THE USE OF TEMPORARY WORKERS AS A RESPONSE TO WORK PRESSURE IN SERVICE OPERATIONS

Luis E. López
Incae Business School
Alajuela, Costa Rica
Tel: +506 2437-2389
Luis.Lopez@incae.edu

Abstract:

This paper examines the effects of organizational responses to work pressure when capacity is managed through an active and aggressive use of temporary employment. The article uses System Dynamics to uncover the organizational structure associated to dealing with work pressure in a company that has temporary workers. The paper describes policies for matching supply with demand in a service system that has temporary employees, reports the elicitation process for discovering system structure, shows the feedback loops associated to responses to work pressure using temporary workers to adjust capacity, and uses a System Dynamics model to understand the organizational effects of temporary worker usage in the organization. Results suggest that companies may be myopically responding to short term gains associated to "temping," foregoing the larger long-term benefits provided by a more stable workforce.

Temporary workers, service organizations, System Dynamics.

Introduction

Service firms' impossibility to inventory makes supply-demand mismatches difficult to manage. Services respond to the work pressure that comes from supply-demand variations with different mechanisms. In the short term they may use overtime or let workers go (when dealing with the unbalance from the supply side); or they can resort to price mechanisms or some other scheme to limit the flow of incoming work (when dealing with the unbalance from the demand side). In the longer term, firms may deal with supply-demand mismatches by increasing or decreasing capacity.

Increasing capacity requires time because service firms need first to assess potential capacity shortfalls and then go to the labor market to procure the necessary resources to close the capacity gap. The process is lengthy. Firms advertise the need, recruit potential candidates, choose candidates, make offers, and see if they accept it. Because of these delays, service organizations tend to rely, in the short term, on alternative mechanism to deal with variations in work pressure, particularly on the use of overtime. Oliva and Sterman (2001) have documented service workers "cutting corners" as a short term reaction to increases in work pressure, with the consequent degradation of service quality. Although overtime may fix the short term demand-supply imbalance, the habitual use of overtime could result in employee fatigue and even on the creation of implicit perverse incentives, as employees settle on a lower level of productivity in the hope of getting as a matter of course higher wages in the form of extra hours. Fatigue from the protracted use of overtime may also result in productivity reductions and higher turnover.

There are other ways to react to mismatches between supply and demand in the short term, such as curtailing incoming orders, for instance. Yet, to deal with capacity unbalances firms may also choose to add capacity outright or, in other words, to add –or subtract- people to the current workforce in order to reduce the gap between supply and demand properly without the inconvenience of dealing with fatigue in the labor force – which may lead to burnout and turnover– or workers keeping the standard of output at the expense of the standard of quality. Ideally, service firms would prefer to set a quality standard ex ante, specified for instance by a time per order; set a work standard, specified in terms of length and intensity of work that would suit a desired competitive position, and then adjust capacity to match supply and demand with a given, sufficiently high, service level. This ideal setting is not feasible due to long delays that are embedded in the delivery systems, like hiring and perception delays, which make just- in-time capacity adjustment difficult. Firms could also generate additional capacity through the addition or subtraction of technology, but this option is generally even more inflexible than adding people.

Organizations, hence, seek mechanisms to make outright service capacity adjustments more flexible. One such mechanism is the use of temporary employment agencies, also known as temp agencies or temporary staffing firms, to maintain personnel capacity that can be changed on short order.

The industry of temporary staffing or temps has grown immensely (Lewis and Sullivan, 1997). The industry trade group ASA (American Staffing Association) reports more than three million temporary people working for staffing companies in the United States in a given week. Although not necessarily large in terms of total employment, the trend to "temp" the economy and the effect of this trend at the firm level are worth studying, mainly because employers may be reacting to short term economic gains, in the form of cost reductions associated to less expensive employees, but could also plausibly be reacting myopically, sacrificing a much higher long term financial gain. This paper investigates the effects that the addition and subtraction of temporary workers to handle fluctuations in work pressure may have upon firm performance.

This article examines the effects of organizational responses to work pressure when capacity is managed through an active and aggressive use of temporary employment. The ongoing research question is related to organizational impact of the addition of capacity through the use of temporary workers, but since this is

a preliminary and exploratory study, we only report upon the structure associated to the handling of work pressure through this mechanism.

We use System Dynamics to uncover the organizational structure for dealing with work pressure. We do so in the context of a case study in a service organization whose managers wanted to understand the dynamics of resource management and worker turnover. The paper describes policies for matching supply with demand in a service system that has temporary employees, and it reports the research process used to uncover causal complexity in the organization. Starting from the causal loop diagram and dynamic hypotheses unveiled with managers, a System Dynamics model is developed which allows for exploring system's responses to varying conditions. The idea is to eventually be able to evaluate a variety of policy initiatives to attain desired organizational results.

This article reports the feedback loops associated to responses to work pressures using temporary and permanent workers to adjust capacity. The model reported here includes four relevant loops, enough to capture a large portion of the dynamics that are observed in the empirical data. The paper uses data from case studies at the firm level, all within the same firm.

The paper's structure is as follows: The next section discusses relevant literature. Thereafter we explain the research question and the method. The following section describes the case study, including the process to identify the problem, the feedback and stock-flow structure of the system, the dynamic hypothesis, and the model. The following section uses the model to understand the dynamics of the system before a brief conclusion. Results suggest that companies may be myopically responding to short term gains associated to "temping," foregoing larger long-term benefits associated to a more stable workforce.

Literature

Temporary staffing or "temping" has traditionally been a popular choice for managing supply-demand mismatches in service organizations. The short term staffing personnel is usually sourced from temporary employment agencies. Temporary staffing as an economic activity has become a large industry that is growing at a very steep pace.

Firms, particularly service firms, choose temping as a strategy for several reasons. According to Bryson (2013) "temping" is used to: a) save money by cutting costs; b) address fluctuations in demand, and c) to address shortages of people or skills for a given demand. More recently, the use of temporary workers is becoming more entrenched as employers do not "temp" just to deal with temporary demand imbalances, but have started to convert their very long-term workforce into bands of temporary workers. The popular press has echoed this tendency and many have heralded the not-too-distant rise of the "permanent temp economy" in which jobs are not occupied by permanent workers formally affiliated to organizations but by temporary workers, or "perma-temps" that work for somebody else while doing "gigs" or "stints" here and there[1].

[1] See for example White, Martha, NBC News, April 24 2014: "For Many Americans, 'Temp' Work becomes Permanent Way of Life;" Smith, Rebecca, September 8, 2014, "The Permanent Temp Economy;" Greenhouse, Steven, NYTimes, August 31, 2014, "The Changing Face of Temporary Employment."

Although the use of temporary workers is growing, its consequences have scarcely been explored, and extant literature reports controversial results regarding the effects of temping upon firms and workers.

Some authors argue that temping may have positive effects upon firm performance and, particularly, worker's well-being. For example, Lane, Mikelson, Sharkey and Wissoker (2003) argue that temporary jobs are just an intermediate stage on toward full time permanent work. The industry trade group ASA (American Staffing Association, 2015), routinely publishes data underscoring the benefits, both for workers and for industries, of temporary work arrangements. For instance, with respect to "staffing employees", ASA (2015) reports that most, 76%, of "staffing employees" work full time, in line with the overall workforce (82%); and "half (49%) of staffing employees say it's a way to get a permanent job"; nine out of ten said staffing work made them more employable, and one third (35%) were offered a permanent job by a client they worked on an assignment. Similarly, advantages to staffing companies are reported in terms of flexibility and access to talent with apparently no downside as Amiti and Wei (2005) report that the fear of outsourcing services to foreign countries does not affect job growth at the sectoral level. Moreover, temporary agency work may be a vehicle for firms to evaluate a potential employee without incurring the cost of actually offering a permanent position to the worker. Jahn and Rosholm (2014) show that firms use temporary agency employment to evaluate potential candidates for permanent jobs. Arvanitis (2005) explored the effect of labor flexibility at the firm level. The author found mixed effects of these arrangements on firm innovation: no effect on sales per employee or introduction of process innovations, but an effect associated to the introduction of product innovation. Bryson (2013) finds that the use of temporary agency workers associates positively with financial performance of firms in the British private sector, but it is not associated with value added per employee or with the perceptions of workers about how intensively they have to work.

Other authors argue that temporary job arrangements are just cost-cutting mechanisms that strip workers of their rights. Parker (1994), for instance, argues that the human resources method based on temping that is currently much in vogue in the United States, is a system that has been created at the expense of workers' skills, training, and labor rights. This author (Parker, 1994: 144-145) argues that temping is: "…roughly analogous to having a formally bureaucratized reserve army of the unemployed at an employer's disposal", and that such army serves "to depress the wages and working conditions of all U.S. workers." Similarly, Hatton (2013) asserts that "temping" by US employers has simply become "a way to reduce benefits and cut wages," and Ford and Slater (2006), exploring the often advanced theory that temping contributes to quality in the workforce, find no evidence of an association between work in temporary employment agencies and the emergence of specialized and sophisticated skills related to the knowledge economy. These authors find that temporary agency work reflects considerations to reduce labor costs, and that temporary agency workers result in low levels of commitment and high levels of job anxiety. Hatton (2014) argues that employers use temporary agency work as a mechanism to discourage the formation and strengthening of labor unions, and Autor and Houseman (2010) find that temping may reduce individual subsequent earnings and employment outcomes.

In all, the literature on temporary work reports mixed effects upon firm performance, and, overwhelmingly, negative effects upon the individuals. There are very few studies that relate temporary work with effects upon the firm. Although some positive correlations have been found between the use of temporary work and the financial performance of the firm, the scant evidence is controversial, and the effect upon the firm is unclear. Temping renders companies with organizational structures that are different and may be unique. Different mixes or proportions of temp workers and permanent workers may have different effects upon different types of operations because temporary workers are intrinsically different (they tend to have shorter tenures, and they are affiliated to the temporary work agency, and not the company they are actually working for).

Even if temporary workers were, in terms of skills and personal characteristics, similar to permanent workers, government authorities in certain countries impose restrictions and regulations upon their

contract structures. Because firms use temping as a cost-cutting device, to, for instance, avoid liabilities associated to severance pay, vacation time, health and other benefits and, possibly, to circumvent paying higher salaries, governments may limit the unrestricted use of temporary employment[2]. For instance, governments enforce time limits to continuous employment under a temporary status in the same organization. If a temporary worker should go beyond that limit, some governments require workers to be reclassified as permanent workers who retroactively accrue all benefits that would have been associated to a similar employment period by a worker under a permanent status. Often, as a result, temporary employment agencies relocate temporary staff to other companies in order to dodge such limits, thus infusing companies with crews who have inherently shorter average tenures, that is employees who rotate more, not by will but by fiat.

Such shorter organizational tenures interact with the characteristics of the organizational system. Oliva (2001) has shown that there may be different optimal policy cocktails for different types of services, such as high contact versus low contact services. But more generally, if an organizational system of any kind is plagued with prolonged delays, the presence of substantial groups of workers with high turnover rates due to shorter tenures may result in systems that exhibit chronically low productivity levels or other unintended negative consequences in terms of coordination, socialization, and management.

Moreover, the use of temps requires an organizational effort to actively manage hiring and firing. Such transactions are costly. Even if temporary agencies purport such coordination efforts as effortless, each staff stir involves fees for the temp agency, which stands to profit from all transfers and all temps.

Finally, for a given learning rate, the use of temps with curtailed tenures may result in a persistently low productivity level –compared to what it could have been without the temps– which must be compensated with larger long-run staffing levels. Should this be the case, the added long-run cost of having more unproductive people perform a task that could be done by fewer productive people must be compensated somehow, either by cutting wages, reducing overtime, increasing utilization, or some other measure.

Research Question

Our main research question is: what are the effects of temping upon overall productivity for a typical service firm?

It used to be that the use of temporary workers responded to temporary increases in demand, such as in the panel on the left of Figure 1. But the new mental model is one in which the substitution of the permanent workforce per se benefits the organization, as exemplified by statements such as (Manpower, 2015):

> For more than 60 years, we've been at the forefront of the world of work, giving us unparalleled expertise in leveraging human potential and an in-depth knowledge of business evolution. We apply our insight to create a continuum of staffing solutions designed to enhance business agility, productivity and competitiveness, with extraordinary results. You'll be set for success more than you ever thought possible.

From the reported literature, and particularly from the claims made by temporary staffing firms, the reference mode would be one in which temporary staffing would lead to increasing and even dramatic improvements in productivity as shown in the panel on the right of Figure 1.

[2] Or do just the opposite and "liberalize" the labor market to allow temping to operate more freely.

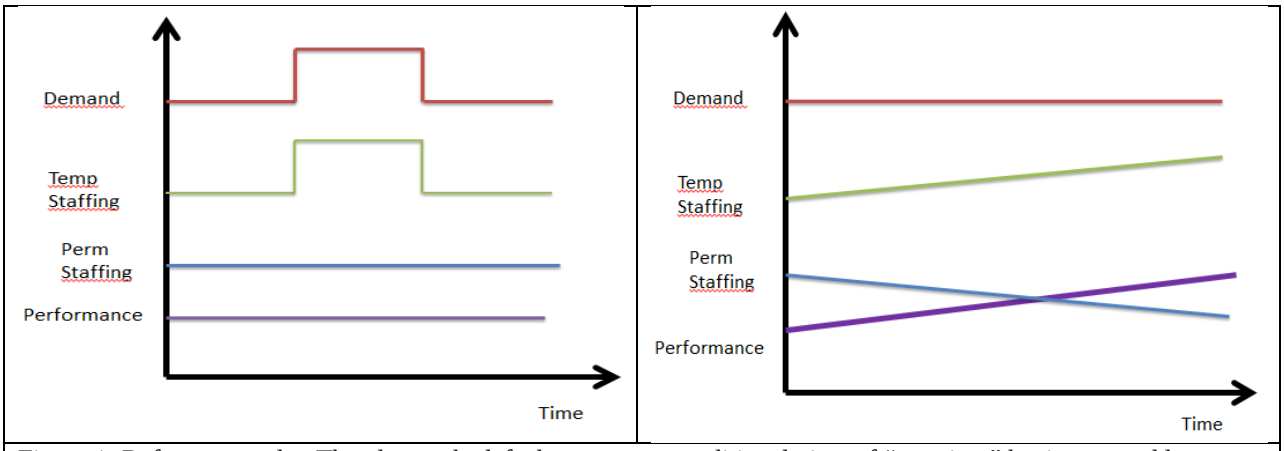

Figure 1: Reference mode. The plot on the left shows a more traditional view of "temping;" business would use extra help to deal with seasonal fluctuations, but would keep a base of permanent employees. The plot on the right shows the new mental model: changing the workforce base into a temporary workforce will increase the profitability of the business irrespective of demand fluctuations or other considerations.

This reference modes imply that an increase in work intensity, for instance due to an increase in incoming orders, can be fully and flexibly managed through an almost instantaneous increase in temporary staffing, thus resulting in the firm fully capturing the value of the demand upsurge. Of course, the feared behavior would be one in which the increase in temporary staffing would lead to a decrease in average productivity, thus bringing firm performance to a littler level than it could have been. Moreover, the mental model in vogue suggests that by substituting perms for temps companies thrive.

Methods

This paper originates in the interest of a service company to understand how to better manage the allocation of human resources in its operations. The firm was organized along projects for specific customers. These projects were, upon estimating future demand, staffed using a combination of permanent and temporary workers. Contracts would be drawn for a given expected incoming order rate, and the service firm's earnings would be contingent on compliance with certain agreed-upon quality standards, measured by on-time delivery or fill rate.

We used a case study methodology mixed with model elicitation procedures. Each of these projects was a case study. The method used had the following steps:

1) We collected information on several variables related to four projects, which were ongoing at the time of the study, starting at the time of project inception.
2) We analyzed case data to assess the dynamic structure of the systems.
3) We conducted a workshop with executives to elicit a problem definition and feedback loops related to the issue of resource allocation.
4) We determined the system's feedback structure.
5) We developed a simulation game based upon the preliminary feedback structure.
6) We used the simulation game in a learning laboratory with the executives to see if the feedback structure was representative of actual day to day dynamics.
7) We developed a formal model that was then used for policy experiments and for understanding the dynamics of the system.

Case study

The company sets up entire operations for each contract. Customer contracts are structured in different ways. Typically, customers settle for a level of service quality measured as average job time, on time completion, or fill rate. The service operator estimates the cost of such an operation at the established service level and negotiates fees with the customer. Once the project was set up, the service operator has an incentive to improve upon the minimum levels specified in the contract to increase financial returns. Contracts impose penalties for underperformance.

We collected data for four contracts. Figure 2 shows the distribution of tenures, in days, for all employees in the four contracts. Data are right censored, as these were ongoing projects at the time of the study. The data aggregated for all four projects studied showed a total of 1317 hires (people entering the system), while 925 exits (people leaving the system). Average tenure, inputting the maximum length for those still residing in the system, was 143 days.

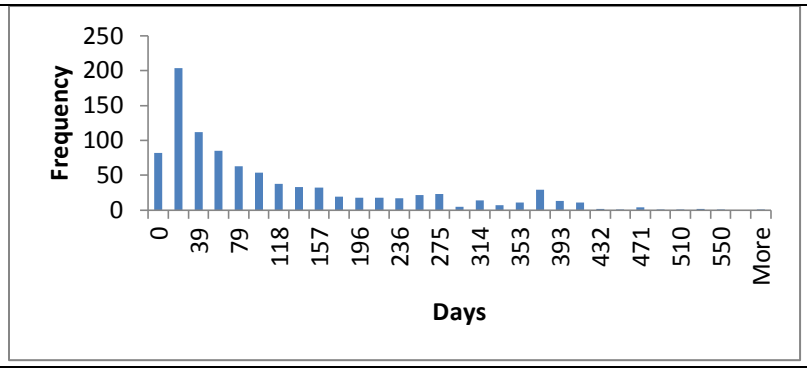

Figure 2: Distribution of employee tenures for all projects.

There was a large tenure difference between temporary and permanent employees. Figure 3 shows the results of a Kaplan-Meier LogRank test for tenures of permanent and temporary members. Permanent employees remain longer, with a probability of survival of 80% after 700 days working in the system. In contrast, temporary workers had an almost null probability of survival after 600 days. An estimation of expected tenures using restricted means, given the lack of failures of permanent workers, resulted in an expected mean tenure of 150 days (95% confidence limits between 140 and 159) for temporary employees, and an expected mean tenure of 555 days (95% confidence between 525 and 585) for permanent employees (that is employees in the company's payroll and not in the temp agency's payroll).

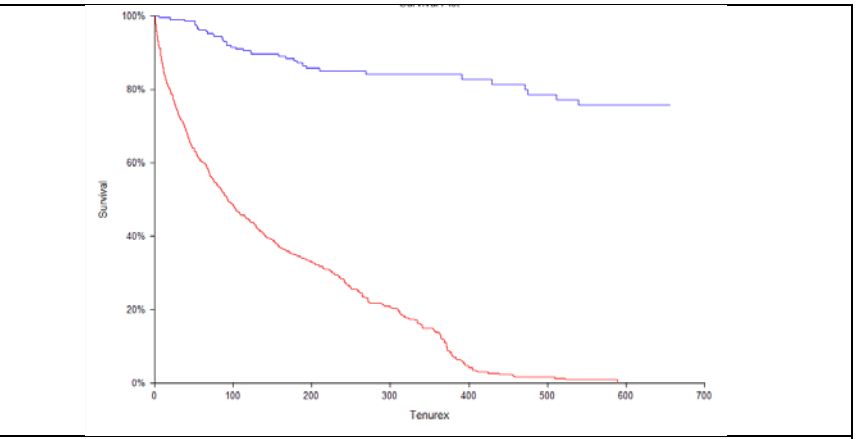

Figure 3: Survival plot of all employees in system.

Figure 4 reports total staff for one of the 4 projects. The total number of people is varies, with a peak of 193 people in the second month of the year and a valley of 151 people in the fourth month of the year.

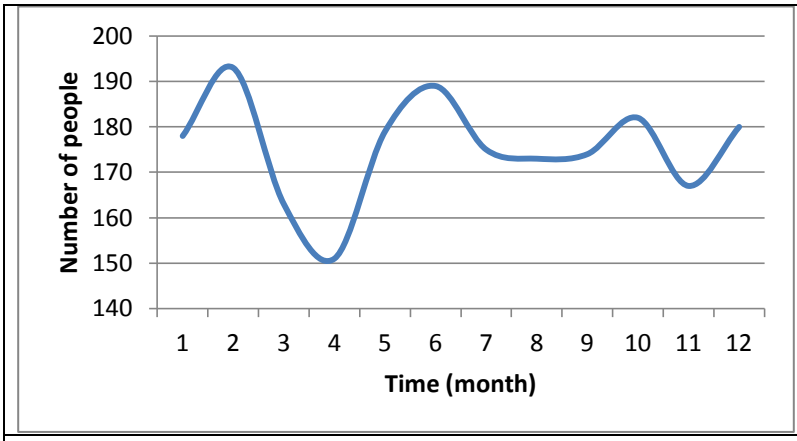

Figure 4. Total number of people in one project.

Most variance in staffing levels is due to temporary employee churning. Figure 5 shows that the number of permanent employees is fairly stable, as suggested by the survival plot in Figure 3, but the number of temporary employees varies significantly.

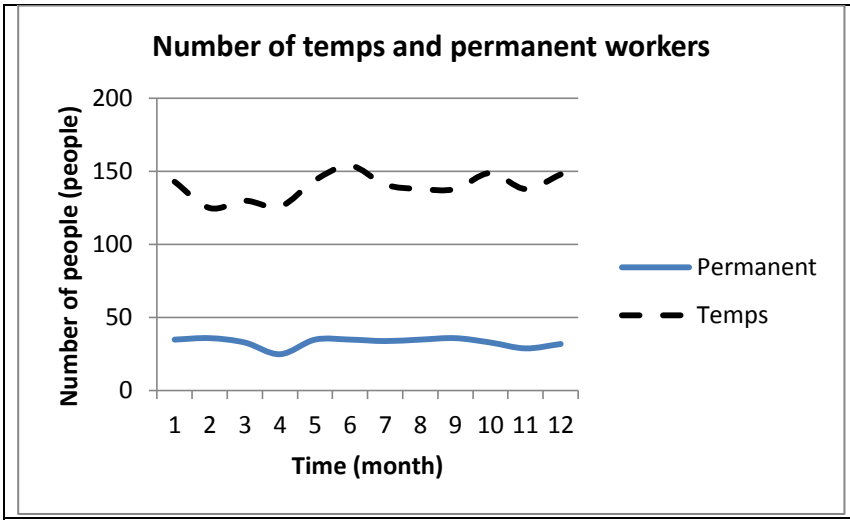

Figure 5. Number of temps and permanent workers in one project

Demand variations are large. Figure 6 shows daily demand for one project. The noisy data shows large daily demand variations. The minimum of the data series in Figure 6 is 168 boxes/day, the maximum is 80,352 boxes/day with an average of 27,243 boxes/day and a standard deviation of 11,078 boxes/day.

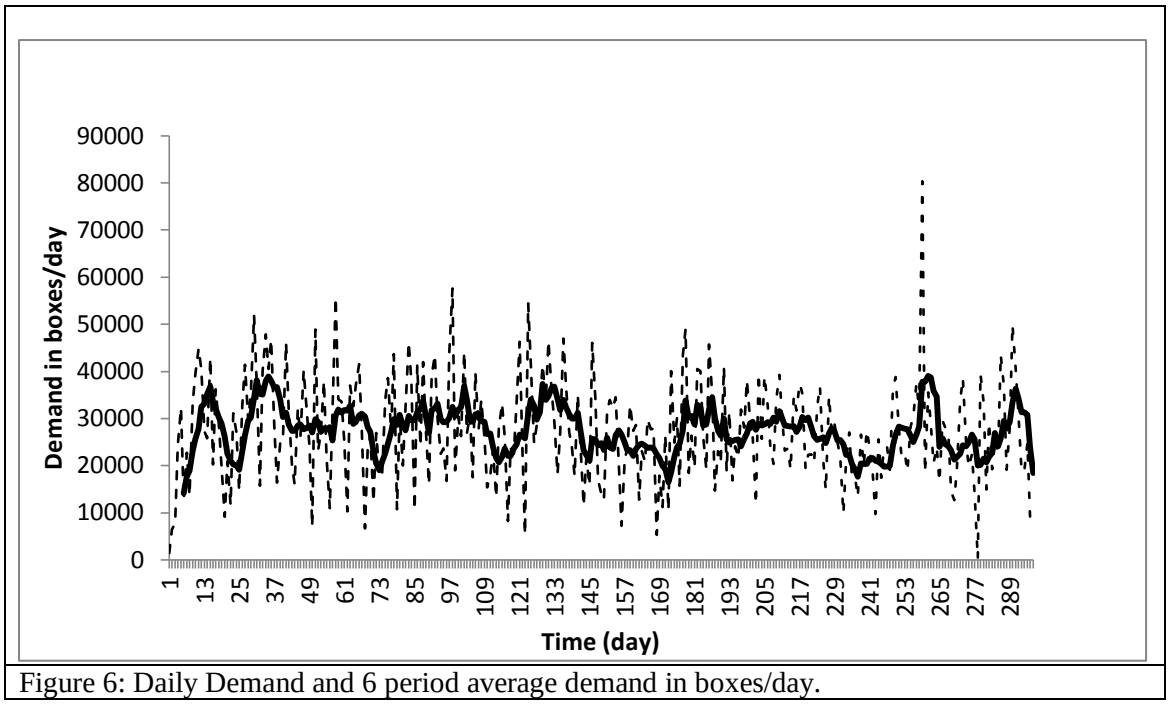

Figure 6: Daily Demand and 6 period average demand in boxes/day.

The use of overtime is abundant and uneven, showing variations that can go from over 8000 hours in one month to about half of that in other months. The system undergoes constant attempts to adjust its capacity by adjusting personnel levels. As Figure 7 shows, peaks in total staff seem to come right after overtime peaks. This suggests management is using overtime as much as possible, but hiring is used when it goes beyond a certain limit. The interaction of overtime and hiring is more clearly revealed when temporary staff is plotted against the backdrop of overtime hours. Figure 8 shows clear peaks in the stock of temps after the peaks in overtime. This suggests that management requests additional personnel when overtime is exceeding some threshold. The required personnel arrive at the project after the peak in overtime has passed, which suggests that there may be delays due to perception formation and hiring or approval processes.

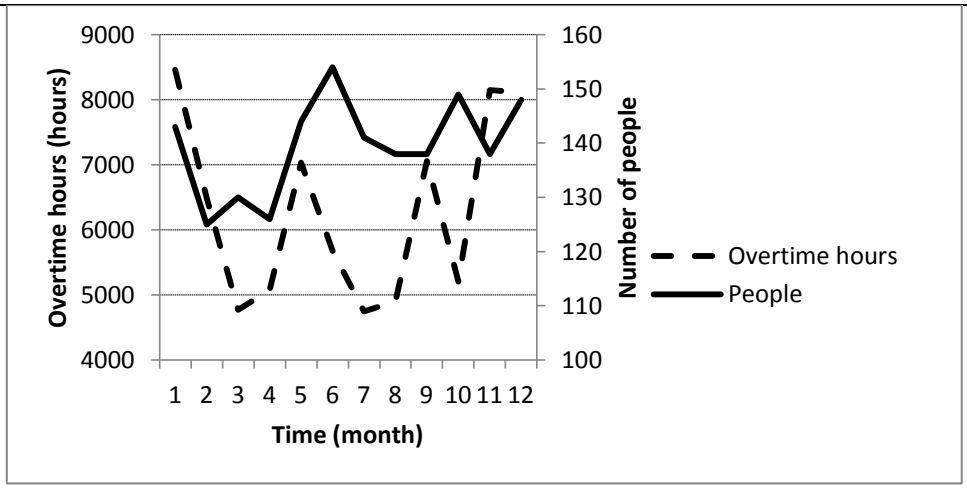

Figure 7: Overtime in hours/month and temporary workers in number of workers for one project.

Causal structure elicitation

The dynamic complexity revealed by the data prompted us to conduct an exercise with the company executives to elicit the system's causal structure. In a one-day seminar executives were asked to indicate the main variables associated to the problem of resource allocation. The 15 executives listed these salient variables which were then pooled. After jointly eliminating duplicates participants ranked them by assigning points from a limited allotment to each variable. Results were discussed and then we then selected the variables with the highest scores and worked in establishing causal relationships among them.

The list of variables included:
1- A people sector, including their level of expertise. This theme was one of the most prominent and recurring subjects in the workshop. This sector includes workloads (overtime), working conditions, hiring and firing and in general how to plan staffing resources.
2- A related sector with installed capacity and service level.
3- Financial matters and performance.
4- Customer demand.

From this exercise we, in conjunction with the executives, developed a causal loop diagram, which is shown in Figure 8. The causal loop diagram has eleven feedback loops. The system appears to be one that is looking to adjust the available resources with a variety of mechanisms.

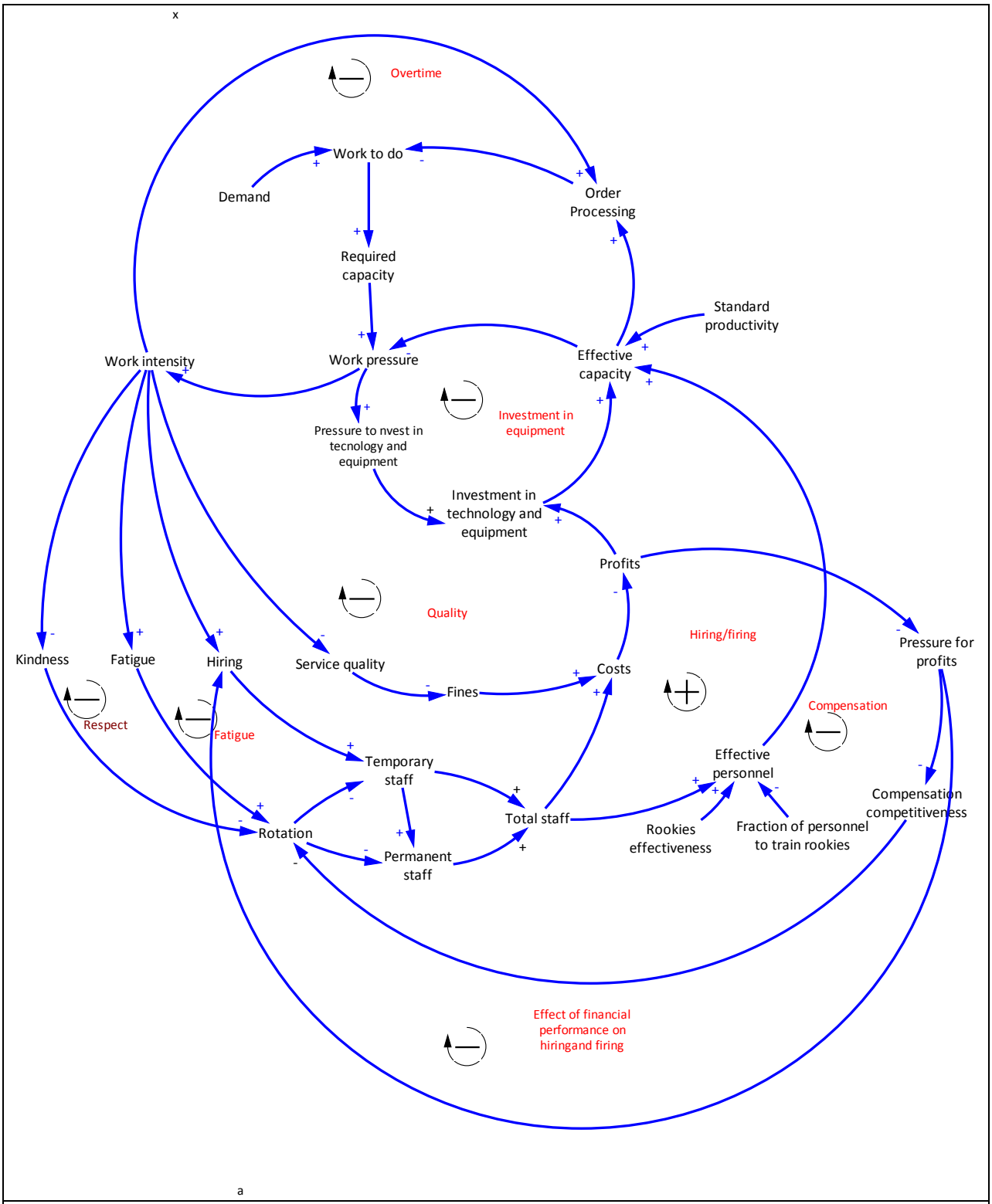

Figure 8: Elicited causal loop diagram

We then looked in detail at those loops the executives thought were most important. These loops are shown in Figure 9. First, there is overtime. The loop exerts short term capacity adjustments, and it is under the control of the project manager. Similar to Oliva and Sterman (2001), work to do implies a required capacity which, upon comparison with the effective available capacity, generates work pressure. Work pressure determines work intensity (if required capacity is above effective capacity, which requires working beyond the normal workday and vice versa). Orders are processed according to this intensity, which extinguishes work to do. If there are unbalances in this loop, overtime or underutilization arises. In Figure 9 we have included the hiring/firing feedback loop. This loop is for longer term capacity adjustment. The loop is under corporate control. Work intensity causes, with a delay, the need to hire (or fire) personnel. When personnel are hired (fired), capacity increases (decreases) bringing the system back to equilibrium.

Figure 9: Overtime feedback loop and Hiring/firing feedback loop

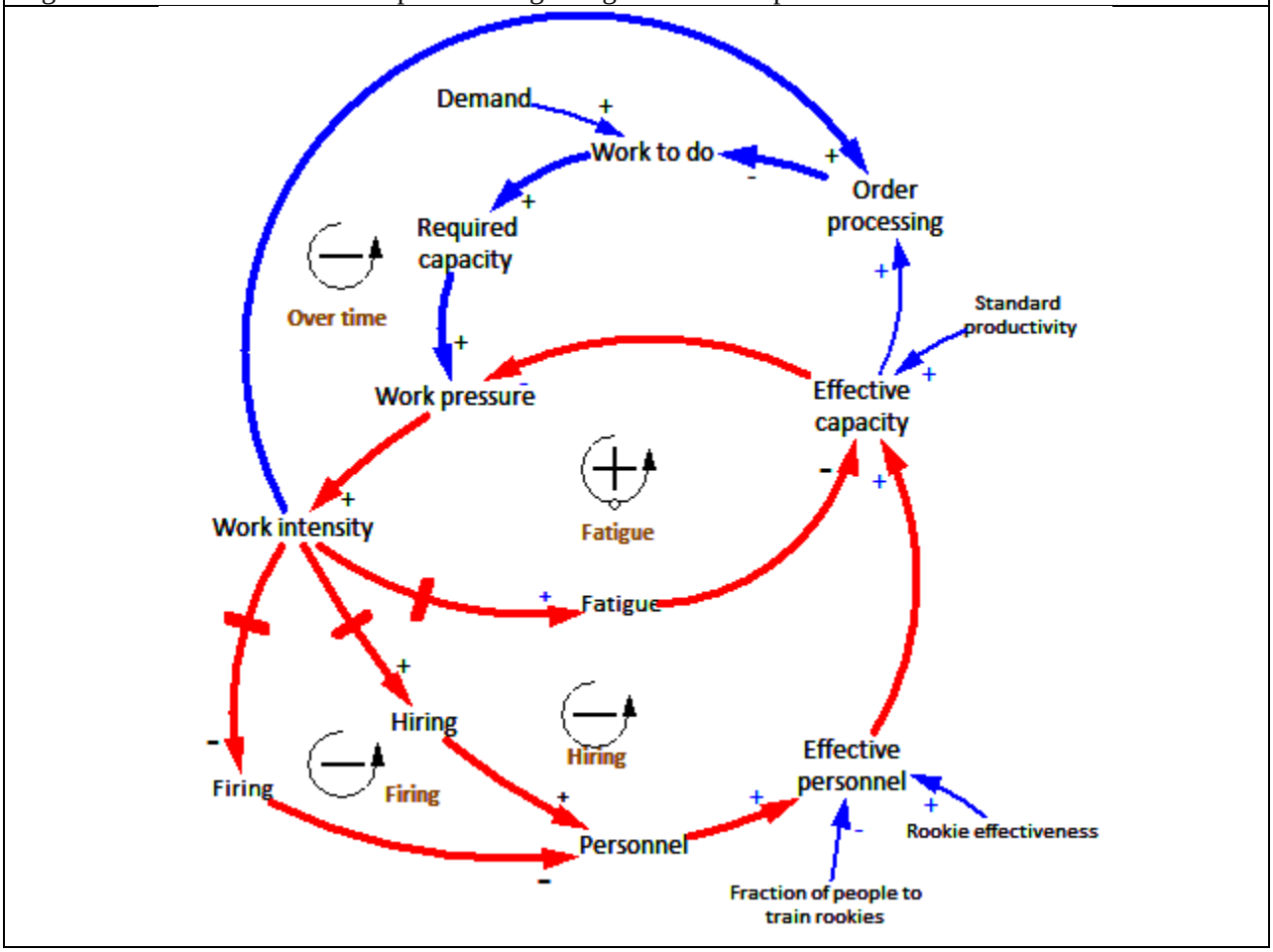

Figure 9 shows that extended overtime use causes fatigue. Fatigue, in turn, reduces productivity, thus increasing the need for overtime. The additional overtime, in a reinforcing loop, increases fatigue above what it otherwise would have been, thus reducing capacity further.

We built a base model with these four loops, and then followed a somewhat unusual elicitation and validation path: With the preliminary model we developed a simulation game, which we called

“Crossdock” that we used to gather additional impressions from executives as to how representative the model was compared to what they experienced day to day. The game was infused with demand and parameter data from one of the operations, which was a cross docking operation, and it was calibrated with realistic parameters. The game included firing, hiring, effects of fatigue on turnover, effects of fatigue on productivity, overtime, and some indicative financial measures which were included to translate service and cost measures into a single indicator. To develop a credible financial picture, we added plausible costs of hiring, firing, overtime, and fines for bad service. Through their decisions, managers had to close the hiring and firing loops (of both temporary and permanent workers), and overtime allocation. The objective was to maximize service rate while minimizing costs and penalties.

The game was well received. Managers thought it was quite realistic, and they were all fully engaged during the learning laboratory. We undertook the exercise as one of systematic observation of behavior. We carefully coded expressions regarding game that would reveal underlying similarities or discrepancies with real life. The game was played in one-week rounds, each lasting 10 to 15 minutes. In each round we went to each of the four groups to observe behavior. In the debrief we again inquired with the whole group. We planned group rounds to carefully observe behavior, and we requested managers to provide a comprehensive data sheet with their analyses and all indicators they kept track of. We did not induce any particular formatting or requested any specific information, but asked them to keep track of whichever variables they thought were important in a spreadsheet. We did not indicate beforehand that the spreadsheet would be collected, but rather did so when the game was over. We also took note of spontaneous manifestations regarding the game.

From these data and observation of behavior we found the following:

Managers constantly monitor demand and personnel levels to order additional staff if needed. However, corporate is reluctant to approve additional staff. Managers have to negotiate with corporate every time they need to fill vacancies. Because of the relative difficulty in hiring personnel, managers may "over-order" to compensate for perceived gaps in staffing requirements.

From the game decision data it appears that managers tend to estimate required personnel comparing to the number of people and not with actual capacity, effectively assuming that all people have homogeneous productivity.

The game was played in groups (4 groups of 4 people each). Interestingly, groups ran two distinctly different strategies. Two groups used a strategy based primarily on the use of overtime. This strategy was, as one group would call it during the game (which apparently had its counterpart in real life), "breaking" the staff. Executives made people work long hours even when productivity markedly dropped and turnover increased, as long as no backlog was left by the end of the day this strategy was considered to be acceptable.

The second strategy was "nurturing" the staff. These groups decided to maintain a reasonable level of overtime and to hire people as needed, hoping to have enough staff to eventually attain an acceptable service level despite having to go through a period of inferior financial results.

The two strategies are clearly reflected in Figure 10. Groups 1 and 2 predominantly chose to use as much overtime as needed, and in the short term they showed favorable results, unlike Groups 3 and 4, which chose to use reasonable levels of overtime. Thus, in the short term the strategy of "breaking" people shows better results, but this was reversed in the long run when the performance of the other two groups tended to improve at a much higher rate than those groups who solely based their strategy on overtime and saw performance stagnate or decline after some point. Structurally, the two strategies were quite

different. The "break-them" strategy relied mostly on rookies and higher personnel levels overall. The "nurture-them" strategy had fewer personnel, but more experts.

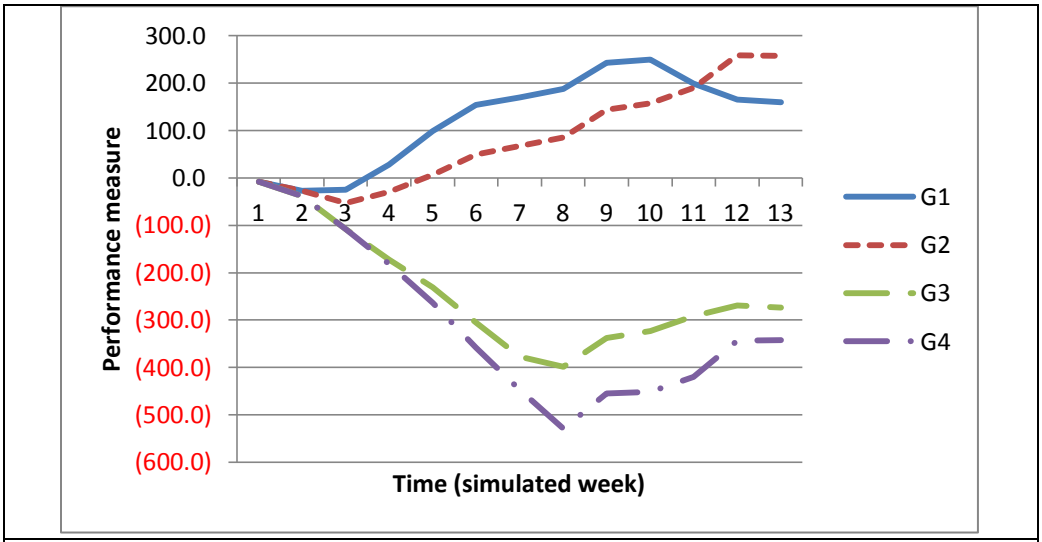

Figure 10: Group simulation results and strategies

In the game it was noted that executives would, as in practice, manage primarily the temporary staff to increase capacity. The temporary workforce serves as a buffer for changes in demand conditions. The game incorporated a feedback in which excessive use of overtime led to fatigue and induced a higher turnover. Managers accepted these feedbacks and did not question them during game debrief, showing that something similar happens in practice. In fact, most managers argued during game debrief that the effects, for example the effect of fatigue on productivity and turnover, were, in practice, more pronounced than in the game.

Of course, game structure may have implicit incentives that differ from those in real life, but nevertheless the learning lab was very useful to study and observe managerial behavior, instill confidence in the model, and helped refine the final version of the simulation.

Following this game, we developed a simulation model incorporating the following assumptions:

a) Personnel moves are made primarily on the basis of temporary staff. This is consistent with actual system data that shows that hiring and firing of temps is much more recurrent than personnel movements of permanent workers. This energetic coming and going of temporary personnel is consistent with the data which showed that temp hiring and firing is brisker, by far, than permanent personnel movements.

b) The project manager has control over the amount of overtime being worked and there are no delays in the immediate adoption of over time.

c) The project manager has control over the number of temporary staff that can be removed at any given time, but removal happens after a delay.

d) Corporate must approve requests for additional staff and, and such requests entail a delay. The larger the number of people required, the longer the delay to approve.

e) The standard worker productivity (in boxes/day/person) is set to 50 boxes per hour per person, according to data supplied for one project and from personal communications by managers, but that productivity varies with the amount of extra hours worked. It is assumed that the more overtime the lower the productivity, as was observed in the actual empirical data (not reported here). It is assumed that this drop in productivity is due to fatigue.

f) The average residence time in the system is longer for permanents than for temps by at least a ratio of 3 to 1, according to managers' communications, corroborating what was observed in the actual data. Temps cannot stay more than a year in the system because of contractual issues.

g) Rookies arrive into the system with 40% of ability (compared to an expert) and require about 120 days to acquire full competition. Executives did not question that a fraction of the capacity of experts needed to teach new people and in fact indicated that this was so in practice.

h) The average time spent in the system is affected by the level of activity. The collected empirical data clearly showed that the greater the work intensity the more people who leave the system.

Since we do not have project financial information, we will use service level and efficiency measures to evaluate system performance. Service backlogs provide a measure of service level. Since the system must process demand within 24 hours after arrival, all backlogs remaining at the end of the day detract from agreed upon service level. A simple measure is fill rate: material processed divided by material received to be processed. Efficiency measures are: a) the use of overtime. Executives would like to use as little as possible, since it is more expensive than regular time. b) Resource Utilization: Management prefers maximizing resource usage. This means that people who are on the payroll at any given time match the needed capacity for the task at hand. Excessive people leads to underutilization and shortage of people leads to overtime. c) Personnel movements. Hiring, Firing, and payroll maintenance are costly. The fewer the number of personnel movements, the better.

The project manager has complete control over the amount of overtime that can be used. Of course the use of overtime eventually impacts the profitability of the project. The manager is more likely to use overtime if its use is more profitable than the penalties associated to backlogs (and hence poor service). However, in the game it was evident that managers do not go into such calculations. They simply use overtime as needed. The workshop showed that working long hours, which could even go beyond a double workday, is not entirely uncommon in practice.

Requests for personnel move through several time consuming stages. The model will request the necessary staff to bring work intensity back to the equivalent of a normal workday load. This process is not instantaneous. In practice managers observe demand and, if there is persistent or chronic lack of staff causing backlogs and overtime, they will request additional personnel. This smoothing of information is taken into account in the model as managers average overtime usage and ask for personnel to bring capacity up or down to attain a preset number of working hours per person. Layoffs function like hiring. When there is staff underutilization, managers seek to close the gap (that is to bring resource utilization up) by firing staff as needed. Firing is not instantaneous because of administrative delays.

There are other loops, such as capital equipment purchases, which are important. However, capital adjustments, in the form of additional equipment or technological change, occur with time delays significantly longer than those related to personnel or overtime adjustment, and they were hence dropped from consideration in this analysis. Profit and financial loops are important, but we do not have access to project financial information and decided not to explicitly consider these loops.

Model

From this exercise we built a simulation model with the loops shown in Figure 9. Figure 11 shows the model.

We use subscripts to model temporary and permanent workers, and we introduce perception and hiring delays in the feedback loops. The personnel sector has two state variables, one for rookies and one for experienced. Each state variable has subscripts for permanent and temporary workers. The formulation implicitly assumes a learning curve as rookie personnel requires time to be up to speed. The time to become experienced captures the effects of many variables which affect the learning curve such as training, workplace ergonomics, mentoring, and so on.

We use 40% as the relative efficiency of a rookie with respect to an experienced person. We added a factor related to the time that experienced personnel must devote to training rookies, which detracts from capacity. For each rookie there is a fractional efficiency loss due to experienced people teaching instead of processing. Tenure times are initially shorter for temps than they are for permanent workers, but they also vary as a function of the smoothed work intensity, mimicking fatigue. Hiring is only of rookies, all temporary, as it happened in practice, and firings are also limited to rookies and particularly temporary workers. If no temporary workers are left, and firing is required, permanent workers will be fired.

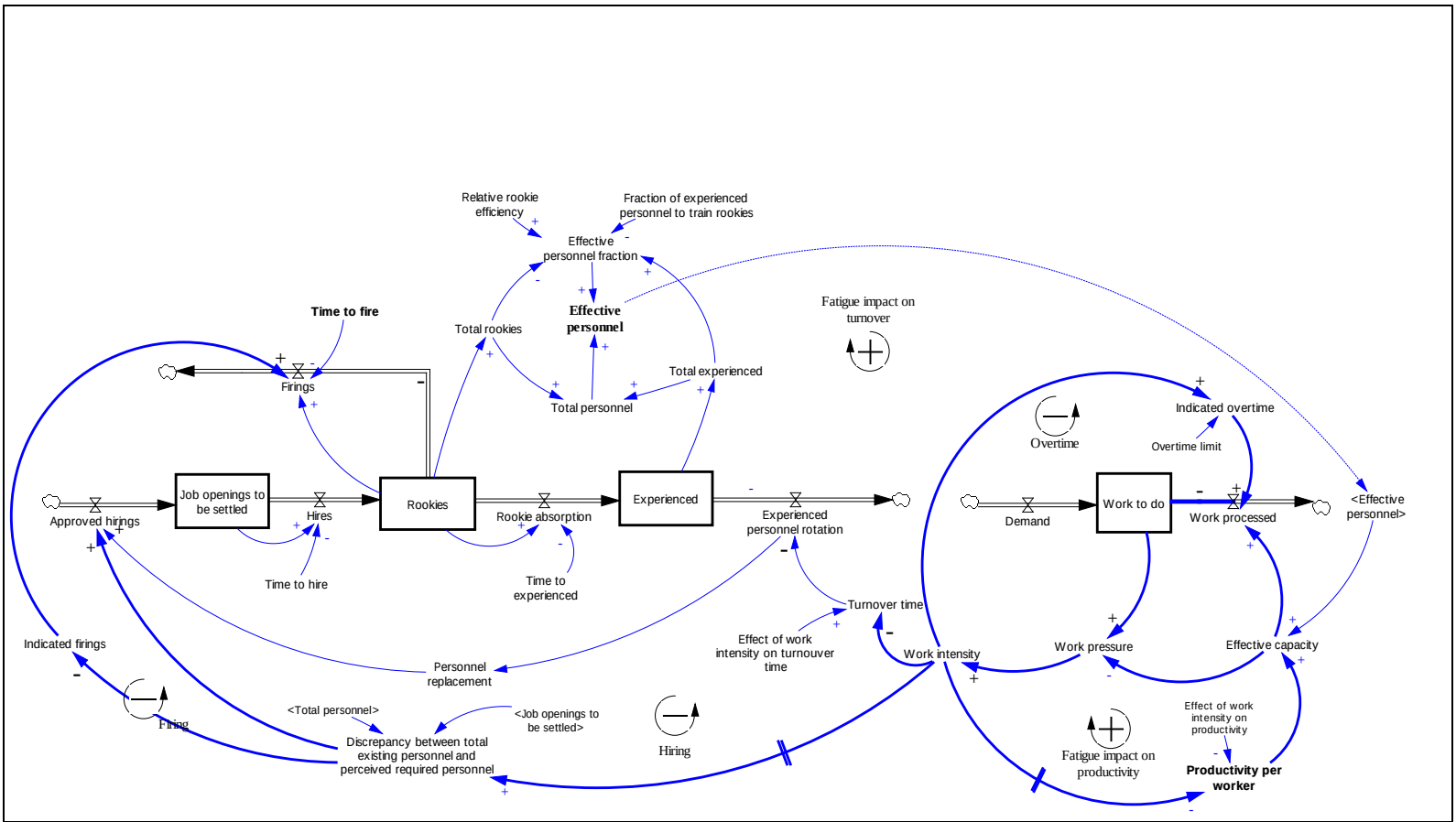

Figure 11: Stock and flow diagram of temporary personnel model.

Demand is exogenous. Customer orders accumulate in a stock of work to do. This stock is emptied by work processed, which is a function of effective capacity. Work pressure compares demand with effective capacity. If demand is greater than effective capacity then there is more pressure, and vice versa. Work pressure translates this unbalance into an index. If the index is above one, overtime is needed to process the day's orders.

The time to process the information and request personnel is short, but the time to hire additional staff depends on corporate and can be relatively long, and up to 40 days, and it varies by project (for example, an analysis of the distribution of delays showed that it fit well to a LogNormal distribution with mean at 6.7 days and a standard deviation of 4.2 days). Time to hire is dependent on the number of temps requested. The larger the number of people required, the larger the time required for approval. This is consistent with the data as staff movements related to staff reductions are much more easily approved than those related to staff increases.

System Dynamics.

The dynamic structure was evaluated first by starting the system in equilibrium. Demand was then abruptly disturbed introducing a one-time step increase of 20% in demand. Thereupon we observed system behavior.

In the short term, the system tries to compensate the sudden capacity shortfall with overtime. Simultaneously, staff is requested to fill the gap. The required staff does not come instantly. It must first be approved by corporate and there are recruitment procedures and paperwork that must be met. Eventually, new staff comes in as temporary rookies who are added to the installed capacity. Because of the delays, the system oscillates.

Despite the oscillations the system maintains a good service level. No backlogs are allowed. However waves of hiring and firing are required to maintain such service level.

Hiring and firing subside as time passes and the system begins to regain equilibrium. The need to provide good service alternates with the need to keep resources fully utilized, but the delays imply oscillations. Eventually the system returns to equilibrium, but due to the short delay times, the system is quite unstable and subject to strong fluctuations. The system's nervousness makes it undergo sharp swings in which periods of intense use of overtime are followed by periods of staff underutilization.

Rookie hiring causes effective capacity to be lower in many lapses to what it could be if all employees were fully experienced. This is because the newcomers are less efficient and because a portion of the experienced capacity must be devoted to training rookies. Similarly, the system undergoes productivity reductions due to fatigue when the use of overtime increases.

The alternate use of overtime and staff changes is clearly observed in practice. Unfortunately we do not have daily data, but our monthly data show that as overtime increases so does the number of people (and vice versa). Even in the monthly data, the use of overtime varies sharply. In the cross docking project average overtime per month, in hours, is equal to 7351. Peak usage is at 50% higher than average, at 11038 hours, and the valley is 37% lower than average, at 4632 hours. Staff adjusts accordingly. In the cross docking operation there were, on average at a given time, 231 temporary workers, but the peak temp usage was 23 % higher , 284 employees, and least temp usage was 25% lower than average at 172.

We can see in Figure 8 above that as overtime usage grows temporary staffing increases, which alleviates the situation and reduces overtime use. Because fewer overtime hours are needed, total personnel decreases. When there is a sustained increase in overtime, temporary staffing increases again, and when overtime decreases, so does temp staffing. The two series track each other well but the data series for temp staffing is lagged (although adjustment seems to be relatively fast, within 30 days). However, overtime is necessary as a mechanism to cope with short term variations in order to meet the customer required service level, which must always be fulfilled.

Figure 12 shows the oscillating nature of the system. With the abrupt change in demand the system can only compensate in the short term with overtime. Personnel can only be hired after a delay. Therefore, the first effect is a marked increase in work intensity, followed by a peak in personnel, very much similar to what is happening in practice. Figure 16 shows work intensity as an index (right hand side axis), and total personnel. The graph shows that after a peak in overtime follows a peak in personnel, just as it happens in reality. In comparing to the actual data, in Figure 7, we see that the model is replicating at least qualitatively, the observed behavior.

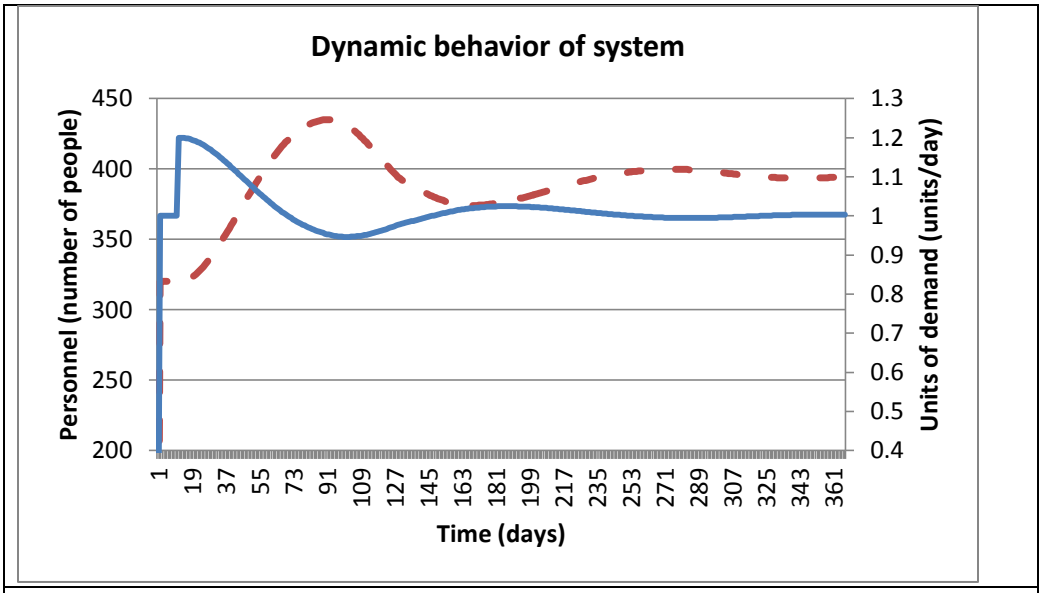

Figure 12: Work intensity and total personnel.

The abrupt demand change generates a need for overtime. The system begins to hire staff to respond to these changes, but because it takes time for the staff to become available, and even longer to acquire the necessary experience to be productive, even more people are hired. Eventually it becomes necessary to make a correction in reverse: to fire people because of staff underutilization. After a few cycles the system returns to equilibrium with the higher level of people needed to sustain the new level of demand. These dynamics are qualitatively very similar to the alternating cycles of personnel and overtime is observed in practice and plotted in Figure 8.

There are several organizational repercussions. First, the system starts drifting toward a different structural arrangement. Delays in the system prevent managers from accurately controlling the system which falls into the observed cycles of over and underutilized resources. In addition, the system has to make a large number of staff movements, both to hire and to fire. People come and go in an attempt,

somewhat futile, to align system capacity demand variations. Flexibility in hiring and firing makes the system to constantly seek balance by hiring and firing.

The system is able to maintain a high level of service. With the combined management of overtime, hiring, and firing it is always feasible to process all daily orders, although some days need long hours.

In practice the noiseless demand that we used is not true. As mentioned, demand shows large variations in demand from day to day, although it is not pure white noise. The demand series has serial autocorrelation. A Portmanteau test for white noise does not permit to reject the null hypothesis that there is no serial correlation in the demand series (Prob > chi2 (40) = 0.0371 y Prob > chi2(10) = 0.0010) with the Akaike information criterion pointing to a significant correlation for lag=6 ($p<0.001$) and Schwarz's Bayesian Information Criterion pointing to a lag of 1. Demand data is strongly correlated by day of the week, that is, for instance, that this Monday's demand is correlated to last Monday's demand, and also there is a weak correlation to demand the previous day.

Such autocorrelation prompts to the use of pink noise for testing model behavior with long runs and different replications. For the purposes of this exploratory paper we used one year of actual demand data. Short of formal calibration, pending the acquisition of additional empirical data, we performed a preliminary analysis with parameters that were reasonable and representative of one of the major operations. Table 1 summarizes the parameters which were estimated for the previously mentioned cross docking operation.

Table 1. Calibration of parameters.

Item	Value	Source
Standard productivity per worker per hour	50 boxes/person/hour	Regression analysis of productivity data
Time to average work intensity	7 days	Anecdotal evidence shows that project managers tend to plan over 1 week cycles.
Time to fire	5 days	Used average of distribution of delays
Time to hire	10 days	Used average of distribution of delays
Time to experienced	100 days for temps and 90 days for permanent workers	Regression of productivity data by tenure, anecdotal evidence and executive opinion. Difference between the two types of workers due to better selection filters for permanent workers
Relative Rookie efficiency	40%	Estimation by executives in charge of projects and regression on productivity by tenure
Fraction of experienced personnel to train rookies	1/15	Estimate based on observation and managerial opinions
Overtime limit	3 shifts	No practical limit exists on the use of overtime, except that it is not possible to work more than three shifts

We then compared two strategies. The first strategy emphasizes the use of temporary workers. In this strategy the average turnover time for temporary experienced workers is equal to 140 days, in line with the empirical data, whereas tenure average time for experienced permanent workers is 480 days, also in line with the actual data. The second strategy is one in which we simply turn temporary workers into permanent workers by allowing them to stay in the system as long as they want, effectively bringing their average tenure time to that of workers in the permanent roster (480 days), thus turning all workers into permanent workers for all practical purposes.

Table 2 : Summary results of two strategies

Item	Perm strategy	Temp strategy	% Difference (with respect to temp strategy)
Overtime (person-days)	2,506	2,758	(9.1%)
Under-utilized time (person-days)	5,518	6,843	(19.4%)
Accumulated temporary rookie days	3,913	9,634	(59.4%)
Accumulated temporary experienced days	13,811	12,131	13.8%
Accumulated total person days	26,159	30,201	(13.4%)
Accumulated hirings (number of instances)	420	790	(46.8%)
Accumulated firings (number of instances)	387	686	(43.6%)

Table 2 shows a comparison of the strategies for several performance measures. In the one year run the temp strategy is inferior. It requires more overtime (9.1%), more underutilized time (19.4%), more rookie days, more total person days, and many more personnel movements. The Temp strategy requires fewer temporary experienced days. It relies on a higher staffing level with much less overall experience. A purely economic approach of course, would require a comparison of the incremental costs associated to the additional experienced person days that the perm strategy demands and contrast those costs with the additional costs associated to overtime, resource utilization, rookie person-days, and most importantly the many more hirings and firings that are required to maintain a give service level. This comparison, which we cannot carry out for lack of financial empirical data, would not take into account qualitative aspects, such as those that the social fiber within the plant experiences as people come and go massively. But a cursory look at table 2 would show that for the chosen set of parameters one could easily make the case that the perm strategy is superior, and that in fact the company would behave myopically if it chose a resource strategy based on the use of temporary workers.

Evidently this result is only tentative. The model must be more carefully calibrated. Noise exerts a great influence, and given the serial autocorrelation in the data, it is necessary to generate pink noise with different noise seeds to perform sufficient replications, as it could perfectly be that the results shown in table 2 are the artifact of a particular series of almost random events. Still, the process we followed to develop the model in close concurrence with company executives gives us confidence in that the structure represents well the actual dynamic structure of the system. In addition, the fact that our study is heavily grounded in empirical data, which has been used to feed model parameters, and the fact that a preliminary calibration exercise provides us model behavior that resembles observed empirical behavior quite closely, gives us confidence in that our model is operating with a sound structure and within reasonable boundaries. Hence, the results provided in Table 2 show that temping may not be as suitable for many firms in the long run as a cursory look at the phenomenon would make us think.

Conclusion

Though we cannot provide a definitive answer to whether an organization should or should not embrace a "temping" strategy, these very preliminary results would seem to indicate that the interaction of different types of workers, temps and permanent, in dealing with changes to work intensity in a service organization may have important organizational effects, and that there are regions bounded by certain combinations of parameters in which such strategy may not be sound. Refining this preliminary first attempt along with the service company will be the task of further research.

References

Amiti, M., & Wei, S. J. (2005). Fear of service outsourcing: is it justified? *Economic policy*, *20*(42), 308-347.

Arvanitis, S. (2005). Modes of labor flexibility at firm level: Are there any implications for performance and innovation? Evidence for the Swiss economy. Industrial and Corporate Change, 14(6), 993-1016.

ASA, American Staffing Association (2015). Staffing Industry Statistics. In https://americanstaffing.net/staffing-research-data/fact-sheets-analysis-staffing-industry-trends/staffing-industry-statistics/; accessed on 8 march 2015.

Autor, D. H., & Houseman, S. N. (2010). Do Temporary-Help Jobs Improve Labor Market Outcomes for Low-Skilled Workers? Evidence from" Work First". *American Economic Journal: Applied Economics*, 96-128.

Bryson, A. (2013). Do temporary agency workers affect workplace performance? Journal of Productivity Analysis, 39(2), 131-138.

Forde, C., G. Slater (2006). The nature and experience of agency working in Britain: What are the challenges for human resource management? Personnel Review; 35, 2, 141-157.

Hatton, Erin (2013). The Rise of the Permanent Temp Economy, The New York Times, January 26, 2013.

Hatton, E. (2014). Temporary Weapons: Employers' Use of Temps against Organized Labor. *Industrial & Labor Relations Review*, *67*(1), 86-110.

Jahn, E. J., & Rosholm, M. (2014). Looking beyond the bridge: The effect of temporary agency employment on labor market outcomes. *European Economic Review*, *65*, 108-125.

Lane, J., Mikelson, K. S., Sharkey, P., & Wissoker, D. (2003). Pathways to work for low-income workers: The effect of work in the temporary help industry. *Journal of Policy Analysis and Management*, *22*(4), 581-598.

Lewis M. Segal and Daniel G. Sullivan (1997). The Growth of Temporary Services Work. *The Journal of Economic Perspectives*. 11, 2 117-136.

Manpower Co. site (2015). http://www.manpower.us/en/Employers.htm. Accessed on March 8 2015.

Oliva, R. (2001). Tradeoffs in responses to work pressure in the service industry. *California Management Review*, *43*(4), 26-43.

Oliva, R., & Sterman, J. D. (2001). Cutting corners and working overtime: Quality erosion in the service industry. *Management Science*, *47*(7), 894-914.

Parker, Robert E. (1994). Flesh Peddlers and Warm Bodies: The Temporary Help Industry and Its workers. New Brunswick: Rutgers University Press).