A MULTI-METHODOLOGY APPROACH TO ADDRESSING ICT SKILL SHORTAGES IN A GOVERNMENT ORGANIZATION: INTEGRATION OF SYSTEM DYNAMICS MODELING AND RISK MANAGEMENT

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Abstract

This paper describes a multi-methodology approach used to reveal feedback dynamics operating in supply of, and demand for, skilled information and communications technology (ICT) employees. It describes how a large public service organization has had difficulty in adapting to rapid technological change, and how this has been exacerbated by employee shortages. The impacts of changing demographics of the workforce and society are investigated, along with how these factors impact upon attracting, recruiting, training, and retaining employees. The paper is as much about what is needed to achieve implementation success as it is about the effective application of tools and techniques in the development of strategy. It describes the lessons learnt when a system dynamics model of the supply of ICT skills was combined with a tool that enabled analysis of the risks that shortages would arise, and the consequent cost of those shortages to the organization.

A Multi-methodology Approach to Addressing ICT Skill Shortages in a Government Organization: Integration of System Dynamics Modeling and Risk Management

Introduction

People, organizations, institutions and environments shape each other (Sastry, 2001: 377). When the environment within which an organization operates is continually changing, so the organization must adapt. Such adaptation must balance demand, supply, willingness to change and effectiveness (Beer, 1966: 474). In terms of workforce, change might take the form of adjustments through hiring or laying off staff; re-engineering business processes (Hammer and Champy, 1994: 80), or outsourcing (Leung, 1997); by acquiring new knowledge, developing individual and collective skills (Davenport and Prusak, 1998; Katzenbach and Smith, 1993: 47), by hiring new employees with targeted skill sets, implementing specialised training programs or by institutionalising the valuable tacit knowledge (Morey, *et al.,* 2002) compartmentalised within in the organization.

This article examines the on-going challenges faced by an organization in balancing the supply and demand for skilled information communications technology (ICT) employees. Achieving this balance would enable the organization to provide more effective support to its parent Government department. Knowing what the future levels of supply and demand will be is very difficult (Career Space, 2001; ICT Skills Foresighting Working Group, 2006). Being one of several organizations in a competitive human resource market, knowing how to influence supply to ensure that its own demand will be satisfied is even more difficult. Further, any balance achieved between supply and demand is likely to be temporary, given that the organization operates in a continuously changing environment. So, once having achieved a balance, to maintain it becomes the next challenge.

Successful organizations select and train their employees to be skilled and knowledgeable in the domain in which the organization operates. Such organizations maintain their preparedness by being sensitive to what is occurring both inside the organization itself and outside in the environment. Whilst the endogenous focus might be on the number of employees needed in each of the required employment categories to efficiently meet the operational demands placed on the organization, the organization must remain cognisant of exogenous factors such as the capacity of the employment marketplace to respond to increasing demand. This marketplace is also shaped by the demographics of the society from which employees ultimately are drawn.

Organizations adapt through a series of change interventions. Each of these takes time, and several may be enacted at any one time. The success achieved depends on the ability of those who design and implement the interventions to determine the most appropriate changes. Given the inertia of Government organizations, the need to change must be established early and change interventions must be implemented well in advance of the date that results are expected. Senior executives also need to be convinced of the veracity of the likely future interventions and be strong enough to lead the organization through the necessary changes.

For the organization, the following make it difficult to establish and maintain a workforce best able to deliver the required outcomes:

- the environment within which the organization operates is changing rapidly;
- the nature of the organization's business is changing, and at an accelerating rate;
- the demographic profile of the society from which its employees are drawn is weakest in the required age groups;
- potential employees having the desired skills are falling in number; and
- the demographic profile of the organization shows a preponderance of workers in older age groups.

In this article we focus on how to design truly effective human resource management strategies. The organization has been experiencing increasing numbers of separations and growing mismatches between required and extant employee skills. Strategies previously tried have not produced the desired results and senior executives have appointed a senior group of middle managers to investigate and recommend effective remedial strategies. The newly appointed strategy development working group reports to the senior executive steering group. So, convincing them that any particular strategy is likely to correct the organization's current and potential future problems will also prove to be a significant challenge.

However, this is a challenge that must be met because obtaining the unreserved support of the steering group is essential to the subsequent implementing of any management initiative. They will play an important role in obtaining higher level support, should initiatives need to be implemented seeking to achieve broader effect, say, in influencing supply. Such a need might be indicated by the existence of a strong dynamic influences operating in the wider manpower marketplace, needing expansion of the problem boundary beyond that initially defined.

Because the organization is part of a government department, departmental or even specific government support may be needed before strategic options such as those affecting society might be implemented. The first step agreed by the strategy development working group was to build a comprehensive understanding of the dynamics and how they work to influence the demand for, and supply of, skilled personnel in the organization, the government department, those industries upon which government relies, and society more broadly. This understanding would prove essential to being able to proceed with their strategy development task.

Possible strategies discussed early by the strategy development working group included outsourcing as a way of reducing the organization's reliance on their own diminishing numbers of skilled employees. The efficacy of such strategies is now being questioned because of the risk that outsourcing may not solve the real problem. Consequences might include shifting undue burden to industry, which industry may not be able to carry or may be politically unacceptable if industry's profit-making opportunities are significantly lessened. Whilst outsourcing might produce attractive opportunities for a few large companies in the industry it is unlikely to be attractive to the many smaller companies who also rely on government business.

Because of the time it will take to build up specialist skills and knowledge, companies who seek to exploit the outsourcing opportunity will incur significant costs. It is likely that only the larger companies may be able to incur such costs in the short-term and offset them in the longer-term. In turn, the 'shifting the burden' initiative might well limit the organization's ability to downsize or outsource, because to ramp up their capacities companies operating in

the support of the government will seek to draw from the same limited pool of potential employees. Therefore, it seems inevitable that they will be tempted to poach employees from the organization itself. With such possible consequences in mind, the senior executives have made it clear that all strategies developed for further consideration must explicitly identify the inherent risks to the organization and associated costs. Further, implementation of short-term initiatives is not to threaten long-term organizational goals. The analysis and recommended options are to be presented in a detailed strategic appreciation, noting that long-term goals are to be achieved through a program of organizational change interventions.

This article explains how, through intimate engagement of the strategy development working group in group model building workshops, a series of system dynamics and risk management models were built to inform the development of a strategic appreciation. This was based upon discovering the complex dynamics that operate in the supply of, and demand for, skilled employees.

The Problem

Given the continued and rapid changes occurring in ICT, how does this large Government organization, whose role it is to deliver ICT business services and new capability projects, ensure that it has the required numbers of people with requisite skills and knowledge now and well into the future to fulfil its role effectively?

Organizational Context

The organization is part of a large Government department. It is responsible for supporting the whole department, ensuring efficient, secure and reliable communications and information handling capability locally, nationally and internationally. The department, and in turn the organization, receives strategic guidance and direction from the Federal Government. The organization's senior executives define ICT capability requirements needed to support corporate governance of the department, both in the short- and long-term. ICT capability requirements are designed to exploit technological opportunities whilst reducing threats to effectiveness and reliability of communications and security of information. Consequently, those in the organization must be skilled in ICT management and knowledgeable in IT, communications technology, information management as well as developments in each of these areas.

The organization currently enjoys high priority for funding in the Department's budget, but funds are limited. The organization's managers are focused on achieving value-for-money in ICT implementation whilst managing risks to continuous and effective ICT service delivery. They are also responsible for concurrent development of new ICT capabilities consistent with the department's strategic goals and expected future operational needs. Enhancements to ICT capability are delivered through an on-going series of projects. The organization's capacity to conduct business as usual and enhance ICT capability depends on availability of human resources, skills and expertise in each of the key knowledge areas, state of infrastructure development (only able to be significantly enhanced as a long-term goal) and availability of a wide range of physical resources.

The role of the organization has evolved to now being a provider, manager and developer of comprehensive 'information age' ICT services to thousands of desktops. The organization is

also responsible for protecting communications and information systems to the extent defined by Government security regulations.

The advent of 'information-age' technology has dramatically changed the way the organization operates, and this has imposed new, and in some instances unique, challenges upon the workforce. The workforce has been forced to adapt to an ongoing series of organizational transformations as well as seemingly endless and increasingly rapid technological change. Further demands have been imposed by growing diversity in means of communication used by the department, need for knowledge of legacy ICT systems, those bespoke systems not easily paid off or replaced because of their unique functionality, and the growing and largely unfulfilled need for integration of new and legacy systems.

All these demands have forced an ageing workforce to confront the need to adapt, or be overwhelmed by rapid changes. With consequent losses from the workforce in prospect it is becoming increasingly difficult for the organization to deliver to meet its changing role. The organization is experiencing shortfalls measured in hundreds of personnel in several key functional areas. Current trends suggest that shortages will continue to worsen.

Recently, a series of senior executive initiatives have been directed at transforming the organization by re-engineering business processes. These involve a shift from in-house design, construction, integration and management of IT, communications and information systems to outsourcing such activities. In the long term the senior executive steering group aims to retain in-house the critical role of managing projects, which are to be delivered by certified professional service provider (PSP) companies. The organization's aim is to progressively outsource, leaving it to focus on attracting, recruiting, training, employing and retaining people in roles of operating, planning, managing and supervising the maintenance and upgrading of ICT systems. The strategy development working group is disturbed that behind these initiatives is a set of untested assumptions that the PSP companies, and industry, generally, have or can develop the capacity and expertise to deliver the outsourced support needed by the organization.

Possible Consequences of Generic Strategies Suggested by the Senior Executives

Concerns have been raised about the unintended likely consequences of concurrently re-engineering business processes and outsourcing. These initiatives could create the undesirable dynamics summarised by the systems thinking archetypes: 'shifting the burden', Figure 1 and 'tragedy of the commons', Figure 2.
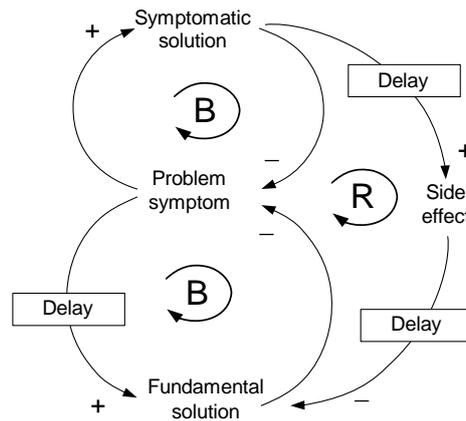
Figure 1. 'Shifting the Burden to Industry' – Possible Consequences of Outsourcing
(adapted after Systems Thinking Organization, 2004(a))

As depicted in Figure 1, the problem symptom is that there are insufficient people in the organization to do the required ICT work. Current practice is to fill the shortfall by employing professional service providers (PSPs) on short-term cost-plus, fixed-fee or time-and-materials contracts, which is expensive. It would appear that one way of reducing costs is to outsource to industry and establish firm fixed-price contracts for deliverables. Outsourcing to industry costs industry more in the short term, as companies in the industry invest in developing expertise and capacity. Costs increase and industry seeks to draw more heavily on the available pool of skilled potential employees in the marketplace. Talented employees currently in the organization are attracted by industry, which reduces the numbers available to the organization. Alternatively, as the costs to industry increase, the number of companies who are willing to increase their capacity to take on such work will decrease, thereby reducing the number of companies available to take on the necessary work. This tends to shift the burden back to the organization, without providing the intended fundamental solution.
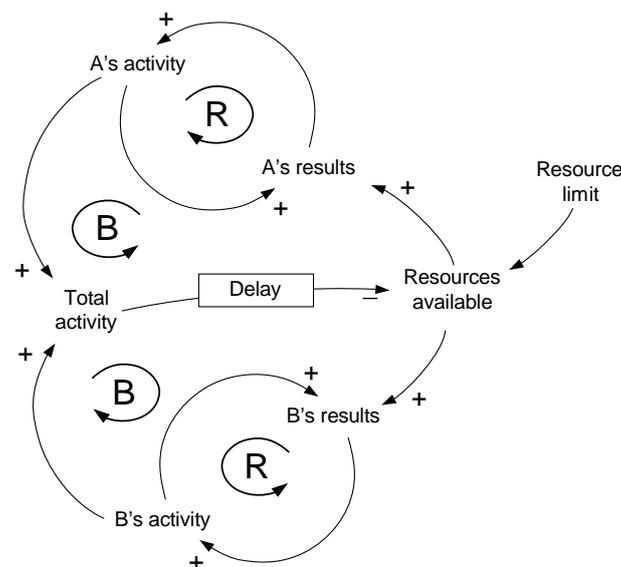
Figure 2. 'Tragedy of the Commons' – Possible Consequences of a Limited Resource Pool
(adapted after Systems Thinking Organization, 2004(b))

The situation depicted in Figure 2 is that industry 'A' takes on more work in an attempt to exploit a business opportunity created by an apparent increase the total activity. Both industry 'A' and the organization 'B' are attempting to increase their activity rates in selected technical application areas, though initially 'A' would be increasing it more. This would occur as the burden is shifted to industry as depicted by the 'shifting the burden' systems archetype, to which this dynamic is also linked. Industry 'A' will attempt to recruit greater numbers of skilled personnel. Unfortunately, because there is a finite limit to the number of employees working in this field personnel are attracted away from the organization 'B', thereby reducing its activity rate.

Unsustainable competition is likely to arise between the organization itself, PSP companies, industry broadly and other government departments for limited numbers of appropriately skilled potential employees in the human resource marketplace. Because these dynamics are inextricably linked the shortages of skilled personnel in appropriate age groups will be exacerbated. This applies particularly those who currently have, or are able to obtain, security clearances needed for employment in the organization. Whilst Figures 1 and 2 summarise thoughts about feedback mechanisms and possible consequences they only tell part of the story and are insufficient for detailed strategy development.

Possible Consequences of Specific Strategies Already Initiated by the Senior Executives

Re-engineering business processes already initiated by senior executives will impose dramatic changes, such as shifts in the roles of software programmers or system administrators into roles as managers of complex ICT acquisition projects. Incumbents may not be particularly well suited for such new roles, nor be enthusiastic about making the transformations the organizational change is about to impose upon them. Despite this, the senior executives remain optimistic about the workforce's capacity and willingness to adapt to their new roles.

Dynamic Influences on Supply and Demand of Employees

Supply sufficient to meet demand for skilled employees on the job is not guaranteed simply by the existence of a large pool of potential employees. The process through which they become employees can have a strong influence on the rate at which demand can be satisfied. The length of time from a change in demand being registered to being satisfied is affected by, time taken to complete education and training, time needed to obtain security clearances, and time taken to become proficient. The adjustment time (Sterman, 2000: 276-80), that is the measure of the inherent ability of the employment marketplace to respond to change, is measured in years rather than months.

For potential employees seeking to enter the organization, the requirements for obtaining security clearances are stringent. This arises because of the special need to have detailed knowledge of how security systems for communications and information systems, and IT are designed and implemented. Note that those in industry employed to deliver the outsourced work require the same security clearances as their counterparts in the organization. The processes culminating in the granting of a security clearance routinely takes several months to complete, depending on the level of clearance required. Hence, the delays involved in obtaining security clearances are similar for both Government and industry employees. Only the government can investigate individuals' suitability for granting of a security clearance and PSP companies must also pay for this service. Further, the cost to PSP companies of

obtaining security clearances for their employees may not be fully appreciated by those companies wishing to exploit outsourcing opportunities. Any strategy to outsource to industry must be implemented with these constraints in mind.

Human resource managers strive to achieve a balance between the needs of the organization itself and the need to nurture the employees. This nurturing creates favourable working conditions and employee benefits such as compensation (remuneration), superannuation and leave entitlements, all of which encourage employee retention. Unfortunately, they do not guarantee it. For example, a government-funded superannuation scheme designed decades previously provides maximum benefits to employees at a nominal retirement age of, say, 60 years old. This will not help a Government organization, which has a high proportion of employees in the 55-60 years age group, to stem the tide of retirements over the next five years. However, the rate of retirements might be reduced by a change to maximum benefits in favour of those who stay in employment until age 65 years (though, for the organization this may actually be deferring an inevitable shortage of skilled labour). Further, recruitment action designed to compensate for these impending retirements is unlikely to succeed if the demographic profile of the broader population (from which employees would be drawn) is similar to the target organization (with relatively few youngsters) or if working in IT or IS fields is unattractive to youngsters in the broader population. Managing such issues is beyond the organization without intervention by the Government. So there is a need to build a strong case upon which representation to Government might be based.

Creating a Shared Systems View of Influences on Employee Supply and Demand

The interactions between forces of supply and demand, employee expectations, and organizational needs produce a complex set of dynamics. To understand these dynamics, the first round of workshops focused on determining what influences the availability of personnel in the changing environment described. For those who deal most closely with employees without having to differentiate between the skills associated with each of the specific employment categories, the workforce problem is basically one of supply and demand, where the organization draws its employees from an external pool which is defined by its size, location, the extent to which it is dispersed, its demographic profile, willingness to seek to work and suitability of individuals seeking work.

From a perspective within the organization there are two main activities; maintaining the organization's capacity to deliver business-as usual, whilst developing the capacity to deliver capability projects. The background level of business-as-usual is only one of the key drivers of demand. Because there is an ongoing program of projects, mostly involving the roll-out of new ICT capability, employees with diverse sets of skills, competence and experience are also needed. The number of projects being developed or rolled out depends on the level of capability desired and the rate of technological change in ICT. As technological change is occurring, many old skills and much knowledge need to be replaced by new. High levels of operational availability of ICT are achieved through having appropriate skills, competence and experience in the current workforce to get the job done right, that is, to deliver reliable ICT.

Demonstration of the organization's ability to "get the right job done right" increases the department's confidence in the delivery of new capability projects. In turn, this releases funding to roll out new projects. This has the effect of creating higher demand to raise the

levels of desired capability the organization might deliver, and as new project teams are established. Decisions to increase the size and structure of the organization are likely to follow. This influences the need to recruit and conduct training programs to raise the levels of skill amongst those newly recruited. This produces a greater supply of personnel to meet demand, though not necessarily to satisfy demand fully. How dynamic mechanisms work to create supply in response to increasing demand came as no surprise. However, it was a surprise to discover that increasing levels of availability of skilled employees, that is, increasing supply, increased the demand for more personnel. Having demonstrated capability to undertake specialist projects leads to obtaining approval to undertake more projects.

The influences on supply and demand identified during the first series of workshops are depicted in Figure 3. This diagram summarises the shared understanding that had been developed. It was particularly useful for identifying the leverage points (Senge, 1990: 64) or pressure points (Coyle, 1996: 222) where effort might be applied to manage the main risks to both supply and demand.

Influences on Supply and Demand of Personnel
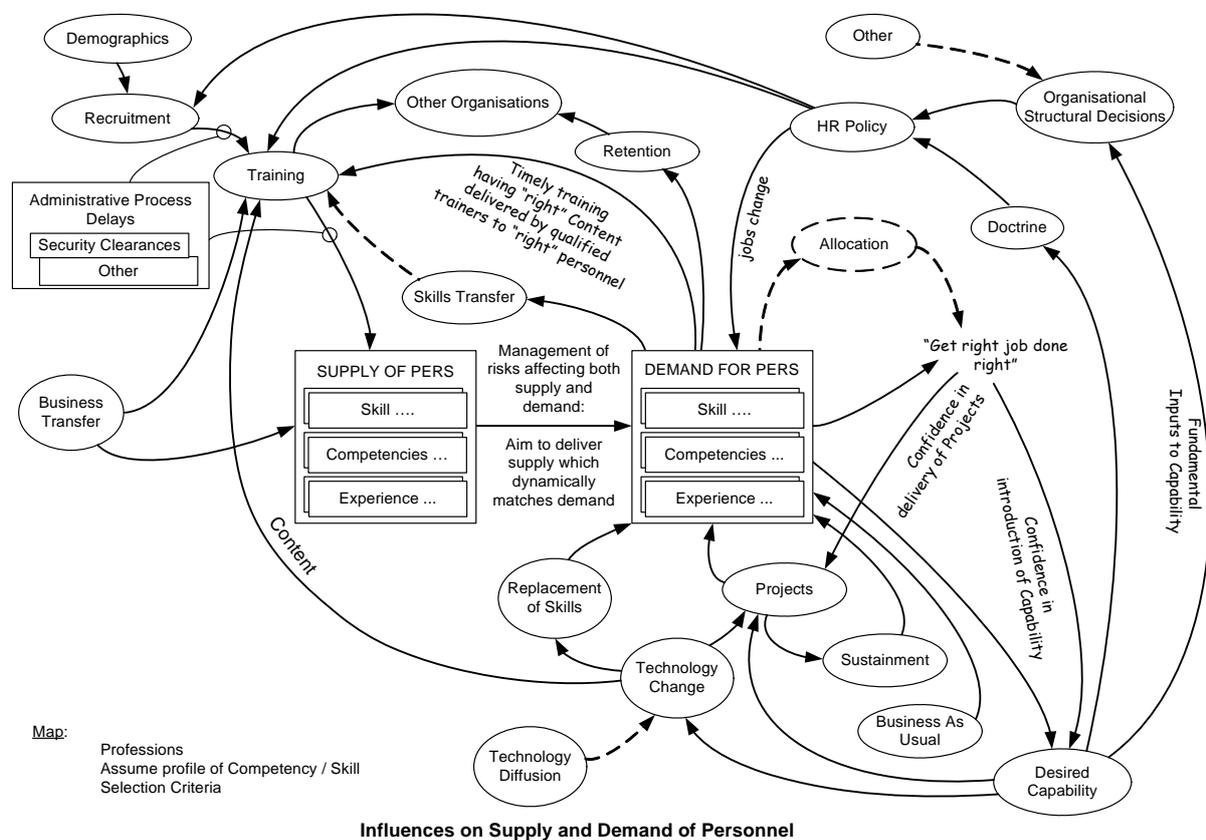
Figure 3. Influences on Supply and Demand of Personnel

This conceptual model provides the basis for conducting subsequent analysis, and was particularly important for examining implications of how the system boundary was to be defined, for example:
- The ability of the organization to attract new recruits would be dependent upon the demographics of the society. It was considered impractical for the organization to change the demographics of the society from which recruits were drawn. Rate of supply of individuals from society was considered initially to be exogenous, though

later it became clear that this had to be treated as an endogenous variable and the system boundary re-defined accordingly. This will be discussed again later.

- Being a technology user rather than a developer, the organization relies on diffusion of technology. The rate of take-up new technology depends on what the technology is seen to offer to increase ICT capability. Technology diffusion is considered to be exogenous.
- Recruiting from industry, both local and overseas, labelled as 'business transfer' might provide opportunities to increase supply of personnel having selected skills and knowledge. The administrative costs associated with achieving business transfers would be substantial.

Recruiting rates might be increased by making the organization more attractive or by changing human resource management policy to enable the specific 'head hunting' from industry of personnel having skills in managing ICT acquisition projects. Even at this early stage, it was evident that to increase supply would require seeking to draw on diverse sources (see Figure 4). Associated with this are the needs to attract increased numbers of potential employees, make the recruiting process more effective, and invest in training recruits with the aim of developing their sense of belonging and loyalty to the organization.

Sources of Supply of Labour for IT Sector
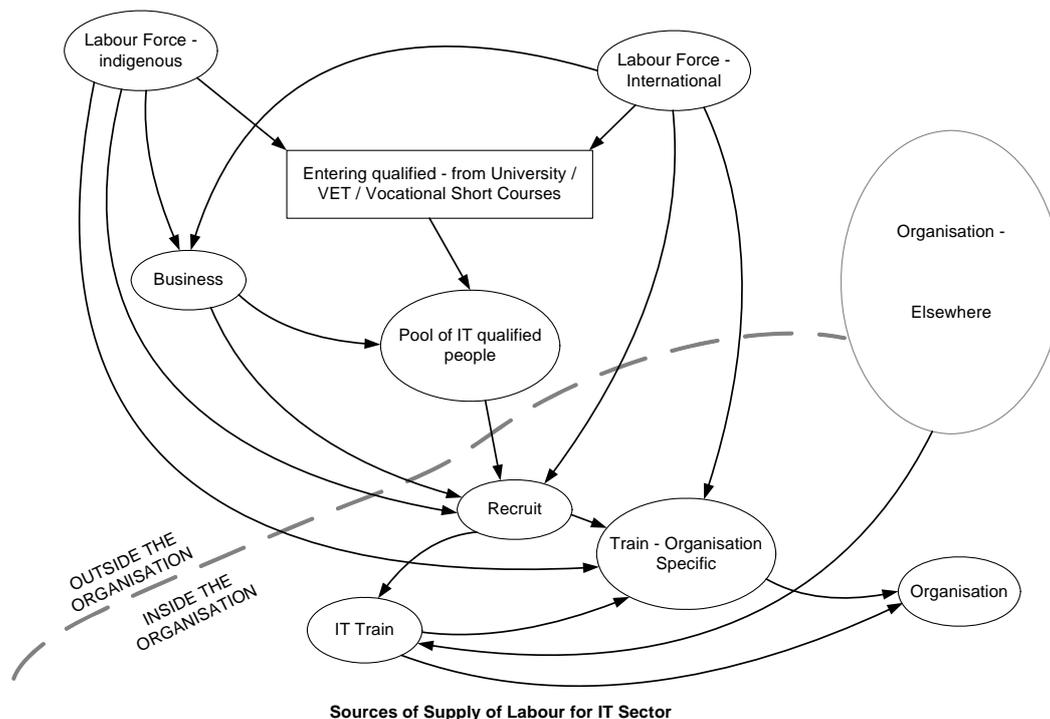
Figure 4. Sources of Supply of Labour for ICT Sector

Assuming that the need to recruit could be established in quantitative terms and by employment category, recruiting initiatives would not immediately translate into increased supply because of delays including those for the obtaining of security clearances. This is depicted in Figure 3 as the 'Administrative Process Delays' intervening between 'Recruitment' and 'Supply of Personnel'.

For the target organization, conflicts have often arisen between short-term and long-term objectives. Short term objectives include having employees available and trained (preferably fully competent) to do the work that must be done today, this week or this month. Long-term objectives emphasise grooming employees for succession to higher levels within an

employment family group. Promotion is necessary for the organization to retain experience-based knowledge. However, with growing diversity in ICT knowledge areas, progression paths and promotion within employment family groupings have become ill-defined, unlike in the administrative careers stream. This lack of definition creates particular problems for human resource managers who are no longer able to design or work with simple succession plans for the management of ICT employees' careers.

Integrated System Dynamics Modeling and Risk Management Approach

System dynamics modeling has been used quite extensively in succession planning to simulate the dynamics of supply. Succession planning models usually analyse the recruiting rates to be achieved and attrition rates that might be accommodated to ensure desired numbers of employees are promoted and available when needed, with demand for employees as an exogenous force. Such models are based on business rules involving time-in-rank as a surrogate metric for competence at current employment level, length-of-service as a surrogate metric for experience overall, and availability of vacancies for successive promotions to occur.   The modeling approach taken here would extend these previous approaches by also taking into account the demographic profiles of the organization and the pool from which new employees were recruited as well as risks associated with discrepancies between targets and actual numbers of employees and the costs of these discrepancies to the organization. A range of exogenous and endogenous forces, described in Figures 3 and 4, would also be taken into account.

An integrated dynamic feedback and risk management model was developed. It had three linked component parts:
- A system dynamics model developed using Powersim™ Studio.
- Analysis of networked Links (AnnL™) software programmed using Microsoft™ Excel.
- An expansive dataset in Microsoft™ Excel. This captured attributes of the workforce, such as numbers of employees, age demographics, employment family, extant skills, time-in-rank, and expected length of service before separation.

The AnnL™ software is designed to prepare business cases. Here, it used inputs from the supply model and estimates of demand for projects that contribute to business capability. The gap between supply and demand was treated as a risk, with an impact determined by the shortfalls in capability that drove the demand. AnnL™ also includes a cost model, which enables possible options to be assessed according to their value for money. AnnL™ can be used to examine the risk-adjusted cost of options, changing recruitment policy or the effect delayed demand. The effects of these options upon expected recruitment rates or demand figures over time were fed back into the Powersim™ Studio model, as part of the evaluation of the risks associated with the options.

The system dynamics model exploited the functionality of a two-dimensional ageing array module:
- As needed, similar modules were linked:
  - in chains to representing multiple periods of ageing with promotion, or
  - in branches to representing the paths taken in transferring from one family employment group to another.
- Each row was used to represent a typical individual in an employment family group.

- Rows were allocated on a pro-rata basis depending on how many typical individuals were in each employment family group. Because each row was unique the maximum number of rows had to be specified from the outset and replicated in each connected module.
- Ages and time-in-rank ageing were based on the typical date of birth specified for each individual, represented by a particular row. Age, time-in-rank and expected time before separation were calculated each simulation timestep.
- The required characteristic ageing time was selectable for each row, by simply inserting a typical elapsed time in the dataset. Ageing was achieved by indexing the contents of each array element one column to the right each simulation timestep. Once the required number of steps had been taken, the contents of the row were lost, promoted into another module or translated into a new module to represent a change in employment.
- Business rules were designed to allow individuals to pass through various control gates such as having been recruited and having a need to obtain the lowest level of security clearance, the individual was allowed to pass after a random time between a and b weeks, higher levels p and q weeks, and highest level x and y weeks.
- Attrition occurred by the deletion of the elements in the randomly selected row. Once attrition had occurred the individual was lost from the employment family group. Rows were selected and deleted on the basis of historical information from which probability of attrition occurring was inferred. Alternatively, the probability was estimated by those in the organization having expert knowledge.
- Individuals recruited laterally joined the selected employment family group by placing them in a new row.

Simulations focused on selected employment family groups for current numbers and likely future numbers in the organization. These baseline simulations focused on recruiting to fill known and expected vacancies. They set out to identify the numbers that would need to be recruited to satisfy demand. Figure 5 shows the typical pattern of growth in numbers entering the organization as a result of recruiting. Important to the organization is the number of employees in each employment family group who have become effective, or proficient. The upper line indicates the target, whilst the lowest line indicates numbers of effective employees.
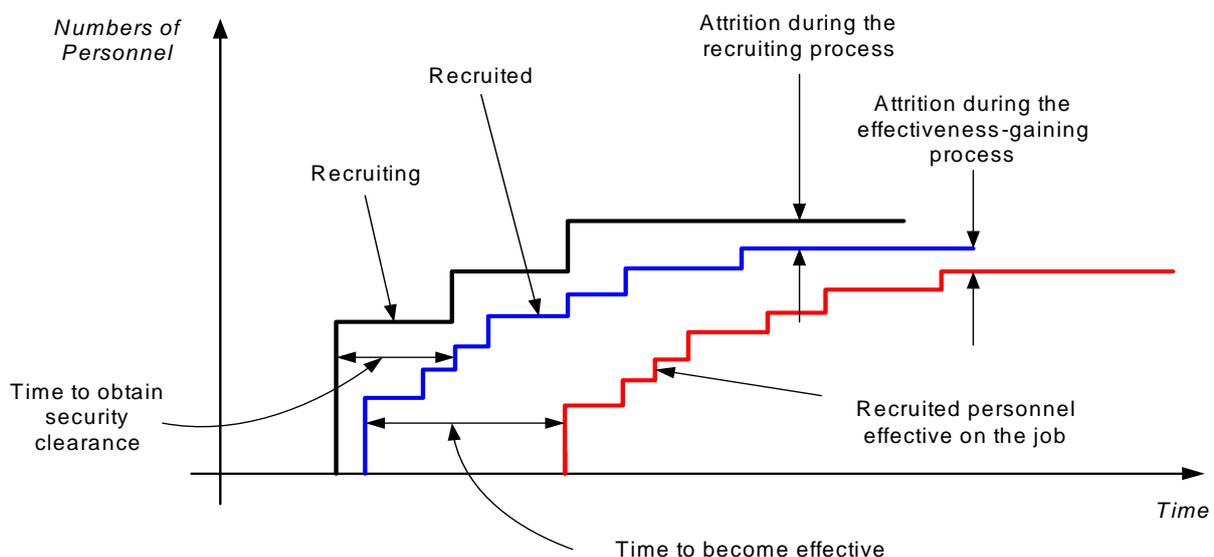
Figure 5. Fundamental Relationships Between Recruiting (Supply) and Being Effective (Satisfying Demand)

The vertical interval between the upper and lowest lines represents the discrepancy between the target and actual numbers of effective employees in the selected employment family group.

The demographic profile of those currently working in the organization was introduced.   As individual employees aged and approached their retirement ages or became tempted to seek alternate employment, it became increasingly likely that they would separate from the organization (see Figure 6). This created growing discrepancies, which had to be corrected by subsequent recruiting activity.

Success in recruiting would be dependent upon the demographic profile of potential employees in the market place. From a modeling perspective taking the demographic profile of potential employees into account only required the model to be extended, and would use the same techniques developed already. At this point, the inadequacies of the data available from the Australian Bureau of Statistics were realised. Until specific data relating to the employment family groups defined in this study could be obtained (the available datasets did not align across the required range of employment family groups), the modeling effort could not be taken further. The alternative of making estimates based on expert judgment alone was determined to be too risky to pursue at this time.
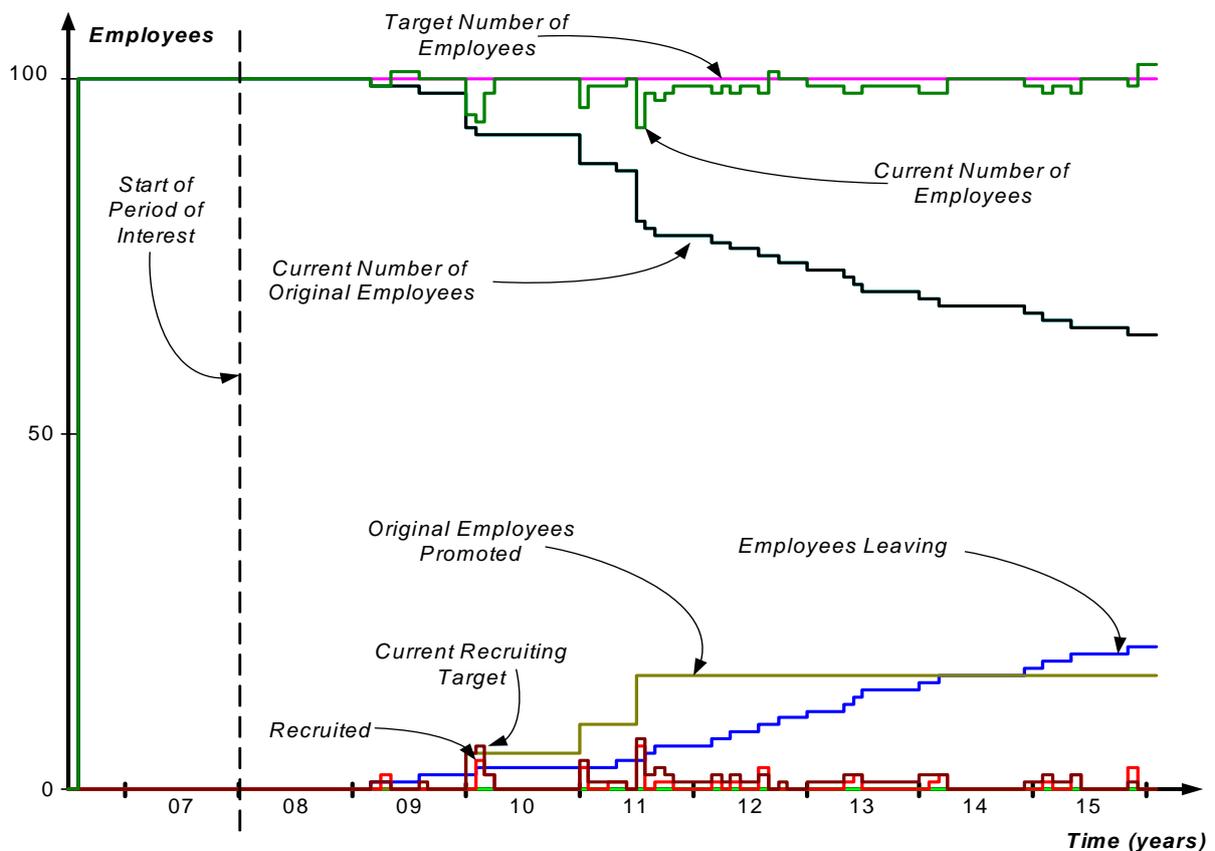
Figure 6. Simulation Results – Recruiting to Replace Expected Separations

Simulations of the system dynamics model identified discrepancies between target numbers of employees in each employment category and likely actual numbers. Discrepancies were seen as risks to the organization's ability to deliver either business-as-usual or new ICT capability projects. At the end of each simulated year, the discrepancies identified were provided as an input into the AnnL™ model. Based on the perceived risk associated with the size of each discrepancy a cost was calculated. In effect this figure was the cost to the organization of carrying vacancies and not being able to do the necessary work, which was the basis for the demand figures also entered into AnnL™. In turn, this cost informed the priority for recruiting. This approach would prove to be an important feedback mechanism which, when analysed through subsequent simulations, could be used by managers to assist in establishing new policies for recruiting, for example:

- Because recruiting targets are infrequently met in full, there is a strong tendency for any discrepancy in numbers to grow. This is a classic undershoot dynamic (Sterman, 2000: 114). One possible alternative would be to seek to recruit greater numbers in the next round to offset the shortfall in the current and previous rounds. However, compensating for undershoot by recruiting excess numbers would only be permitted in extenuating circumstances. Government policy normally allows for recruiting only to fill existing vacancies. An argument could now be formulated to the effect that there was a significant risk in continued undershooting of the recruiting targets and the costs associated with this warranted an exception to the policy. If approved, excessive recruiting was more likely to return the required numbers of recruits, provided that sufficient supply existed. Note that in the simulation depicted in Figure 6, to achieve numbers of current employees near the target it was necessary to recruit at rates significantly greater than 100% of current vacancies.

- Because of the time taken to recruit, obtain security clearances, become effective on the job, and accommodate attrition along the way (see Figures 5 and 6), it would be necessary to find ways to reduce delays and decrease the service times, particularly in the security clearance queues. The particular queue a recruit entered for the purpose of obtaining a security clearance would be determined by the employment category in which they might find employment, and how well they had been prepared by their vocational education and training. The service time (time to process them) would be determined by their ethnic background and length of citizenship. Whether service was completed or not would be determined by the patience of the recruit, the continued attractiveness of employment in the organization and the attractiveness of other offers of employment they might receive from elsewhere whilst waiting in the queue. In other words, the pipeline into the employment pool was very 'leaky', with the extent of the leaks dependent upon several variables identified in the model. The queue length, service times and attrition rates would be identified later as critical constraints upon the supply rates that might be achievable.

The Next Steps – Testing the Models

Interventions to satisfy forecast demand need to be designed by taking into account:
- the mechanisms through which recruits are attracted,
- how recruits are selected and processed administratively,
- the mechanisms used to obtain security clearances,
- training delays,
- delays in developing necessary levels of proficiency,
- risks that discrepancies would arise between demand and supply, and
- costs to the organization of having these discrepancies.

The senior executives had already specified the target numbers of employees in each employment category to be achieved through business process re-engineering and outsourcing. The models described above provide the basis for investigating potential strategies for achieving those numbers. Before being able to test the models it was essential to refine the preliminary requirements for the model and develop a specification against which the model would be tested. Note that this specification could not have been developed until the problem had been investigated in some detail. Iteration is very often necessary when investigating complex problems (Homer, 1996). This specification would also enable the data collection needs to be identified. The specification covered:

- the current numbers of employees in each employment category;
- the target numbers of employees in each employment category for each of the next five years;
- the probability of losses through separation occurring over the period, including:
  - transfer to other government departments;
  - resignation;
  - maternity leave; and
  - death, disability or illness.
- estimates of the likelihood that individuals would separate for reasons of being unhappy about the role changes that the organization was now attempting to impose upon them.

Conclusion: Some Lessons from Modeling

The earliest models clearly indicated that there were three key parameters: the time to complete the recruitment process, time to obtain security clearances, and the time to become fully competent on the job. These models also suggested that managing retention of employees having specific skills the organization wants to retain, would be critically important. Finding ways to increase rates of lateral recruitment would also be important.

The working group's need to simulate various scenarios to answer "what if?" questions about how the required mix of skills needed by the organization could be achieved, raised issues about how the models should be designed. Selection of the most appropriate level of aggregation in the treatment of employees in the model and characterization of individuals within employment groups became important considerations. Having made particular choices would mean that the design of the model would be subsequently difficult to change. Design choices had to be carefully considered, and based on the working group's needs.

Achieving a suitable mix of skills in the organization led to asking whether recruitment policy should be flexible, that is, allowing for *ad hoc* recruitment – hiring in anticipation of demands project by project, establishing a minimum annual recruitment rate – such as a having an annual intake of university graduates, recruiting to replace those lost, recruiting to replace those lost plus those that might be lost before becoming effective on the job, or a mix of these.

The simulations and scenario planning identified other alternatives, including recruiting individuals pending ultimate granting of security clearances accompanied by a deliberate choice to invest more heavily in in-house training of those recruited.

Whilst it may be tempting to make working in the organization more attractive to potential recruits by offering them more favourable employment benefits, such initiatives would increase costs to the organization. These additional costs would then impact negatively on essential organizational activities by reducing funds available in the organization's budget. The associated risk would be acceptable provided the costs were relatively low. If costs were to increase disproportionately for small or moderate increases in risk, then the option would become unattractive. In effect, integrating the two modeling approaches captured previously ignored but important feedback mechanisms involving cost and risk in the context of the whole of the organization's activities.

The integrated modeling approach provided greater insights than one built in just one tool or the other (or involving one exclusive modeling approach). Group model building proved to be most useful in informing strategic decision-makers of the implications of their proposals. There was considerable change in the problem-as-first-stated and the problem-as-last-stated. Only when conceptual system dynamics models were developed did the true systemic nature of the problem begin to emerge, and acceptance by the key stakeholders begin to develop. Members of the strategy development working group involved in the workshops came to appreciate how each of the feedback dynamics operated and how these produced the symptoms they had been observing, but previously had been at a loss to explain.

The combining a systems dynamics and risk management modeling approaches enabled the surfacing of feedback mechanisms unlikely to be revealed through the separate use of these or other methodologies. Understanding of these feedback mechanisms enabled the development of several strategy recommendations likely to be much more effective than those previously attempted. Specific recommendations regarding the gathering of data about variables which influence supply and demand will be crucial in the testing and development of subsequent models. A sense of shared ownership of the strategic recommendations, expressed by the members of the working group, stemmed from being involved in the group model building activities and experimenting with scenarios developed by the working group.

Despite being unable to take the modeling effort to its logical conclusion because of lack of data, sufficiently powerful insights were developed to enable the strategy development working group to argue strongly for the recommendations contained in its strategic appreciation report. They are now confident that they can convince the senior executive steering group of the efficacy of their strategy recommendations.

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