternative team configurations

		Configuration I		Configuration II	
		Type 1 Team Assistant	Type 2 Team Assistant	Type 1 Team Assistant	Type 2 Team Assistant
Activity Category	Team Meeting	4.50%	4.39%	4.38%	4.38%
	Team Meeting Preparation	6.53%	6.68%	6.69%	6.64%
	Not Busy	25.00%	12.26%	21.64%	15.59%
	Work at Screen Desk	3.53%	1.83%	3.09%	2.14%
	Gather Information	5.42%	10.09%	7.00%	9.34%
	Arrange Site Visits	5.58%	-	5.69%	-
	Make Payments	1.00%	7.21%	1.79%	6.83%
	Assist Vocational Rehab. Consultants	48.36%	48.36%	48.47%	48.46%
	Handle GRTW Issues	-	9.18%	1.25%	6.62%