EMPLOYEES VERSUS INDEPENDENT CONTRACTORS: THE APPLICATION OF PRE-EMPTIVE LINEAR GOAL PROGRAMMING TO FIND A SUITABLE STAFFING MODEL

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ABSTRACT

The skills held by the workforce of Technical Engineering Design (TED) companies are the value proposition that TED firms sell to their clients. TED firms typically use a mixed workforce of employees and independent contractors to provide flexibility in resizing their workforce, as customer demand for their services fluctuates. The workforce configuration used affects the daily, strategic and financial sustainability of TED firms, while influencing their competitiveness in winning tenders for new projects. This study developed a pre-emptive linear goal programming model to determine how employment positions should be staffed using employees and/or independent contractors for a local South African division of a global TED firm. A total of 9 dimensions were identified to evaluate the current workforce. The primary dimensions of significance were the corruption risk associated with a skilled position, strategic importance of a skill to the firm, the perceived value of intellectual property held by an employee, and skill retention costs. This study was able to determine a good workforce model of employees and independent contractors, aligned with the specific constraints and strategic workforce objectives that management of the TED firm wished to achieve.

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1 INTRODUCTION

The South African labour market is undergoing dramatic changes, seen from the introduction of the youth wage subsidy and labour unions wanting to scrap the use of labour brokers. South African business is polarised with divisions between protected and excluded workers, with businesses having to contend with on-going unrest in the labour sector and increasing labour costs [1]. Further challenges that managers need to contend with include cultural differences of a diverse South African workforce and the implementation of affirmative action that has created uncomfortable labour relations [2].

In response to these challenges, businesses have turned towards outsourcing activities that were previously performed in-house. Outsourced firms acquire skills directly themselves or further sub-contract to a third party. Outsourcing provides a risk management mechanism for business to increase its labour flexibility. It enables the use of specialised skills as and when required, which would otherwise be costly to maintain in-house. Importantly, using independent contractors frees employers of South Africa's onerous labour legislation [3].

Determining whether to classify a person as an employee or contractor is a difficult decision for a firm to make, which can impact on both the individual and the employer. Table 1 provides a comparison between common differences of employment terms.

Table 1: Common difference between employees and contractors terms of employment [4]

Policy	Employees	Independent Contractors
Layoffs	• Entitled to severance benefits. • Risk of going to the CCMA. • Strongly discouraged by unions.	• No severance compensation. • Relationship allows termination/no renewal of contract.
Firing for Cause	• Require extensive documentation and consultation before firing.	• No restrictions on manager's ability to terminate contract.
Career Development	• Training commonly provided • Promotion opportunities and pay increases	• No additional training provided. • No career ladder access in firm.
Performance Management	• Annual performance review, with clear targets and bonus	• No performance review or pay incentive.
Benefits	• Pension fund, medical aid, access to share options.	• Labour broker may provide limited benefits.
Costs	• Generally lower cost, limited overtime pay.	• Higher per unit cost, can charge for overtime.

However, using a mixed workforce of employees and contractors creates its own set of challenges for businesses. Questions relating to changes in organisational culture, increased risk of intellectual property loss, goal alignment and the impact on business economics all arise. All these factors influence the best mix of employees versus contractors. This paper presents a model for determining this mix using the aforementioned factors. The model is developed using a mixed workforce of employees and independent contractors for highly skilled workers in a South African division of a global Technical Engineering Design (TED) Company. The TED division provides highly specialised engineering design services and technology, in a project orientated environment.

2 CONTEXT

In 2012 the TED Company had sales to customers in South Africa in excess of EUR 400 million and new orders in excess of EUR 500 million. The TED division typically handles numerous projects concurrently that can take anywhere from 1 to 6 years to complete. This division currently consists of a total of 61 people of which 73% are independent contractors and 27% are permanent employees. The South African norm of independent contractors to employees is 13.9% to 63.5% respectively, with 22.5% being unspecified [5]. The typical skills used within the TED division are shown in Figure 1, with the number of employees and contractors in each role indicated.

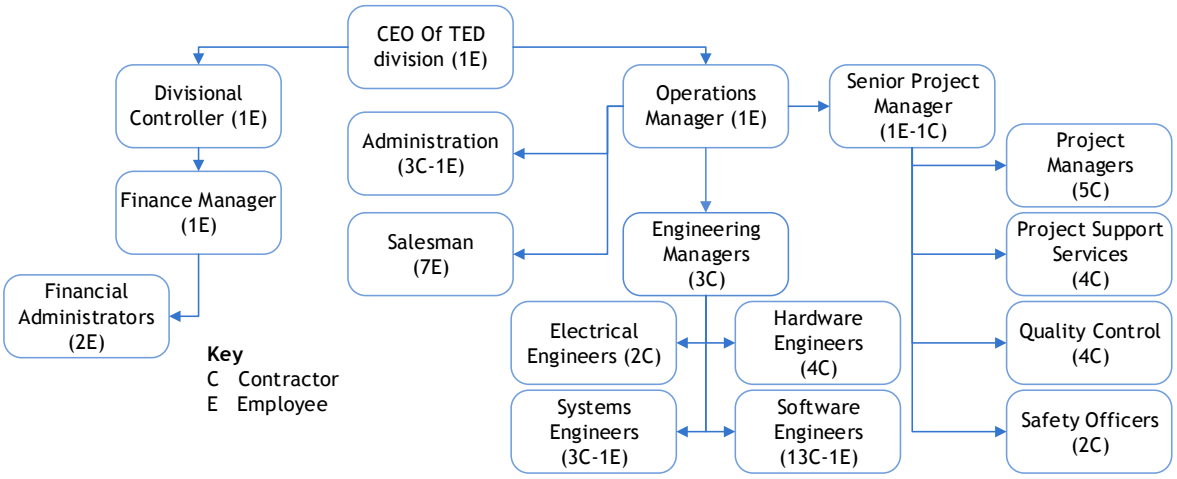

Figure 1: Organogram of TED division

According to the TED Company's internal policies, the division is restricted by the official headcount it can have. Officially the division has a total headcount of 23 staff, consisting of 17 people classified as permanent employees and 6 people classified as contractors. The additional 38 independent contractors are acquired via procurement services through labour brokers and do not reflect in the official head count of the division.

2.1 Purpose of the study

The TED division wanted to ensure that its workforce configuration maximised their competitive advantage within the industry. It is strategically important for the division to win project tenders, which can be worth R10 to R100's of millions and can involve the exclusive use of the TED Company's services for the operational life of a production facility. However, there are the major constraints of irregular customer demand of the division's services and limited availability of specialised skills in the labour market. While the TED division may require certain skills during the design and commissioning of a plant, it does not want to carry the cost of the specialised skills during periods when not required. Conversely, if the TED division does not retain the specialised skills, the skills can be lost to a competitor, making it more difficult to offer a competitive tender when bidding for future projects.

The current high contractor workforce configuration has created further challenges in the division. Management have major concerns over intellectual property risks associated with its reliance on contractors in key positions. Internal policy restricts the ability to train contractors, which is viewed negatively by contractors as limiting their skills development opportunities. The high proportion of contractors has resulted in contractors managing contractors. This has created a distinct lack of organisational goal alignment and uniform company culture. Contractors are not incentivised to meet the TED division's project targets, given the temporary nature of their employment. Contractors also attempt to extend their work allocations for as long as possible, to increase their number of billed

hours, by performing re-works with higher job specifications than that which is required. While there is job security offered to employees, some contractors are reluctant to become employees due to lower salaries that will be earned. Cultural differences also exist within the division. The implementation of affirmative action is playing a role in job security, access to job opportunities and changes in employment practices.

Additional concerns of the TED division include:

- Project incentives cannot be provided for contractors to help incentivise good performance.
- The current workforce configuration has created a high cost structure due to the impact of contractors' fees.
- South Africans labour legislation is unclear around laws regarding contractors, with extensions of the law indicating that long-term contractor contracts' can indicate permanent employment.

Given these challenges, the division understands that its current workforce configuration is not the best model to use, given its dependency on contractors for most tasks performed in the division. The TED division wants a workforce configuration that is agile to respond to market demands while considering the impact of softer organisational aspects, and financial implications of such a workforce.

2.2 Objectives of the study

From this study three main issues arise, which require answering:

1. What is the best overall ratio of employees to independent contractors that should be used by the division, given its specific needs?
2. What is the best employment classification for each skill category used within the division?
3. In the event that the division needs to adjust its workforce size, how should this be done for each skill category?

2.3 Research Methodology

To conduct a structured workforce planning exercise, a pre-investigation was conducted by:

- Reviewing the TED division's current human resource policy,
- Understanding what are the prioritised skills required by the division, and
- Understanding the main concerns around using employees or contractors.

With a background understanding of the needs for this study, a comprehensive literature review was conducted to investigate:

- Factors involved in deciding whether to classify a person as a contractor or an employee,
- Quantitative measures required in evaluating the suitability of using employees and contractors, and
- Techniques and principles involved in workforce planning.

From the findings of the literature review, a customised framework and model were developed to answer the specific objectives of the TED division. Data was then collected for the model, followed by an analysis of the model's results and a feasible workforce configuration determined.

3 LITERATURE REVIEW

3.1 Employees versus Independent Contractors

The allocation of an employment classification for an employee or contractor is a problematic decision for a firm to make. Each classification can provide mixed benefits to a firm but creates its own set of challenges in managing the workforce.

Using employees ensures that they are aligned in achieving firm specific goals, due to their socialisation with other employees, organisational culture and pressure from superiors to perform. Increased employee commitment to the firm can be attributed to the job security employees enjoy that enables long term goal alignment. Firms are at less risk of expropriation by employees as they have a stronger allegiance with the firm and internal bureaucratic processes that can, to some extent, control employees. In the case of a high wage environment, the Efficiency Wage Model suggests that employees are incentivised to work harder, and a firm can reduce its turnover while attracting higher quality candidates [6].

It has been found that contractors have better technical knowledge in comparison to employees. However, contractors lack the understanding of firm specific processes which hindered their work. This leads to contractors being used mainly for technical roles, at a premium cost, within the firm rather than user interaction roles [7]. Contracting out allows for smoothing of the workload of the regular workforce. This is despite contractors having a higher per unit cost during peak periods of work. Nevertheless, firms should rather employ highly specialised skills like engineering and draftsman roles, to prevent difficulties in work continuity and expropriation concerns of intellectual property [6].

3.2 Why Contractors Contract?

In a South African context becoming a contractor, through a labour broker, provides access to jobs that would otherwise not be available to the applicant. This is due to a firm's preference to remain flexible and avoid cumbersome labour legislation. Furthermore, labour hired through business procurement services does not reflect in a firm's Black Economic Empowerment rating. Contractors employed through labour brokers have increased chances of obtaining work, following completion of their current contracts [8].

However, the realities of working as a contractor in South Africa does have disadvantages, with labour brokers charging a monthly fee of 8-15% of the contractor's salary. Working as a contractor involves making compromises between:

- Independence from the organisation versus being given the status of an outsider;
- Increased financial security during contracting work versus uncertainty of the next contract;
- Enhanced income versus hidden costs to remain up-to-date in the field, and
- Having one's skills traded as a commodity within the market does not always provide interesting work [9].

It is clear that the role of contractors is varied, with clear benefits for both the firm and an individual to be used as a contractor. While firms face associated management dilemmas, contractors' primary concerns are over job uncertainty.

3.3 Human Resource Models, Management & Architecture

In human resource management (HRM) the most common models applied are the soft and hard versions, which have opposing views of the nature and managerial practises that should be applied. Truss *et al.* [10] found that no organisation implements either approach in the application of HRM. In reality, every workforce is faced with strict organisational goals,

coupled with the challenge in managing people. Thus any future HR management model should account for both the soft and hard aspects in configuring a workforce, to leverage the benefits offered by both management approaches.

The principal factor to consider from a HRM perspective is that of employee motivation. Motivation can encourage a particular behaviour that impacts directly on a firm's success or failure of a given strategic objective. The measurement of organisational commitment can provide an indication of an employee's congruency between his beliefs, and acceptance of organisational goals. This can provide insight into an employee's intent to search for a new job and gain an understanding of job turnover rates [11]. The Job Diagnostic Index is one of the most widely used tools in this area. The index measures five dimensions of job satisfaction, by looking at pay, supervision, co-workers, promotion opportunities and work tasks. The tool can enable management to use non-financial facets in order to retain and manage human assets.

HR architecture aims to align employee positions and relationships, to gain a competitive advantage. An HR architecture draws on numerous theories related to economics, organisational theory and strategic management. Each theory offers a different view on how management should configure its workforce, yet all are similar in the two dimensions of the value and uniqueness of a skill. These dimensions should always be present in deciding when to acquire human capital. Skill value is defined as a skills ability to lower a firm costs and increase customer benefits to influence the firm's performance [12].

3.4 Employee Evaluation Methods

The main aim of an employee evaluation and selection systems is to improve a firm's competitiveness and performance, in conjunction with its competitive goals. Given that a firm's success relies on having the right people in the right jobs at the right time, selection of candidates should be based on an organisation's strategic goals and cultural objectives.

Golec and Kahya's [13] proposed the identification of enabling factors that allow for goal achievement. Enabling factors can refer to employee competency based factors and are identified through stakeholder engagement. Identified organisational goals should be ranked by importance, so that candidates can be evaluated against prioritised goals. Heuristic algorithms can be used to evaluate candidates that include a set of constraints to guide the selection process. This typically leads to the creation of a mathematical function, which is able to determine a numerical score for each candidate, enabling relative candidate evaluation through score comparisons.

3.4.1 The Job Diagnostic Survey

The Job Diagnostic Survey (JDS) developed by Hackman & Oldman [14], is a comprehensive tool that can be used to measure three particular variable classes of a specific job of interest. The JDS can measure how a particular job is currently designed to enhance internal motivation and job satisfaction of the people who perform them. The JDS is also able to measure the personal affective reactions people have towards their jobs, and the broader organisational setting in which they work.

3.5 Workforce Planning Techniques

Typically operations research (OR) methods are applied in solving workforce planning problems, with common approaches involving optimisation, simulation or decision analysis. In the context of OR, workforce planning falls under various classifications of problem types, and can be referred to as manpower planning, personal scheduling or team formulation. Each type of problem address a different aspect of workforce planning, and all attempt to determine a good workforce configuration, given a set of constraints and similar objectives. Manpower planning, the focus of this study, emphasises high level workforce planning of a workforce's size and type of employment allocations. Contrariwise the team formulation

problem, a variation of the assignment problem, considers a large group of candidates of varying skill types and their personal and social attributes.

Price *et al.* (1980) [15] suggested a two staged approach when attempting to determine a workforce plan. Firstly, to use descriptive techniques like Monte Carlo Simulation to imitate the actual behaviour of organisational polices to determine forecasts for future manpower requirements. Secondly, normative techniques like linear programming and its extensions, can be applied starting from the forecasted requirements to determine a solution according to the stated objective and constraints.

Conversely, Song and Huang (2008) [16] applied dynamic programming to determine a workforce capacity plan based on employee turnover rates, inter-departmental transfers and operational cost limitations due to changes in supply and demand.

Whisman et al. (1988) [17] used goal programming to create a workforce plan that incorporated both quantitative and qualitative objectives. Qualitative objectives involved acquiring staff for specific training grades, smoothing recruitment fluctuations from period to period and maintaining a reasonable level of experience within the workforce. The quantitative objective related to minimising personal costs.

4 MODEL DEVELOPMENT

For this study, a model was developed to provide a focused approach on the critical factors required to determine a workforce configuration. From careful analysis of literature and through stakeholder engagement, two major themes emerged, namely the risks and the financial feasibility of using a mixed workforce configuration. These themes consist of various sub-themes, shown in Figure 2, which were identified as the prioritised factors to evaluate the TED division's workforce.

All workforce evaluation factors shown in Figure2 had been identified in various literature sources to evaluate an employment position, with the exception of the corruption risk. The TED division's stakeholders, consisting of 3 employees and 1 contractor, considered the corruption risk factor to have the highest prioritisation in determining whether a skill position should be internalised or externalised. In the TED Company, corruption was seen as inherent to specific skill types, with contractors having a higher perceived risk than that of an equivalent employee in the same role.

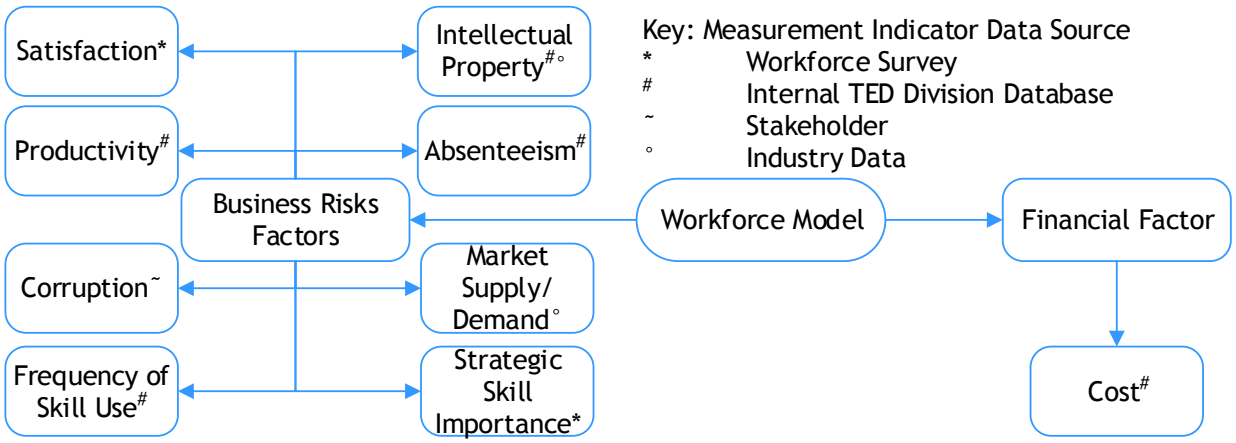

Figure 2: Workforce planning model indicating workforce evaluation factors

Given that the TED division wanted to evaluate their workforce against the objectives of minimising its business risk factors and the financial impact of its workforce, pre-emptive linear goal programming (GP) was seen as the best technique to use. GP would enable each employment position to be to be designated based on a prioritised order of both the soft risk and hard financial evaluation factors that were identified.

4.1 Goal Programming

Goal programming (GP) is applied when multiple decisions are required. Each objective (goal) can be expressed as a function of a target cost, hiring or employment quota (etc.). Each objective is included as a constraint which should be satisfied within a specified range by the decision-maker. Empirically, GP is considered to provide good results and provides an indication of the degree to which certain goals can be attained [15].

In goal programming there are three types of goal classifications:

1. A lower one-sided goal (≥), which sets a lower limit that does not want to be exceeded, but falling above the limit is acceptable.
2. An upper one-sided goal (≤), which sets an upper limit that does not want to be exceeded but falling below the limit is acceptable.
3. A two-sided goal (=), sets specific targets that should not be missed on either below or over the specified amount.

GP can be further classified as:

a. Non-pre-emptive goal programming, where all goals are considered to be equally important.

b. Pre-emptive goal programming, where goals are rated on a hierarchy of priority levels. When this GP is solved mathematically, the most important goal (highest assigned penalty level) receives priority, followed by the second most important goal and so forth [18].

Given that a GP is a special form of a linear programme, it can be solved using the simplex method algorithm. Mathematically, GP's are always expressed as minimisation problems whereby the GP finds the positive deviation, of deviation variables $\boldsymbol{d} = [d_1^{+/-},\ldots, d_m^{+/-}]$, about decision variables $\boldsymbol{x} = [x_1,\ldots,x_n]$. For deviation variables $\boldsymbol{d}$, the +/- refers to the over or under achievement of a stated goal.

The objective function of a GP is expressed as $Z = \boldsymbol{p}^{+}\boldsymbol{d}^{+}+\boldsymbol{p}^{-}\boldsymbol{d}^{-}$, where $\boldsymbol{p}^{+/-} = [p_1^{+/-},\ldots, p_m^{+/-}]$ represents the assigned priorities in a pre-emptive goal programming. Z is subject to the goal constraints $\mathbf{Ax} - \mathbf{d}^{+}+\mathbf{d}^{-}= \mathbf{b}$, where $\boldsymbol{b}$ is the requirements vector expressed as $\boldsymbol{b} = [b_1,\ldots,b_m]$. **A** is referred to as the technological coefficients which consists of a $m \times n$ matrix of elements a_{ij}, where $i = 1,\ldots,m$ and $j=1,\ldots,n$. By converting a GP into a linear programme, goals are stated as constraints with non-zero solutions of $\boldsymbol{d}$ indicating goals are achieved with a deviation [16].

In the case of a pre-emptive GP the assigned penalty weightings must be scaled by a factor $M_1, M_2,\ldots,M_{p-1}$. M_1 represents a vastly larger number than M_2, M_2 vastly larger than $M_3\ldots M_{p-1}$, where p is the number of ordered priority levels considered for the model [18].

4.2 Workforce Planning Model Formulation

Each of the risk and financial sub-factors, in Figure 2, were measured on various dimensions, described in equations (1) to (9). The evaluation dimensions for each sub-factor were determined from literature and through stakeholder engagement.

$$Satisfaction = f\{supervision, growth, motivation, security, pay, fringe\ benefits, social\ orientation\} \quad (1)$$

$$Productivity = f\{performance\ measurement\} \quad (2)$$

$$Absenteeism = f\{annual\ leave, unpaid\ leave, sick\ leave\} \quad (3)$$

Intellectual property = f {current pay, market pay, duration spent at TED, strategic importance of skill} **(4)**

Strategic Skill Importance= f {management rating, non-management rating} **(5)**

Frequency of skill use= f {skill demand, utilisation} **(6)**

Market Supply/Demand = f {market salary, perceived availability} **(7)**

Corruption = f {internal rating} **(8)**

Cost = f {cost to company, overtime cost} **(9)**

4.2.1 Data Collection

Data for each of the sub-factors described in equations (1) to (9) was collected through one of the four sources shown in Figure 2.

The workforce survey used, was largely based on the Job Diagnostic Survey developed by Hackman and Oldman [14]. The survey used a Likert scale system for respondents to answer questions. In the application of Likert scales, there is the common assumption that regular intervals of equal magnitude can be applied across the point scales. A major flaw in this method is the assumption of independence and lack of correlation amongst factors. An alternative approach to avoid the shortfalls of Likert scales is to normalise the values using the formula:

$$z = \frac{(x-\mu)}{\sigma} \quad \textbf{(10)}$$

Where z is the z-score value of an x value belonging to a distribution with mean μ and standard deviation σ.

The method of normalising a score is based on view that people are good at identifying whether something is good or bad/positive or negative but have difficulty considering multiple inputs. Normalised survey scores help interpret the results in terms of their relative ranking to one another, and to the mean and standard deviation of the score's population [18].

Calculated scores from the workforce survey were group by skilled type. The mean normalised scores were determined for both employees and contractors in the same skill type, for use in the GP model.

For data collected from the TED division's internal database, the mean values of employee and contractor data was used for the various skill types.

4.3 Pre-emptive Goal Programming Workforce Model

A linear pre-emptive goal programme was used to describe equations 1 to 9 mathematical. The decision set used in the model was for all the skill types shown in Figure 1. An additional skill type of 'All' was included in the decision set to determine the best overall ratio of employees to contractors, without considering each specific skill type individually.

The objective function for the GP gave priority, in descending order, to the corruption risk, intellectual risk, strategic importance of skills to the TED division and cost factor when evaluating an employment position. The remaining factors in Figure 2 were un-weighted in the objective function.

The GP was subject to constraints derived from equations 1 to 9. Each constraint had an employee and contractor variable multiplied by a numerical constant used to describe the specific constraint score for the employee or contractor variable.

The GP was converted into a linear programming (LP) problem through the introduction of deviation variables prior to the problem being solved. A LP was run for each skill type in the decision set.

For the 'All' skills type, an additional constraint was added to the model to determine the effect of different ratios of employees to independent contacts used within the workforce.

The final workforce configuration that the TED division should use, was determined by analysing the results gathered from sensitivity reports generated by the LP. Mathematically the GP converted to a LP can be expressed by:

Decision Set:

S Set of all skill groups considered in the model.

Variables:

i Corresponding to the function describes in equations (1) to (9), where *i* = 1 to 9

j Skill type, where *j* = 1 to 13, for each skill represented in *S*.

u Number of employees in *j*.

v Number of contractors in *j*.

z Number of candidates considered for the workforce plan for *j*.

w_j Proportion of employees in *j*.

x_j Proportion of contractors in *j*.

$y^{+/-}_i$ Deviation variable for *i*.

Constants:

A_j Calculated score, for factor *i* for employees *j*.

B_j Calculated score for factor *i* for contractors *j*.

$$Min\ Z = y_1^- + y_2^- + y_3^+ + M_2 y_4^+ + M_3 y_5^- + y_6^+ + y_6^- + y_7^+ + M_1 y_8^+ + M_4 y_9^+ \quad \textbf{(11)}$$

St.

$$\sum_{i=1}^{9}(A_{ji}u_j + B_{ji}v_j - (y_i^+ + y_i^-)) = \sum_{i=1}^{9} z_j(A_{ji} + B_{ji}) \quad \textbf{(12)}$$

$$u_j + v_j = z_j \quad \textbf{(13)}$$

$$w_j u_j - x_j v_j = 0 \quad \textbf{(14)}$$

$$w_j + x_j = 1 \quad \textbf{(15)}$$

$$u_j, v_j \geq 0 \quad \textbf{(16)}$$

$$y_i = y_i^+ - y_i^- \ \ where\ y_i^+ \geq 0,\ \ y_i^- \geq 0\ \forall\ i = 1\ to\ 9 \quad \textbf{(17)}$$

5 DISCUSSION AND RESULTS

From the workforce survey, it was possible to identify the strategically important skills of the TED division. Normalising the survey scores, helped to identify which skill groups should be internalised and those staffed by contractors. Thus, all the skills that have a positive score in Figure 3 are considered essential to the division and should preferably be staffed by employees. Currently only sales and finance is completely staffed by employees, with 1 software engineer (out of a total of 14) and 1 senior project manager classified as an employee.

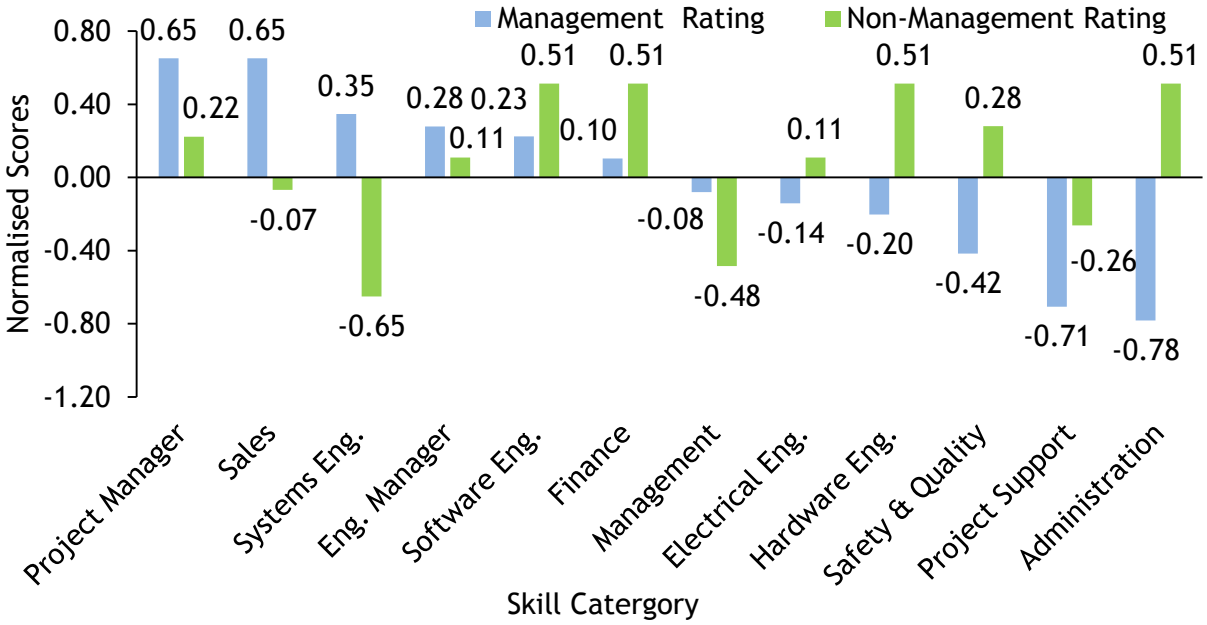

Figure 3: Normalised mean strategic skill importance scores

Surprisingly, management rated the strategic importance of itself lower than that of other skill positions, as seen in Figure 3. Management's mean strategic importance score also reflected a negative standard deviation score to that of the overall mean strategic importance of their skills. This negative score implies that management's position can be staffed by contractors given a lower importance relative to other skill groups. However in reality, having contractors in management positions is known to create problems related to goal alignment and highlights the allocation of staff depends on the model's input data.

From the optimal solutions generated by the linear programmes of each skill category, shown in Figure 4, a workforce configuration of 63% employees to 37% contractors is produced. This classification of the workforce was largely determined by the assigned priority levels of the risk and financial factors identified in Figure 4, which have all be incorporated into the LP. Skill categories with high corruption ratings, intellectual property ratings, skill importance ratings and high contractor costs are favoured completely for employees.

The proposed workforce configuration shown in Figure 4 would only be viable if the demand for the TED divisions services were continuous and provided sufficient amounts of work for all staff. The workforce classification in Figure 4 can still be used to determine which skill types should remain completely staffed with contractors, with greater flexibility still required in the skill categories with employees only.

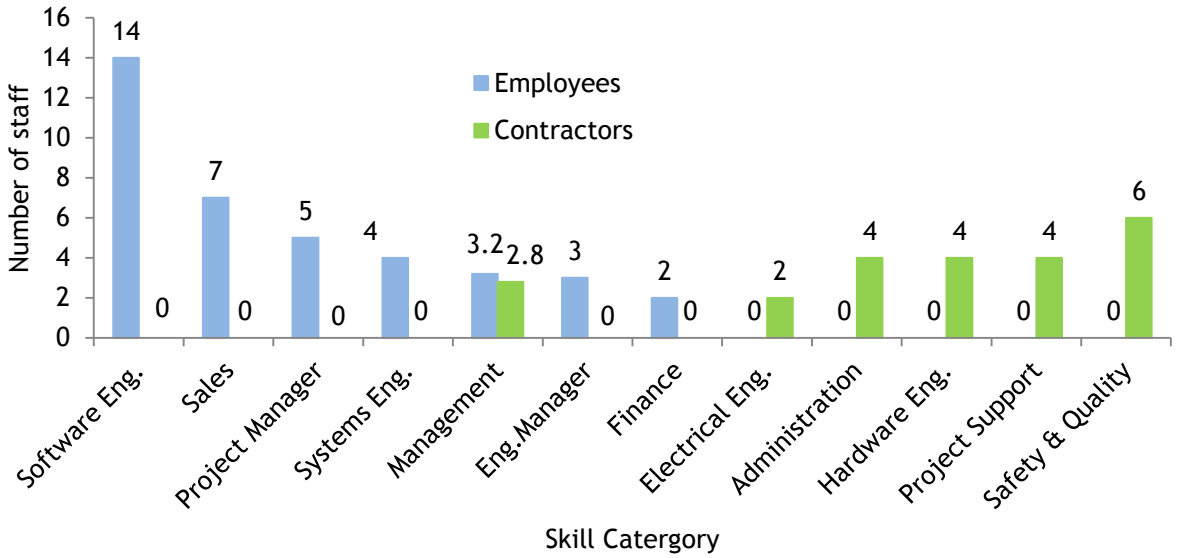

Figure 4: Optimal workforce configuration for all skills

The 'All' skills category results, shown in Figure 5, indicate that the lowest objective function value was obtained for a workforce configuration of 80% employees and 20% contractors. From evaluating the sensitivity reports generated for each ratio considered, it was found that as the number employees increased and number of contractors decreased,

- There was an increase in:
  - Staff motivation and job satisfaction levels;
  - The number of tasks completed by an employee than a contractor in the same position.
- There was a decrease in:
  - Staff absenteeism levels;
  - The amount of time spent on project tasks;
  - In the perceived corruption risk to the TED division,
  - Costs.

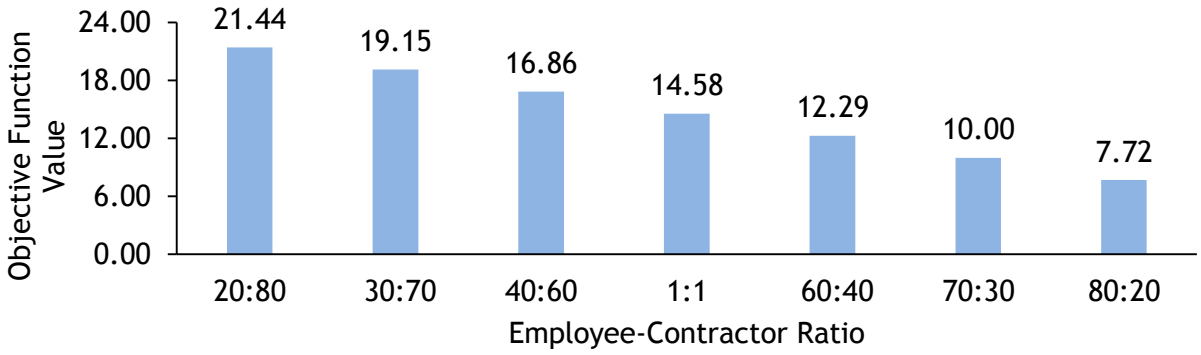

Figure 5: Objective function magnitudes for workforce ratio combinations of employees to contractors

Based on the ratio findings an overall workforce configuration of approximately 40% employee to 60% contractors was recommend for use. This ratio provides a compromise between the risks the division faces, and helps maintain workforce flexibility, while considering the practical implications of changing from the TED division's current workforce

configuration. Furthermore from the sensitivity reports generated, it was found that there was only a marginal improvement in goal achievements for employee ratios above 40%.This is also evident by the objective function values shown in Figure 5, which improve marginally less as the proportion of employees increases.

Having determined an overall workforce ratio, each skill category was evaluated on the dimensions of the value and uniqueness that a specific skill offers. This resulted in the workforce configuration shown in Figure 6, consisting of 43% employees to 57% contractors. This proposed workforce configuration enables easy resizing in most skill positions by having a mixture of employees and contractors. Importantly, at least one employee has been allocated to each of the engineering skills to enable work continuity and manage work specific risks.

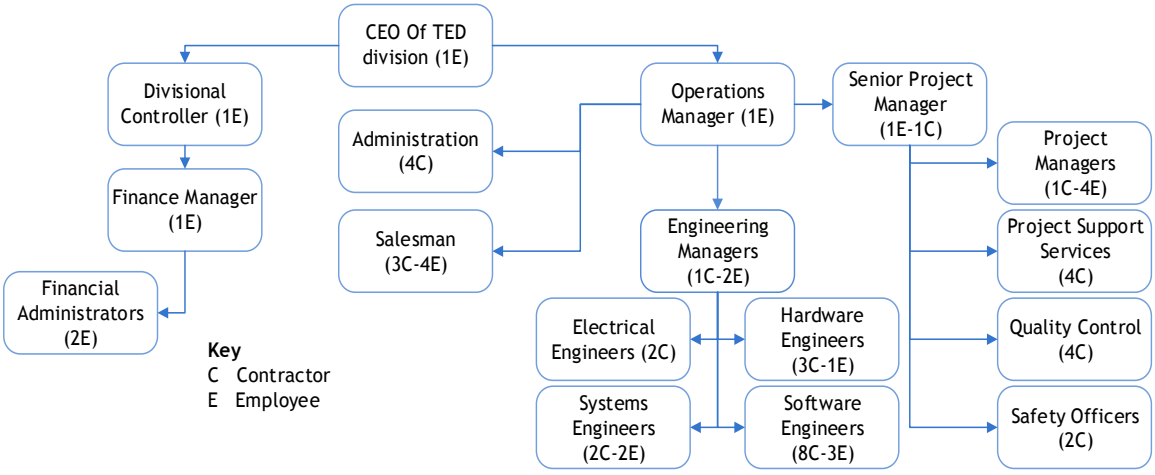

Figure 6: Proposed workforce configuration

6 CONCLUSIONS

Theories of workforce planning and the application of pre-emptive linear goal programming have been applied in finding a suitable workforce configuration for a division of a technical engineering design company. The model constructed enabled each skill type used within the division to be evaluated against a prioritised list of 9 dimensions. The use of a pre-emptive linear goal programme provides a customised approach to finding a workforce configuration specific to the needs of the division. The approach used can be easily adapted to similar workforce planning exercises with specific scenario requirements. It is recommended that further work be done on including customer demand for skills into the goal programming model.

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