

Measuring Non-Monetary Incentives Using Conjoint Analysis

by

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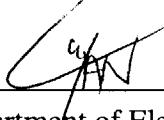
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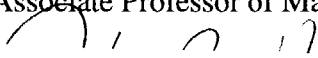
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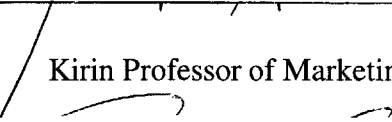
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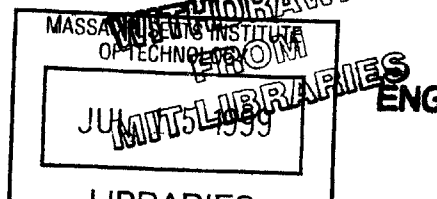
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ABSTRACT

Using conjoint analysis to measure importance of non-monetary incentives to supervisors and their reporting staff at the Research, Development and Engineering Center of the U.S. Missile Command.

This study is built upon the theoretical work on agency theory, citizenship behavior and psychological contracts. These theories explain the relationship between the supervisor and the subordinate and suggest how non-monetary incentives can improve such relationship. This study has identified the non-monetary incentives valued by supervisors and subordinates, measured the relative importance of these non-monetary incentives and, as part of the data collection, explored online conjoint analysis.

There are three phases in the study. The first phase involves qualitative interviews with the subjects. The qualitative interviews confirm the list of attributes that have previously identified from the literature reviews. The attributes are winnowed and categorized. The second phase is the card sort. Participants are asked to group and identify exemplar from a set of attributes. The result is a final list of attributes that will represent people's needs in making them an effective employee. These attributes are then turned into job profiles that are used in the conjoint analysis. In this last phase, participants express their preferences on different job descriptions via the web. The analysis followed reveals how participants value different attributes.

Results of the exploratory analysis tentatively conclude that both supervisors and supervisees value company fairness, opportunities to do high-impact work, and salary as very important. Using online conjoint analysis has been an effective data collection method for this study, however, the design of the tool needs improvement to account for inconsistency and reliability.

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Chapter 1: Introduction

1.1 Motivation and Goals

Firms use various rewarding policies to encourage workers to work harder, take new challenges, or adopt new organizational changes. Money, in the form of salary increases or bonuses, is one of the most common and fundamental policies. If monetary rewards are not available, alternative incentives must be determined. This leads to the question: is monetary compensation the key to motivate workers? We believe that other non-monetary attributes are equally or sometimes even more attractive to workers, that they are willing to give up some monetary compensation in exchange for those non-monetary attributes. Therefore, it is important for an organization to identify these non-monetary incentives and understand how they affect workers' attitudes towards their jobs.

As one of the sponsors of the ICRMOT, which is affiliate with CIPD, U.S. Army Research, Development and Engineering Center (RDEC) assisted us on this research. About 100 scientists and engineers from the laboratory participated in the study. Facing the need for efficient budgeting, the managers of the Laboratory are finding it increasingly difficult to retain their engineers. This study is motivated to seek an understanding from the engineers at this organization what and how much they value various aspects of their jobs.

The goals of this study are to 1) identify the non-monetary incentives valued by employees; 2) measure the relative importance of these non-monetary incentives and 3) investigate any efficient transfers between firms and employees. By quantifying non-monetary incentives, firms can design compensation systems that will satisfy their employees while potentially reducing the cost of providing this compensation. The

measurements are done using conjoint analysis, a technique widely used in marketing research to study trade-offs in product designs. This technique has been pre-tested in an earlier study of non-monetary incentives (Wernerfelt, Simester and Hauser, 1997). As part of the measurement, this study investigates the issues of collecting data using the web. These issues include design of the questionnaires, control of the experiment, validity and biases, and technical challenges of the implementation. This study will establish frameworks for online data collection method. The result of the data will contribute to part of the ongoing research at the Center of Innovation in Product Development (CIPD) and International Center for Research on the Management of Technology (ICRMOT) in hope of helping organizations managing resources.

1.2 Overview of This Thesis

This thesis will first introduce the motivation and the goals of measuring the non-monetary incentives, as discussed in the previous section. Then, Chapter 2 provides some theoretical background relating to non-monetary incentives. It will explain the key concepts and tools used in the study. Chapter 3 describes the methodology of the research, from qualitative interviews to card sort and finally online conjoint survey. The chapter discusses the actual process of data collection and includes some data. Chapter 4 focuses on the analysis of the data collected through the web. Chapter 5 is a summary of the key findings and suggestions for future research.

Chapter 2: Background

2.1 Definition of Non-Monetary Incentives

In the working environment, non-monetary incentives refer to that which motivates or encourages workers to improve or extend their efforts without receiving monetary compensation. For example, firms that provide free dinners encourage employees to work late. As a result, firms might get more productivity from the employees.

The example described above reflects several assumptions. First, the basic assumption is that firms would like to increase employee productivity in order to increase their own profitability. Second, providing dinners is sufficient to induce the employees for working late. Third, it is assumed that employees will reciprocate for their rewards. Finally, that the cost to the firm of the dinners is less than or equal to the value of the increased effort by the employees. These assumed behaviors can be explained by agency theory, citizenship behaviors, and psychological contracts.

2.2 Agency Theory, Citizenship Behaviors, Psychological Contracts

Agency theory describes the relationship between a principal and an agent. In such a relationship, the agent selects how much effort and where to direct the effort. Problems arise when the objectives of the principal and the agent are not aligned and when the principal cannot observe the agent's effort. If the principal can observe, the problem can easily be resolved with a contract that rewards the agent for following the principal's directions. For example, a parent wants her child to do his homework and she promises him chocolate if he does (contract). Suppose the child is sitting by the kitchen

counter where his mother can see him (observation), the child will get chocolate (reward) as long as the mother sees him doing homework. If the principal cannot observe the agent's behavior, the principal will seek ways to align the agent's goals with the principal's goals. This is typically done using a contract that rewards the agent for measurable changes in output. For example, a child likes chocolate and his mother wants him to do homework (agent's and principal's intents). She offers him chocolate if he has his homework done (contract). The child will get his chocolate as long as he has his homework done and the mother does not need to watch him work (lack of observation). The alternative is to invest in monitoring the agent's choice of effort (Eisenhardt, 1989). The study of non-monetary incentives fits into the agency relationship in that the agent is self-interested, utility maximizing, and risk-and-effort averse, whereas the principal wants to increase the value and performance of the firm (Eisenhardt, 1989; Jensen & Meckling, 1976).

Citizenship behavior, in the context of working environment, refers to the fact that when an employer treats an employee well, the employee reciprocates by doing a better job. This behavior plays a significant role in studying non-monetary incentives as this study assumes that the employee's attitude towards their work is affected in a positive way in the presence of the appropriate type of non-monetary incentives. Tsui, Pearce, and Tripoli (1997) demonstrated that employees performed better on core tasks, showed more citizenship behavior, and expressed a higher level of loyalty when they worked in an "over-investment" relationship. Such a relationship is one where an employer offers open-ended and broad-ranging rewards, including training and a commitment to provide the employee with career opportunities.

A psychological contract is a set of beliefs regarding mutual obligations between employee and employer (Robinson, Morrison, 1995). These obligations may range from definitions of roles to treatment by the organization. The non-monetary incentives establish obligations in these contracts. For example, a subordinate's trust that a supervisor will treat all subordinates fairly is a form of psychological contract. Because the subordinate trusts the supervisor, the subordinate does not feel that he or she is being discriminated against. Should a psychological contract be violated, the subordinate will feel betrayed. The violation will eventually lead to disappointment and negative citizenship behavior, thus it is crucial to establish the proper psychological contract in the first place (Morrison, Robinson, 1997).

Studies by Milkovich (1993), Lazear (1995) and Tirole (1998) have documented the value of non-monetary incentives. Mills (1993) claimed that non-monetary incentives and recognition could lead to an increase in creativity and motivation for superior performance. Wernerfelt, Simester and Hauser (1997) pointed out that the social transfers from employees to supervisors in certain rating systems could create value for the firm. For example, in Wernerfelt et al.'s paper the supervisors were concerned about whether their employees respected them and would forgo up to \$10,000 in salary in return for this respect. On the other hand, the employees were most concerned about having to forgo interesting assignments just to show managers that they were loyal and wanted to work for them, and would trade off over \$5,000 in salary to avoid this situation. These previous works set a foundation for this project on quantifying non-monetary incentives.

2.3 Conjoint Analysis

The quantitative values of non-monetary incentives come from estimating utility functions based on a set of attributes. This technique is called “conjoint analysis”. It is widely used in marketing research. The two main approaches to conjoint measurements are *compositional* and *decompositional*. The compositional approach requires respondents to assess values for attribute levels. These values are used to build up preferences for attribute bundles or profiles. The decompositional approach begins with overall evaluations of objects defined on multiple attributes and derives values for attribute levels from these evaluations (Green and Srinivasan, 1978). Depending upon the type of conjoint survey conducted, statistical methods such as ordinary least squares regression, weighted least squares regression, and LOGIT analysis are used to translate respondents’ answers into importance values or utilities. The absolute values obtained by these statistical methods are not important, only the relative values between each of the attributes are needed. The goal of these calculations is to evaluate respondents’ answers in a manner that reveals the underlying value they consciously or sub-consciously place on changing the level of each attribute. For example, any rational person will prefer a \$50,000 salary to \$40,000 salary for a job, if everything else is equal (task, company, etc.). However, other non-salary factors should be considered. Some people might never consider the \$40,000 job because they do not like the company, while some people might accept it. A person, who always chooses Job A over Job B, regardless of salary, obviously places more importance on the job itself than salary. Conjoint analysis allows us to compute the relative value among options considered in the research design.

Table 2.1: Steps Involved in Conjoint analysis*

Step	Alternative Methods
1. Selection of a preference model	Vector model, ideal point model, part-worth function model, mixed model
2. Data collection method	Full profile, two-factor-at-a-time (trade-off analysis)
3. Stimulus set construction	Fractional factorial design, random sampling from a multivariate distribution, Pareto-optimal designs
4. Stimulus presentation	Verbal description (multiple cue stimulus card), paragraph description, pictorial or three-dimensional model representation, physical products
5. Measurement scale for the dependent variable	Rating scale, rank order, paired comparisons, constant-sum paired comparisons, graded paired comparisons, category assignment
6. Estimation method	Metric methods (multiple regression); nonmetric methods (LINMAP, MONANOVA, PREFMAP); choice-probability-based methods (logit, probit)

*Adapted from Green & Srinivasan (1978)

Table 2.1 shows the basic steps involved in conjoint analysis and the alternatives available for each step. One of the key issues in implementing conjoint analysis is the choice of preference model. While some models can provide accurate estimation of individual utility functions, they often require relatively lengthy data collection time, which can be burdensome on the respondents. Self-explicated and full-profile models are the two of the models used in conjoint analysis. The hybrid model features elements of both self-explicated and full-profile model.

2.3.1 Self-Explicated Model

In the self-explicated model (Green, Goldberg & Montemayor, 1981), the respondent provides the relative desirability of each level of every attribute, and then rates the relative importance weight of each attribute. Generally, four to eight levels of each attribute are used and a 10-point weight scale is used. Ties on the weight are permitted. These self-explicated values are used to estimate preferences for profiles described in terms of those attribute-levels using a simple additive model:

$$(1) \quad U_h = \sum_{j=1}^J w_j u_{ij}^{(h)}$$

Where U_h is the total utility of alternative h , w_j is the self-explicated importance weight of attribute j , and $u_{ij}^{(h)}$ denotes the fact that alternative h has a desirability score of u on level i of attribute j . w_j are simply constants for adjusting separate desirability ratings on a common scale.

The self-explicated model is compositional in that each of the components, w_j and u_{ij} , is estimated explicitly by the respondent and U_h is derived rather than given directly by the respondent. The primary advantage of this model is its simplicity, thus it is easy to use even when the number of attribute is large (Green et al., 1981), but this model has several problems as described by Green and Srinivasan (1990) and by Cattin et al. (1982).

2.3.2 Full-profile Model

In the conjoint model, the respondent is shown a set of complete stimulus profiles and asked to rate each overall profile on some evaluative scale (e.g., on a 1 to 10 scale of buying intentions) (Green et al., 1981). The evaluative response to the h -th alternative is assumed to be given by the separable approximation of:

$$(2) \quad V_{i_1, i_2, \dots, i_j} \cong \sum_{j=1}^j v_{i_j} + \sum_{j < j'} t_{i_j i_{j'}}$$

where V_{i_1, i_2, \dots, i_j} denotes the respondent's overall evaluation of a stimulus profile with level i of attributes 1, 2, ... j . This model includes all main effects and, sometimes, (selected) two-way interaction terms¹ – the V 's and t 's, respectively, in equation (2).

¹ The model can also have 3-way, etc. interactions, but they are rare.

The full-profile model is decompositional because the part-worths are estimated after the evaluation. The key advantage of the full-profile approach is that it can give a reasonably realistic description of stimuli by defining the levels of each of the factors and possibly taking into account the potential environmental correlation between factors in real stimuli (Green and Srinivasan, 1978). A potential limitation of the full-profile approach is information overload (Green and Srinivasan, 1978). Respondents may be tempted to simplify the task by ignoring some less important factors when evaluating the profiles. Furthermore, respondents may face difficulties to judge several factors at the same time.

2.3.4 Hybrid Conjoint Model

Hybrid conjoint model combines the simplicity of the self-explicated approach with the greater generality of full-profile model to develop multiattribute utility functions that retain individual differences (Green, 1984). This method is carried in two stages (Green et al. , 1981). The first stage is identical to that of the self-explicated model – respondents are asked to give attribute-level desirability values for the levels of each attribute separately, and then rate the attribute importance. The second stage resembles the full-profile model – respondents evaluate a limited set (usually three to nine) of full profiles, drawn from a large master design. The overall utility is expressed as the following:

$$Y_h = Y_{i_1 i_2 \dots i_J} \cong a + bU_{i_1 i_2 \dots i_J} + \sum_{j=1}^J V_{i_j} + \sum_{j < j'} t_{i_j i_{j'}}$$

where each $U_{i_1 i_2 \dots i_J}$ is separately computed (and the centered) for each respondent via equation (1); a is an intercept term, b is a regression parameter representing the

contribution of the self-explicated utility to Y, and the V's and t's are also regression parameters, estimated at the cluster level.

The underlying rationale of the hybrid conjoint model is that respondents who give similar responses on the self-explicated task are also likely to give similar kinds of responses on the overall profile evaluation later. Note that the last two terms of equation (3) carry the effects of full profile presentation beyond that predicted by a linear function of the self-explicated utilities. Hence, it is a simple matter to run a models comparison test for each cluster to see which of the V's and t's (if any) are needed to account for additional variance in the Y's. Table 2.2 summarizes the characteristics of the three preference models.

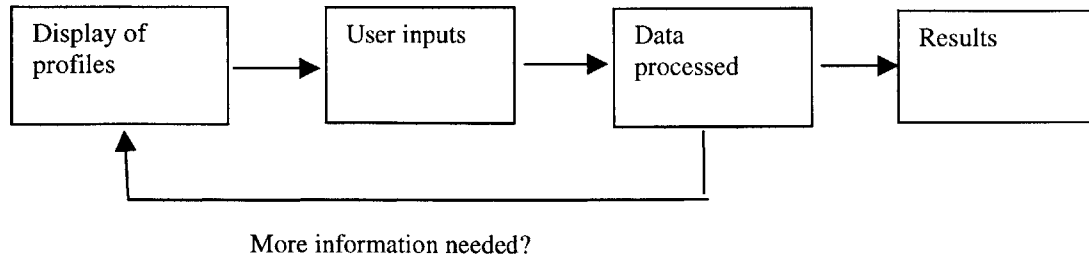
Table 2.2: Summary of three Preference Models

Model type	Characteristics
Self-Explicated	Respondents rate each attribute level, then weighs each attribute for each level.
Full-profile	Respondents evaluate each profile with several factors at a time.
Hybrid	Combines both self-explicated and full-profile; respondents view fewer profiles

2.3.5 On-line Conjoint Analysis

We are motivated to use the web for conjoint analysis because this method offers convenience and speed that using paper lacks. The process of an online conjoint analysis begins with a user presented with some profiles. The user evaluates these profiles by selecting which profile he or she prefers. The online tool captures the response, then displays more profiles until the tool has obtained sufficient information to analyze the user's utility function. After that, the data is analyzed, either by the on-line conjoint analysis tool or by another analytical tool such as SPSS. Figure 2.1 illustrates the procedures of an online conjoint analysis:

Figure 2.1: Procedure of an Online Conjoint Analysis



Because we want to have more controls over the experimental design and have a better understanding of the implementation of online conjoint analysis, we decide to create our own tool instead of using the available commercial software. Nonetheless, we referred to some online conjoint demos as examples. The basic design issues of the online conjoint analysis tool are the interface, the content, the algorithm and the database.

The interface is essentially the web site. Its design must be reasonably robust – meaning that it should be capable of handling fairly high traffic without drastic drop in speed. Furthermore, the web site should be stable. If it crashes often, it will frustrate the user and thus reduces the response rate. The content of the online conjoint tool is the stimuli or profiles. They must explain the questions and describe the profiles clearly in order to maximize data accuracy. To encourage responses, the web pages should be designed to be compatible with most browsers. For this reason, advanced features, such as Java, may not be used because all browsers do not support it. When designing the profiles, which are also referred as cards, we must consider the number of attributes, number of attribute levels, and number of cards. The number of attributes and levels needed depend on the study objectives. The key is to include all the attributes that have impact. In this study, the attributes are determined through Voice of the Customer (Griffin and Hauser, 1993). The attribute levels must be mutually exclusive and exhaustive. There is a trade-off in choosing the number of attribute levels: having more

levels results in a longer interview, but gives finer resolution; fewer levels shortens the interview, but the increments between levels are coarser. For the purpose of this study, only 3 levels are chosen. The algorithm of the online conjoint analysis tool is the central unit that controls the order of the interview, presents questions and captures data. This computer program should employ modularity² in design, so that different component can be added into the program later. Efficiency and robustness can be concerns, especially when the program is expected to handle large amount of data or many questions. The database is where the data reside. It may contain some information about the user beforehand for security.

² Modularity means that the computer program is broken into different parts. Each part is responsible for a specific task. If one part of the program is changed, other parts remain unaffected. Thus, it offers flexibility and convenience.

Chapter 3: Methodology

This study consisted of three phases. The first phase was the literature search and qualitative interviews. The second phase was the card sort using attributes identified in the previous phase. The third phase was collecting data online for conjoint analysis.

3.1 First Phase: Literature Search and Interviews

Wernerfelt, Simester and Hauser (February 1997) made an initial measurement of the cost and value of social transfers from employees to supervisors and concluded that these transfers can be quite substantial. As discussed in Chapter 2, literature on incentive, pay and organizational structure provided theoretical foundation. The literature also revealed some attributes that seemed to be valued by workers³. McCoy (1992) pointed out that teamwork and information sharing is an effective form of intrinsic compensation. Gibbs (1994) and Drago et al. (1998) suggested that promotion is an important incentive. “Portraying an image of a caring boss”, “avoiding negative consequences and confrontations with employees”, and “avoiding disapproval from peers” were attributes important to supervisors (Tziner et al., 1996). Recognition-based programs gave employees a greater feeling of job security by singled out as valuable performers (Mulford et al, 1992). Table 3.1 lists the attributes gathered from the literature review. These attributes were confirmed through the qualitative interviews.

³ Hong-mei Shang provided some of the literature review.

Table 3.1 Attributes from Literature Review

Attributes described as a group	Attributes
Perceived empowerment	<ul style="list-style-type: none"> • Access to information • Access to resources • Control over budget • Respect from subordinate and organization • Authority/power • Psychological contract/trust • Participative climate
Low employment variability risk	<ul style="list-style-type: none"> • Not afraid of being terminated (e.g. layoff, early retirement, etc.) • Low amount of time looking for new project • Corporate social performance • Not affected by business cycle or bad corporate earnings
Equity	<ul style="list-style-type: none"> • Equal reward allocations • Low wage dispersion • Fair rewards • Social justice (including issues about reducing interpersonal conflicts) • Distributive justice • Relative incentives • Fair rating of job performance
Various perquisites	<ul style="list-style-type: none"> • Opportunities to attend seminars, training (including in-house training) • Merchandise and travel • Vacation • Concierge services (e.g. car wash, baby sitting services etc.)
Enjoyment	<ul style="list-style-type: none"> • Interesting, challenging work • Fun • Job satisfaction • Take pride of organization or company • Learning special skills (including becoming an expert or having good understanding of the project)
Praise, recognition	<ul style="list-style-type: none"> • Recognition awards • Publication or press announcement
Independence	<ul style="list-style-type: none"> • Job autonomy • Flexible schedules • Ability to work at home
Perceived hardness by supervisors	<ul style="list-style-type: none"> • Supporting supervisors

The qualitative interview was the second step in Voice of the Customer (Griffin and Hauser, 1993). A group of first-line supervisors and their corresponding staff at the Laboratory were interviewed. They expressed their opinions on the characteristics important in maintaining a pleasant working relationship between supervisors and their staff. They also voiced their expectations and needs of what they look for in a job, a new

employee, and reward systems. From the transcript of the interviews, a list of non-monetary attributes was extracted as shown in Table 3.2. This list was combined with another list of attributes identified earlier in the literature review. Once any overlapping attributes were winnowed, the final list is developed into two: one for the supervisors and one for the supervisees. The two lists become the attributes used in the card sort. Appendix B includes the two lists.

Table 3.2 Attributes Extracted from Interviews

Access to company resources easily (e.g. secretary)
Access to cutting-edge equipment
Access to technical resources
Achievement awards
Article about you in the newspaper
Avoid supervisory responsibilities
Avoid uncertainty
Be part of a team
Becoming proficient in new assignments (becoming an expert)
Career
Caring supervisors
Carpet on the floor, bigger office, wider desk
Certificates
Come into my office and tell me what you think about this or that
Comfortable working environment (e.g. casual wear, nice cafeteria, gym facilities)
Comfortable working styles
Company hold annual parties, outings, etc.
Company support extra-curricular activities
Concierge services (e.g. car wash, baby sitting services, etc.)
Controls and flexibility (are these opposites?)
Cut them loose on the reigns and give them their head
Develop contacts in other organizations
Develop reputation for doing good work with management and co-workers
Develop reputation for helping coworkers along
Doing things for them that may provide them some protection
Doing work that has impact
Enormous amount of responsibility
Enormous amount of responsibility on the project
Exposed to everybody's technology
Exposure to new ideas
Fair distribution of assignments
Fairness -uniform performance objectives
Feel good about themselves as a result of a performance evaluation
Feeling of security or protection

Feeling that the company is caring about its employees' personal as well as professional development
flexible retirement package
Flexible work hours
freedom of action
Freedom to choose of assignments
get on programs where you can excel
get to go to an important conference
go out to dinner
going additional good assignments
good geographic location
Have competent team members
Have cooperative co-workers
Having reputation to do good work
high impact on the mission
High potential, good prospect
Impact on process planning
Impact on technical knowledge
interesting and challenging international work
Interesting and challenging work
involved in technology advances
job location near family
Job security/ assurance
Kudos
Little politics within company
long-term training
low administrative work
low temporary duty requirements
low travel requirements
maintain knowledge of state of the art technology
make the organization more effective through my work
make them feel good about themselves
manager lets them see and reap the benefits of their own work
managers and supervisors provide researchers and engineers with the contacts they need
managers and supervisors provide researchers and engineers with the tools they need
managers and supervisors stay out of the way of researchers and engineers
Managers do not interfere engineers' jobs.
Meaningful rewards/recognition
minimum out of town duty (business travel)
nice boss
Nice office
No discrimination against gender, race, age, etc.
number of years retentions (we need to know more about this)
one on one relationship with a supervisor
Opportunities of increasing self worth
opportunities to attend technical seminars, conferences
Opportunities to move to different groups within the company and the boss feels

comfortable with it.
opportunities to present work or publish papers
opportunity to make a presentation at a conference
parking space
participate in distance learning opportunities
Pay raise
pick them up when they fall and stumble
plan new technical directions
potential to grow in the job
Prestige
Promotion
promotion to "Man in the Job" (this is a special Army fellows program, kind of like tenure)
promotions
protection against risk (of termination)
put in a leadership role
reach and help you if you've really messed up
Receive feedback or guidance from supervisors (mentoring)
receive good mentoring
Receive training whether formal or informal
reimbursement for education
resolve technical issues
Respect from co-workers
Retention rights (we need to know more about this)
Retention rights
Simple reporting structure (e.g. report to only one boss)
Social justice
supervisor takes some responsibility for my career
take courses at local universities
Take pride of organization or company
Taking leadership roles in assignments
team awards
Technical managers are viewed as equally important as general managers
temporary duty opportunities
time off
travel opportunities
Vacation
Variety of assignments
very responsible positions
Well-informed of the projects available
work close to home
work on a high impact assignment
write a paper or leadership-communication based on the assignment
Good evaluation report

3.2 Second Phase: Card Sort

The purpose of card sorting was to further winnow the list of attributes. The setup consisted of a deck of cards, with an attribute written on each card. The cards were arranged in random order. Participants sorted the cards into groups based on the perceived similarity of the cards and chose an exemplary card from each pile. Participants then put relative weights on the attributes for each pile. In this study, the participants also evaluated how well their organizations meet the attributes by assigning letter grades (A, B, C, D and F; A being extremely well and F being the organization not meeting that attribute not at all). A copy of the instructions is enclosed in the Appendix A.

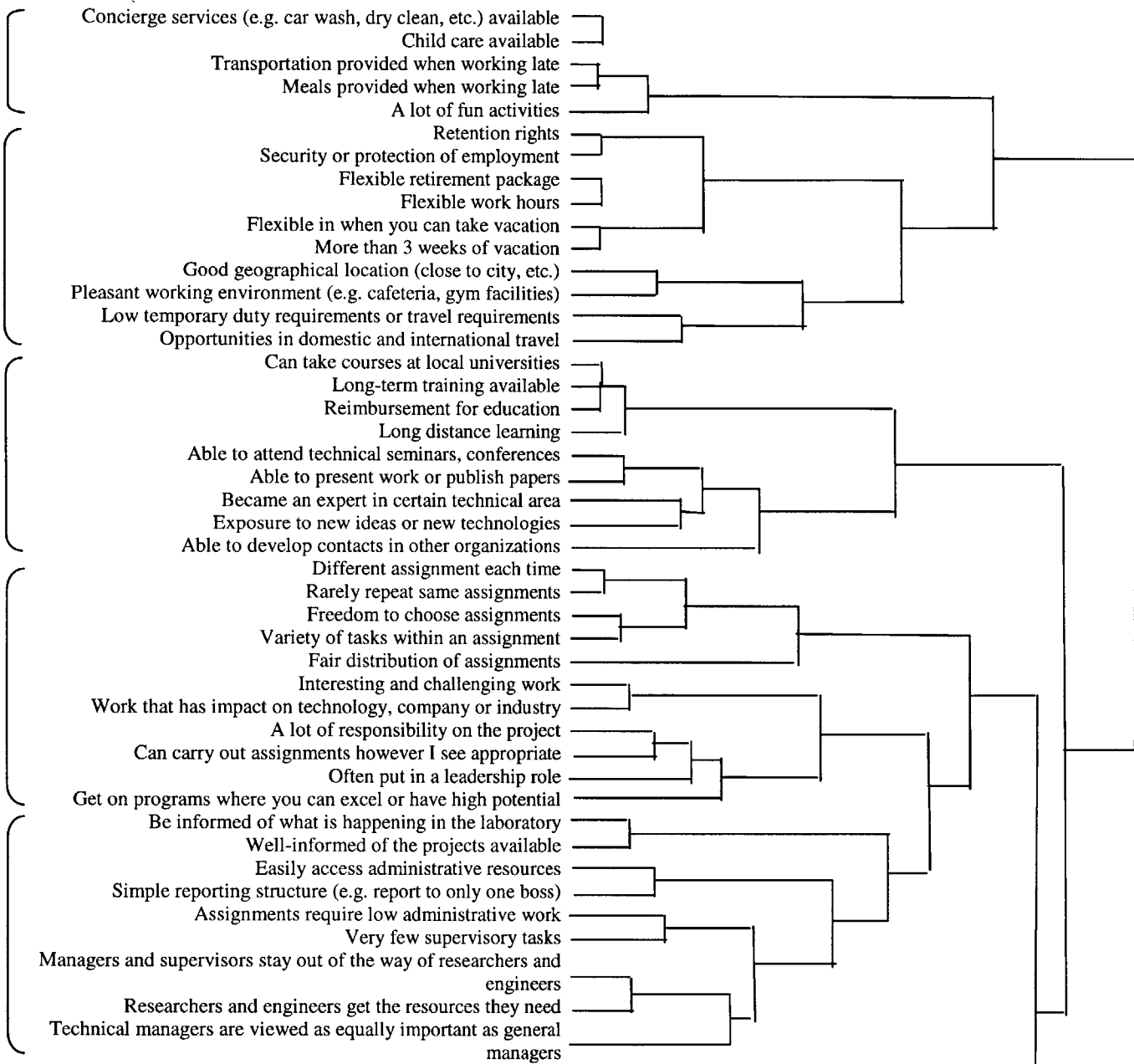
Two decks of cards were developed to accommodate differences in the needs of supervisors and their reporting. The two lists of attributes for the supervisors and supervisees are included in Appendix B. Once the card sort was completed, with assistance from Applied Marketing Sciences, data were processed to form a co-occurrence matrix⁴. To find out how closely that the attributes were related, cluster analysis was run, yielding a tree diagram using the Ward method. Figure 3.1 and Figure 3.2 illustrate how the attributes were grouped together. In Figure 3.1, seven distinct clusters could be observed as indicated by the parentheses. In Figure 3.2, there were nine distinct clusters. These clusters implied that the participants frequently placed the attributes into the same pile. In other words, the participants perceived a strong connection among these attributes.

⁴ A co-occurrence matrix records how often the attributes are put in the same pile.

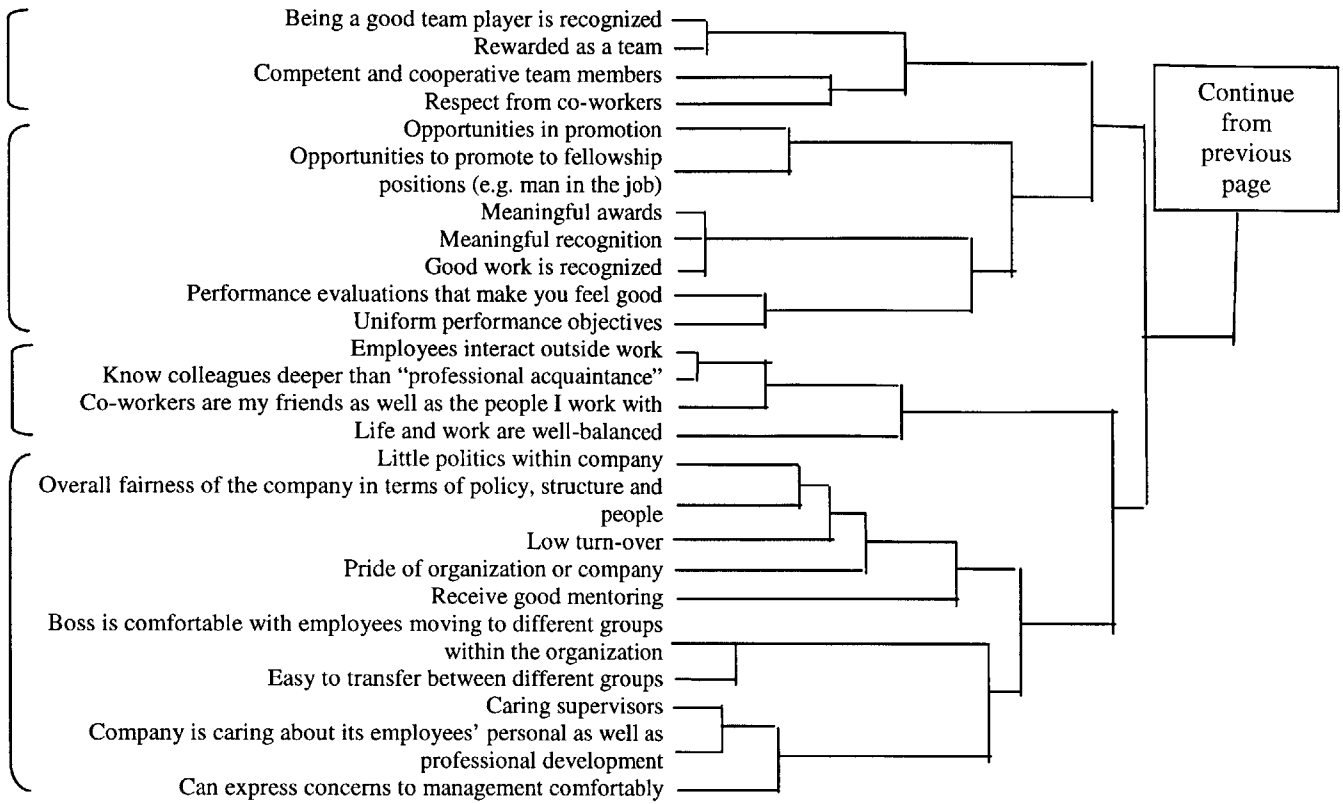
Figure 3.1: Cluster Analysis Distance Diagram for Supervisors



Figure 3.2: Cluster Analysis Distance Diagram for Supervisees



Continue on next page



To identify which attributes were the most important to the participants, we counted the number of times that a particular card was chosen to be exemplar⁵ of a pile (Exemplary Count) and calculated the average weight participants put for that particular card (Exemplary Importance). We went through this process for each cluster and the result is included in Appendix C. For the supervisors, attributes such as “overall fairness of the company”, “work that has impact”, “interesting and challenging work” and “security of employment” were very important as these attributes had a score 80 out of 100. Furthermore, they were chosen as the exemplars by more than 12 participants. Table 3.3 shows some of the most significant attributes to the supervisors.

Table 3.3: Most Significant Attribute to the Supervisors

Cards (phrase describing the attribute)	Average * Importance	Exemplary Count
Overall fairness of the company in terms of policy, structure and people	80.38	13
Work that has impact on technology, company or industry	83.85	13
Company is caring about its employees' personal as well as professional development	63.33	12
Interesting and challenging work	89.92	12
Pride of organization or company	85.17	12
Life and work are well-balanced	82.73	11
Competent and cooperative subordinates	82.00	10
Freedom in how to do the work	83.89	9
Security or protection of employment	80.89	9
Become an expert in certain technical area	80.00	8

* There are 31 supervisors participated in the card sort.

Supervisees valued “exposure to new ideas or new technologies”, “get on programs that have high potential” and “interesting and challenging work” as these attributes received high importance scores and were chosen as exemplars more than 10 times. Table 3.4 summarizes the most significant attributes valued by the supervisees.

⁵ The exemplar represented the most important attribute in a pile.

Table 3.4: Most Significant Attributes to the Supervisees

Cards (phrase describing the attribute)	Average * Importance	Exemplary Count
Company is caring about its employees' personal as well as professional development	72.08	12
Get on programs where you can excel or have high potential	80.91	11
Interesting and challenging work	97.18	11
Exposure to new ideas or new technologies	81.56	9
Overall fairness of the company in terms of policy, structure and people	87.22	9
Opportunities in promotion	92.00	8
Security or protection of employment	85.83	6

*There are 34 supervisees participated in the card sort.

Notice that the supervisors and the supervisees shared many common views on the attributes. After some qualitative judgements, we developed eight phrases to make up the job characteristics for the profiles in the next stage of the study. The eight characteristics are the following:

Table 3.5: Eight Job Characteristics for the Profiles

	Supervisor	Supervisee
Attribute #1:	Company has fair policies, structure and people, and cares about personal as well as professional development. Good work is recognized.	Company has fair policies, structure and people, and cares about personal as well as professional development. Good work is recognized.
Attribute #2:	Colleagues are friends, more than "professional acquaintances".	Colleagues are friends, more than "professional acquaintances".
Attribute #3:	Employees are willing to sometimes accept less interesting and challenging assignments.	Always receive interesting and challenging assignments.
Attribute #4:	Employees are willing to do administrative work and update me with regular reports.	Low administrative work and minimal reporting requirements.
Attribute #5:	High-impact, expertise-enhancing work and the freedom to do it.	High-impact, expertise-enhancing work and the freedom to do it.
Attribute #6:	Security or protection of employment.	Security or protection of employment.
Attribute #7:	Employees are always available to work late or take temporary duty assignments in other locations.	Not expected to work late or take temporary duty requirements in other locations.
Attribute #8:	Salary	Salary

These attributes were created in such a way that efficient transfer was possibly measured. In this way, the attributes of the supervisees' job profiles were somewhat opposite to those of the supervisors.

3.3 On-line Conjoint Survey

3.3.1 Card Design

In this study, the conjoint methodology used was a 3^8 fractional factorial of modified full profile approach⁶. This means that each profile was composed of 8 attributes and each attribute had 3 levels. The levels described how well each profile fit a particular attribute. The profiles fit an attribute at one of three levels: better than average, about average, and below average. The stimuli were presented through the web, two profiles at a time. The respondents were asked to select an appropriate ratio that represents how much they prefer one profile over another. The utilities were then estimated based upon these ratios.

To prevent user information overload, we decided to present no more than four attributes at once for each set of profiles. Therefore, the eight attributes described earlier are divided randomly into two sets of four. For 4 attributes (NA) with 3 levels (NL), the number of cards or profiles (NC) should be 9, where $NC = NL * NA - NA + 1$ (Curry, 1999) to ensure orthogonality. Five pairs were necessary in order to cover all 9 cards. The order of presentation avoided dominated pairs⁷. To obtain maximum information with minimum number of questions, the card design also eliminated transitivity loops. Appendix D shows the cards used in this experiment. The cards were shown in this conjoint survey according to the following steps:

1. The eight attributes were randomly divided into two sets of 4 attributes, with 3 levels.

Suppose A1 to A8 corresponded to the eight attributes and L1 to L3 corresponded to the three levels, four sets (S1 to S4) of pairs were generated. S1 consisted of four of

⁶ Refer to Chapter 2.3.2 for more detail description of full profile conjoint model.

the eight attributes, say A1, A2, A3, and A4. S2 consisted of the other four attributes, say A5, A6, A7, and A8. S3 consisted of two attributes randomly chosen from S1 and S2 respectively, say A1, A3, A5 and A7. S4 consisted of remaining attributes from S1 and S2 that were not chosen in S3.

2. The cards were generated using special software to ensure orthogonality. Each card contained four attributes. The software algorithm determined the level of the attribute. The cards were turned into paired comparisons. No dominated pairs and no transitivity loops were allowed.
3. Step #2 was repeated for each all four sets of cards, namely S1, S2, S3, and S4. The purposes of S3 and S4 were to link the attributes of S1 and S2 together.

3.3.2 Web Site

The web site was the key instrument for data collection. The setup included a web server, web pages illustrating the profiles/cards, Common Gateway Interface (CGI) script controlling the flow the survey and importing data into a database tool, and a database containing the data.

Web Server:

The web server was set up on a Microsoft Window NT based computer. The web site could be accessed through the URL <http://motivation.mit.edu>. This web site runs on Netscape Enterprise Server v3.6. Once all the web tools were installed, *motivation.mit.edu* was ready to display web pages and perform other web functions.

⁷ The effect of dominated pairs happen when the choice of preference is obvious. The dominated pairs should be avoided because they give less interaction.

Web Pages:

The web pages were written in HTML. The pages displayed introduction, questions and examples of the survey. The pages worked jointly with the CGI script to control the flow of the online survey. Because the CGI script is stateless⁸, all values that were previously passed into the program are lost once the program is called again. To create a pseudo state, some important values needed for computation were passed as hidden HTML code throughout the web pages. For example, the user ID acted as a key for correct database entry, therefore, it was important to inform the CGI script the user ID every time the respondent submitted an answer. The user ID was embedded along with other inputs in the query string. These hidden codes signal the CGI script about the state of the web page. The next page figure 3.3 shows a sample of a question.

⁸ The CGI script re-creates all variables every time the script is called and does not remember any values previously stored in the variables. This is a problem if previously values are needed for computation next time the script is called.

CGI Script:

The Common Gateway Interface (CGI) script was written in Visual Basic 6.0. In this study, three CGI scripts were created to be responsible for different parts of the survey. The three scripts were called Start-Project, Supervisor-Project and Supervisee-Project.

Start-Project captured a query string, which contained the user ID, then validated it. If the user ID was invalid, the program would prompt an error message and asked the user to re-log on. Otherwise, it would look up the database and identify the user to be either supervisor or supervisee. The program then directed the web site to display the appropriate set of questions⁹. The flowchart in Figure 3.4 illustrates the mechanism of Start-Project.

Once the user submitted an answer, by clicking “Next” button on the screen, either Supervisor-Project or Supervisee-Project would be called. Suppose the user was a supervisor, Supervisor-Project would be called to parse out the index for the question number, the user ID and the answers embedded in the query string, using the ParseKeyData function. The program checked for any empty input. If there were empty inputs, the program would prompt an error message and ask the user to answer the question again. If there were no empty inputs, then the program would update the database record corresponding to the user ID. Next, the program displayed another question. The two job profiles in a question were placed side by side as shown in Figure 3.3.

⁹ There were two sets of survey questions: one for the supervisor and one for the supervisee. In order to ensure that the respondents would be answering the appropriate questions, user IDs were pre-set. Only the supervisors would obtain the supervisor’s user ID, in which each of them was unique. Similarly, only the supervisee would obtain the supervisee’s user ID.

Figure 3.4: Flowchart for Start-Project

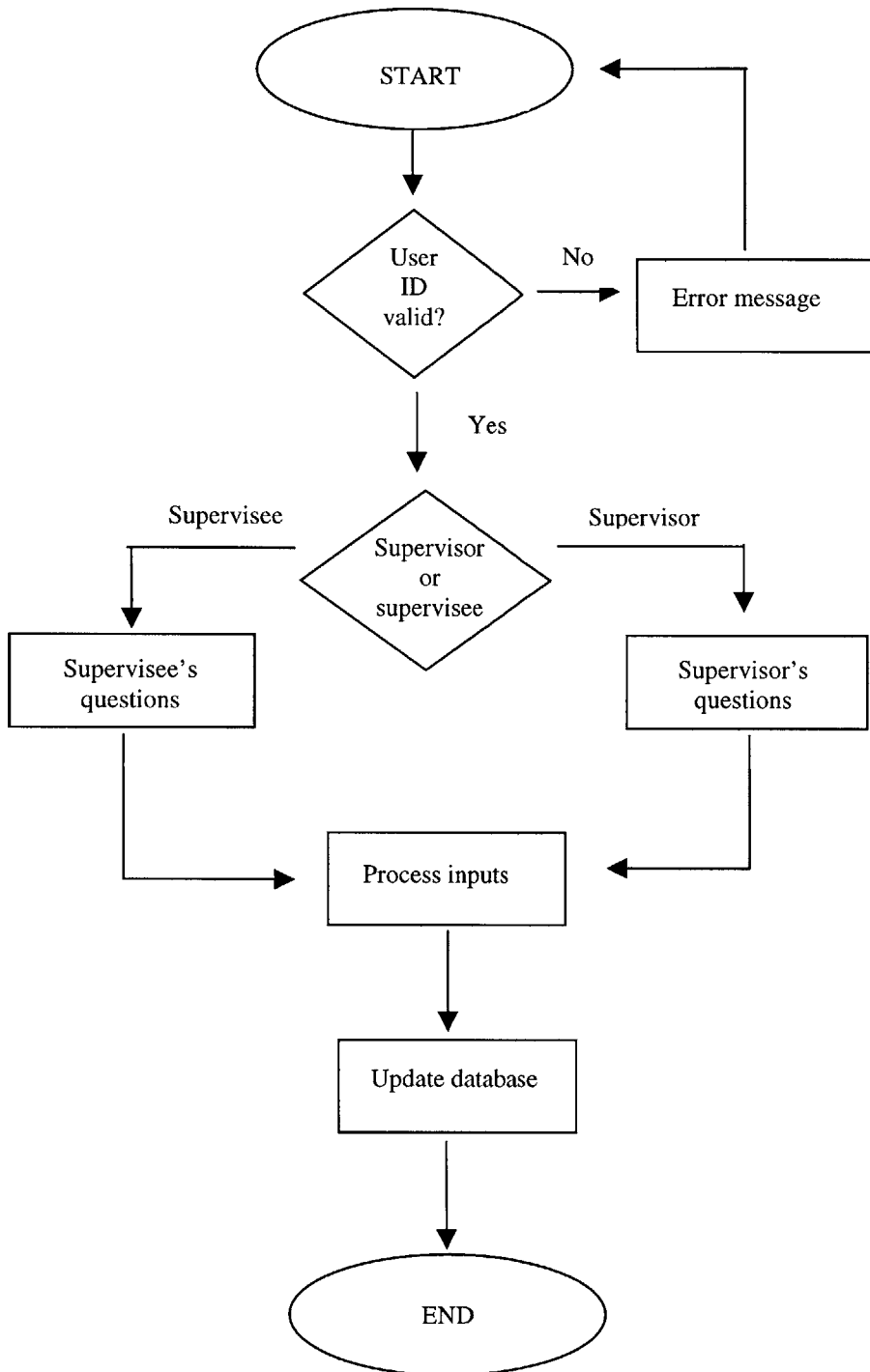
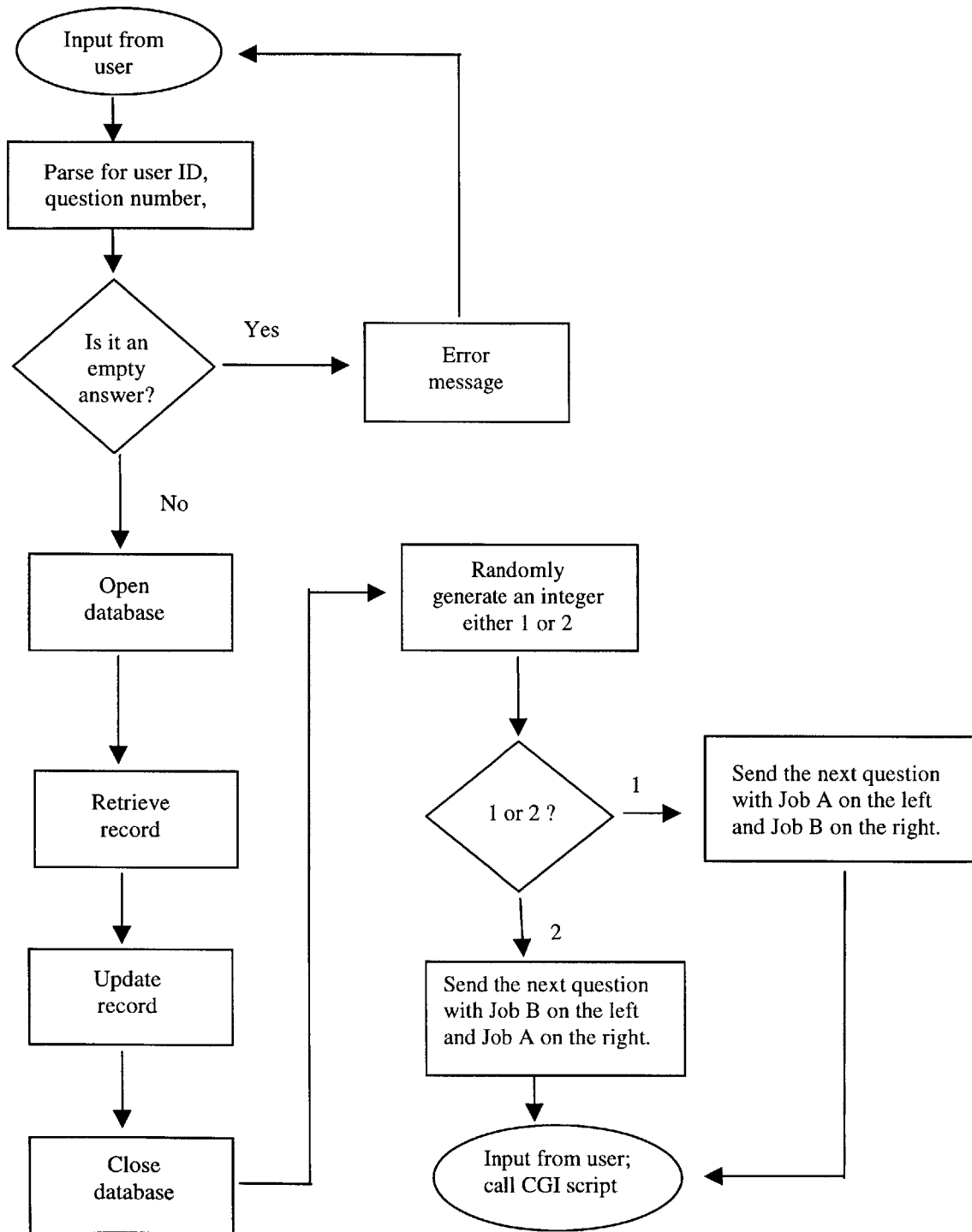


Figure 3.5: Flowchart for Supervisor-Project / Supervisee-Project



To ensure that each profile had equal chance to be on the left side or the right side, the program randomly generated an integer either 1 or 2 to determine which profile went to which side. If the integer was 1, Job A would be placed at the left and Job B would be placed at the right¹⁰; and vice versa if the integer was 2. The user ID and the index indicating the question number were also sent as HTML code. Figure 3.5 illustrated the mechanism of Supervisor-Project and Supervisee-Project.

To attract participants to the online survey, the web site must be easy to use and be compatible to most browsers. For this reason, the web pages were written in HTML and CGI script was used, although JavaScript or Java might be more powerful for this purpose. The colors used in the web pages were also browser friendly. The only feature in the web site that might not work in all browsers were the highlighted bullets showing the long description of the phrases. Only Netscape 4.0 or above supports that feature.

Database:

A simple database was set up using Microsoft Access 97. The database consisted of three tables: one contained the user ID and the times the user responded to a certain question; one contained the supervisees' answers and the other one contained the supervisors' answers.

3.3.3 Actual Data Collection

When a participant first entered the web site, he or she would be asked to log on using the pre-assigned user ID. The CGI script would look up the database to verify the user ID and determine whether the respondent was a supervisor or supervisee, then directed the respondent to the appropriate set of questions. The online survey would

¹⁰ Job A and Job B are for our reference. The user actually does not know which profile is Job A or B.

begin by asking the respondent to rate his or her current job on the same characteristics used in the conjoint analysis. They had to grade their current job as “about average”, “worse than average”, and “better than average”. The average job referred to jobs that require similar tasks and responsibilities.

Following that was a brief demonstration of how to answer the conjoint questions. The demonstration allowed the respondent to become familiar with the format and understand the instructions. After two examples, the respondent would start answering the 20 questions. Each question asked the respondent to select the preference ratio that best reflected how he or she felt about the two job profiles. For example, choosing “50:50” meant that one was neutral about either job.

At the end of the survey, there were 11 questions on demographics. These questions asked about the respondent’s previous job experience, primary field of expertise, tenure with the organization, tenure with their group, age, gender, marital status and their children. The information was collected to help explain respondent’s preferences to different job characteristics.

Chapter 4: Results and Analysis

4.1 General Analysis

With 29 supervisors and 100 supervisees invited to participate in the survey, 27 supervisors and 70 supervisees responded. The incomplete or invalid¹¹ responses were removed, so the working data set consisted of 19 supervisor responses and 53 supervisee responses. Although not all group members entered the survey, total participants represented 25 working groups, each comprising one supervisor and four supervisees. The online conjoint analysis tool recorded how long the participant spent to answer the questions. On average, each participant spent 17 minutes to complete the survey and about 45 seconds on each question. This information was helpful to identify invalid responses. For example, someone who spent less than 5 minutes to complete the survey was probably not answering the questions carefully.

In terms of demographics, 80% of the nineteen supervisors had worked at elsewhere before they joined the Laboratory. 65% of them were over 46 years old. Most of the supervisors were married with children, in which many of them were 22 years old or above. For the fifty-three supervisees, 83% had worked previously elsewhere. They primarily worked in industry or civilian government. 85% of the supervisees were married, but almost 19% of them did not have children. Table 4.1 summarizes the key statistics about the participants.

¹¹ Some participants did not seem to answer the questions seriously. They spent less than 10 minutes on the entire surveys or they chose the same preference ratio all the time.

Table 4.1 Key Statistics about Participants

	Supervisor (19 responses)	Supervisee (53 responses)
Response rate (valid answers)	70%	53%
Average time spent on survey	20 minutes	15 minutes
Demographics		
Has worked previously elsewhere	Yes = 16/19=84% No = 3/19=16%	Yes = 44/53 No = 9/53
Previous employer	Industry = 8/19=42% Civilian govt. = 7/19 = 37% Military = 1/19 =5% Not relevant = 2/19 =11%	Industry = 20/53=38% Civilian govt. = 21/53=40% Military = 1/53 = 2% Not relevant = 11/53=21%
Current expertise	Computer engineer = 1/19 =5% Electrical engineer = 2/19 =11% Mechanical engr. = 5/19 =26% Chemical engineer = 1/19 = 5% Other type of engr. = 7/19 =37% Scientist = 1/19 =5% Other tech. profsl. = 2/19 = 11%	Computer engineer = 5/53 =9% Electrical engineer = 15/53=28% Mechanical engr. = 10/53 =19% Chemical engineer = 1/53 =2% Other type of engr. = 11/53 =21% Scientist = 8/53 =15% Other technical profsl. = 3/53=6%
No. of years with current group	Less than 1 year = 2/19 =11% 1 – 2 years = 2/19 =11% 3 – 5 years = 4/19 =22% 6 – 8 years = 1/19 =5% 9 – 10 years = 1/19 =5% 11 – 16 years = 4/19 =22% More than 16 years = 5/19=26%	Less than 1 year = 0/53 =0% 1 – 2 years = 5/53 =9% 3 – 5 years = 14/53=26% 6 – 8 years = 8/53=15% 9 – 10 years = 7/53=13% 11 – 16 years = 11/53=21% More than 16 years = 8/53 =15%
No. of years with the Laboratory	< 1 years = 0/19 =0% 1 – 2 years = 2/19 =11% 3 – 5 years = 0/19 =0% 6 – 8 years = 1/19 =5% 9 – 10 years = 2/19 =11% 11 – 16 years = 7/19 =37% > 16 years = 7/19 =37%	< 1 year = 1/53 =2% 1 – 2 years = 3/53 =6% 3 – 5 years = 7/53=13% 6 – 8 years = 7/53=13% 9 – 10 years = 9/53=17% 11 – 16 years = 16/53=31% > 16 years = 10/53=19%
Age	26-30 years old = 0/19 = 0% 31-45 years old = 7/19 =37% >45 years old = 12/19 =63%	26-30 years old = 2/53=4% 31 – 45 years old = 27/53=51% >45 years old = 20/53=38%
Gender	Female = 1/19 =5% Male = 18/19 = 95%	Female = 9/53=17% Male = 44/53=83%
Marital status	Married = 18/19 =95% Not married = 1/19 = 5%	Married = 45/53=85% Not married = 8/53 =15%
No. of children	No children = 2/19 =11% 1 child = 1/19 =5% 2 children = 9/19 =47% 3 children =7/19 =37%	No children = 10/53=19% 1 child = 7/53=13% 2 children = 19/53=36% 3 children =16/53=30% 4 children = 1/53 =2% 5 children = 1/53 =2%
Age of the youngest child	< 3 years old = 1/19 =5% 4 – 10 years old = 5/19 =26% 11 – 13 years old = 0/19 =0% 14 – 17 years old = 1/19 =5% 18 – 21 years old = 2/19=11% > 21 years old = 8/19 =42% Not relevant = 2/19 =11%	< 3 years old = 12/53=23% 4 – 10 years old = 13/53=25% 11 – 13 years old = 2/53=4% 14 – 17 years old = 3/53=6% 18 – 21 years old = 5/53=9% > 21 years old = 7/53=13% Not relevant = 12/53=23%

Age of the oldest child	4 – 10 years old = 1/19 =5% 11 – 13 years old = 1/19 =5% 14 – 17 years old = 3/19 =16% 18 – 21 years old = 2/19 =11% 22 yrs old or older = 10/19 =53% Not relevant = 2/19 =11%	4 – 10 years old = 8/53=15% 11 – 13 years old = 8/53=15% 14 – 17 years old = 2/53=4% 18 – 21 years old = 4/53=8% 22 yrs. or older = 14/53=26% Not relevant = 17/53=32%
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Table 4.2 illustrates the distribution of preference ratios of the twenty job profiles in the survey. Although the supervisors and the supervisees had different set of questions, the two sets of questions corresponded to the same type of attributes. For example, on question 1, the profiles on supervisors' and supervisees' questions consisted of attributes about company fairness, doing high-impact work, work flexibility and relationship with colleagues. Refer to Appendix D for detailed profiles of each question.

Table 4.2 Distribution of Preference Ratios

	1:99		10:90		20:80		30:70		40:60		50:50		60:40		70:30		80:20		90:10		99:1	
	S	W	S	W	S	W	S	W	S	W	S	W	S	W	S	W	S	W	S	W	S	W
Q1		2	2	1	1	4		5	3	4	1	7	1	9	5	10	3	9	2		1	2
Q2	2	3	1	4	10	7	4	7	2	6		5		7		8		2		2		2
Q3		3	2	3	3	4	1	4	2	13	3	2	1	5	2	8	4	8	1	3		
Q4			1	4	2	14	2	4	2	4	1	4	2	4	3	3	5	12	1	4		
Q5				2	3	5	3	6	1	2	2	4	1	7	2	10	6	8	1	7		2
Q6		19	5	16	3	8	4	6	3		1		1	1	1		1	1		1		1
Q7		1		2	1	2		8	4	6	1	9	3	9	6	8	3	5	1	3		
Q8				2	1			2	4	1	1	2	3	5	6	15	3	14	1	9		3
Q9		2		2	3	7	3	10	3	9	4	10	3	6	2	4	1	2		1		
Q10				1	2	9	3	5	3	4	3	10	3	5	3	9	3	5	3	4		1
Q11	3	21	7	13	7	9	2	5		2				1		1				1		
Q12			1	2	1	5	4	8	3	6	5	4	1	5	2	6	2	11		5		1
Q13				10			1	30	1	3		2	4	1	2	8	3	14	7	9	1	9
Q14		12	3	9	5	15	6	3	3	8	2	5		1								
Q15				1				1		1		4	1		1	11	4	14	9	14	4	
Q16		6		9	1	3		4	1	2	2	3		1	5	6	8	4	2	8		7
Q17		3	2	7	5	12	5	11	6	11	1	2		5		1				1		
Q18		3		1		4		1		3	2	7	2	12	10	7	4	6		7	1	2
Q19				6	9	12	7	14	3	13		8										
Q20				2	1	4	2	3	4	9	2	14	5	9	4	4	1	5		1		2

*S = supervisor W = supervisee

*Q indicates the question number

*The ratios represent how much the respondent prefers one job over another. For example, 20:80 means that the respondent prefers Job A over Job B in 20 to 80 ratio, 50:50 means that the respondent is neutral about the two jobs.

4.1 Utility Model

The utility model used to calculate the utilities of attributes is based upon the function that total utility equals to the product of the individual utility of an attribute and the weight of the attribute.

$$(1) a_A = \prod_{i=1}^8 \prod_{j=2}^3 w_{ij}^{\delta_{ij}^A}$$

where a_A is the total utility of profile A, w_{ij} is the utility of attribute i at level j , δ_{ij}^A is an indicator variable that equals 1 if and only if alternative A has attribute i at level j . For Equation (1), when attribute i is at level j , $\delta_{ij} = 1$ and $\delta_{ik} = 0$ for all levels k , not equal to j . Thus, the utility for attribute i equals w_{ij} . (Notice that when $\delta_{ik}=0$, then the term for the k^{th} level is equal to 1.0 and, hence, does not affect the product.) In this study, the respondent chooses preference over two profiles in terms of a ratio. This ratio is expressed as a_A/a_B , where a_A is the total utility of profile A, and a_B is the total utility of profile B. Therefore, the following equations can be obtained:

$$(2) a_A + a_B = 100$$

$$(3) \frac{a_A}{a_B} = \frac{\prod_{i=1}^8 \prod_{j=2}^3 w_{ij}^{\delta_{ij}^A}}{\prod_{i=1}^8 \prod_{j=2}^3 w_{ij}^{\delta_{ij}^B}}$$

To express equation (3) as in linear form, we can take the logarithm of (3), thus,

$$(4) \log\left(\frac{a_A}{a_B}\right) = \log\left(\frac{\prod_{i=1}^8 \prod_{j=2}^3 w_{ij}^{\delta_{ij}^A}}{\prod_{i=1}^8 \prod_{j=2}^3 w_{ij}^{\delta_{ij}^B}}\right)$$

$$\begin{aligned}
&= \log \left(\prod_{i=1}^8 \prod_{j=2}^3 w_{ij}^{\delta_j^A} \right) - \log \left(\prod_{i=1}^8 \prod_{j=2}^3 w_{ij}^{\delta_j^B} \right) \\
&= \sum_{i=1}^8 \sum_{j=2}^3 \log w_{ij}^{\delta_j^A} - \sum_{i=1}^8 \sum_{j=2}^3 \log w_{ij}^{\delta_j^B} \\
&= \sum_{i=1}^8 \sum_{j=2}^3 \delta_j^A \log w_{ij} - \sum_{i=1}^8 \sum_{j=2}^3 \delta_j^B \log w_{ij} \\
(5) \quad \log \left(\frac{a_A}{a_B} \right) &= \sum_{i=1}^8 \sum_{j=2}^3 (\delta_j^A - \delta_j^B) \log w_{ij}
\end{aligned}$$

From equation (2), we can substitute $a_B = 100 - a_A$. Suppose X equals to the summation of the difference in δ_{ij} and β_{ij} equals to the $\log w_{ij}$, then equation (5) becomes:

$$(6) \quad \log \left(\frac{a_A}{100 - a_B} \right) = X \beta_{ij}$$

$$(7) \quad Y = \log \left(\frac{a_A}{100 - a_B} \right)$$

Substituting Y, resulting:

$$(8) \quad Y = \beta_{ij} X$$

Where (9) $\beta_{ij} = \log w_{ij}$, so (10) $w_{ij} = e^{\beta_{ij}}$, where i is the attribute and j is level of the attribute.

Equation (8) formed a linear equation with a slope of β_{ij} . In this conjoint analysis, X was the matrix that represented the change of levels in each profile for the twenty questions in the survey. Because we were interested only in the changes of levels, we fixed the lowest level (“worse than average”) to be zero as a basis point, then derived a matrix of 0, 1, and -1 based upon the summation term of δ_{ij} in equation (5). The complete matrix is enclosed in Appendix E. Since X was the pre-determined matrix and

Y was obtained from the preference ratios entered by the respondent, β_{ij} could be estimated by running a linear regression. The resulted coefficients were the estimated values of β_{ij} . Since $\beta_{ij} = \log W_{ij}$, W_{ij} could be calculated by taking the exponential of the coefficients resulted from the linear regression.

4.2 Results on Supervisors

Linear regressions were run using the logarithmic form of the preference ratios against the matrix, equation (6). Table 4.3 summarizes the coefficients, their corresponding utility calculated using equation (10) for the average ratios, median ratios and aggregate ratios. The average ratio for each question (total of 20 questions) was the sum of the preference ratio from each respondent divided by the number of valid responses. For the supervisors, there were 19 valid responses. The median ratio was the median of each answer out the sample size. The aggregate ratio was the individual answer from each respondent. 19 dummy variables were created to represent the respondents. Equation (6) essentially looked like 19 sets of mini equation (6) stacked together, with dummy variables equaled to 1 for the appropriate respondent and 0 otherwise.

Table 4.3 Summary of β and Utilities for Supervisors

	$\beta(\text{avg})$	$\text{Exp}(\beta\text{avg})$	$\beta(\text{Med})$	$\text{Exp}(\beta\text{Med})$	$\beta(\text{Agg})$	$\text{Exp}(\beta\text{Agg})$
(Constant)	8.486E-02		.155		.125	
Fairness_2	1.333	3.792	1.312	3.714	1.448	4.25
Fairness_3	1.968	7.156	1.916	6.794	2.151	8.59
High impact work_2	0.736	2.088	0.733	2.081	.829	2.29
High impact work_3	1.073	2.924	0.994	2.702	1.198	3.31
Employees available_2	0.465	1.592	0.560	1.751	.475	1.61
Employees available_3	0.496	1.642	0.451	1.570	.524	1.69
Colleagues are friends_2	0.214	1.239	0.223	1.250	.238	1.27
Colleagues are friends_3	0.257	1.293	0.223	1.250	.281	1.32
Low admin. work_2	8.187E-02	1.085	0.148	1.160	7.06E-02	1.07
Low admin. Work_3	0.125	1.133	0.224	1.251	.113	1.12
Job security_2	-1.94E-03	0.998	7.588E-02	1.079	-1.35E-02	0.99

Job security_3	1.124	3.077	1.273	3.572	1.285	3.61
Less int. tasks_2	-2.58E-02	0.975	-5.63E-02	0.945	-4.48E-02	0.96
Less int. tasks_3	3.347E-02	1.034	9.911E-02	1.104	2.67E-02	1.03
Salary_2	0.553	1.738	0.591	1.806	.626	1.87
Salary_3	0.972	2.643	1.091	2.977	1.154	3.17

* β () = coefficients of average (avg), median (med) or aggregate (agg).

Exp(β) is the utility of the attribute, from Equation (10).

Constant is the intercept of the regression.

All attributes at level 1 (“worse than average”) had a coefficient of zero, so its corresponding utility was 1.

The attribute followed by a number indicates the attribute at either level 2 (“about average”) or level 3 (“above average”). Please refer to Appendix D for the meanings of the attributes.

Table 4.4 - 4.6 illustrate results for average ratio, median ratios and aggregate ratios when regressions were taken by including the most significant attribute (at 0.05 level or t-statistics of 1.98) one at a time. The result confirmed that salary, employees being always available and doing high impact work were highly valued by supervisors.

Table 4.4 Stepwise Regressions for Supervisors (Aggregate)

	Unstandardized β	Std. Error	Standardized β	t	Sig.
(Constant)	5.294E-02	.030		1.775	.077
SALARY_2	.898	.069	.761	12.928	.000
SECURE_2	.720	.074	.437	9.751	.000
SALARY_1	.477	.067	.405	7.155	.000
AVAIL_2	-.147	.057	-.116	-2.572	.011
HIMP_1	.136	.051	.118	2.684	.008
AVAIL_1	.146	.066	.101	2.223	.027

Table 4.5 Stepwise Regressions for Supervisors (Average)

	Unstandardized β	Std. Error	Standardized β	t	Sig.
(Constant)	5.139E-02	.062		.823	.423
SALARY_2	.705	.142	.997	4.949	.000
SECURE_2	.547	.151	.555	3.625	.002
SALARY_1	.371	.140	.525	2.642	.018

Table 4.6 Stepwise Regressions for Supervisors (Median)

	Unstandardized β	Std. Error	Standardized β	t	Sig.
(Constant)	8.564E-02	.066		1.306	.211
SALARY_2	.794	.145	.960	5.485	.000
SECURE_2	.677	.154	.586	4.411	.001
SALARY_1	.389	.143	.470	2.725	.016
AVAIL_1	.288	.130	.283	2.214	.043

Table 4.7 shows the coefficients for the attributes at level 2 (“about average”) and level 3 (“above average”). Company fairness, doing high-impact work and salary had large differences in their coefficients between level 2 and level 3. This meant that supervisors perceived a high gain in utility from accepting an attribute at “about average” to “above average”. For example, a supervisor would have an increase of 102% in utility if he transferred to a company that was above average on company policies from a company that was only average in having fair policies. This increase was calculated using Equation (11):

$$(11) \frac{e^{\beta_{ij+1}}}{e^{\beta_{ij}}} = \frac{w_{ij+1}}{w_{ij}} = e^{\beta_{ij+1} - \beta_{ij}}$$

From Table 4.7, the coefficients for Fairness_2 and Fairness_3 were 1.448 and 2.151 respectively. The ratio of utility is w_{ij+1}/w_{ij} , hence $\exp(\beta_{ij+1})/\exp(\beta_{ij}) = \exp(2.151-1.448) = \exp(0.703) = 2.02$. Hence, the increase was 102%.

Table 4.7 Linear Regressions Results on Aggregate Ratios for Supervisors

Model Summary	R = 0.656	R square = 0.430	Adjusted R square = 0.374	Std. Error of the estimate = 0.50099	
ANOVA	Sum of Squares	Degree of Freedom	Mean Square	F	Sig.
<u>Regression</u>	65.315	34	1.921	7.654	0
Residual	86.592	345	0.251		
Total	151.907	379			
Coefficients					
	Beta	Std. Error	Standardized Coefficients	t	Significance Level
(constant)	0.125	.117		1.071	.285
Fair_2	1.448	0.589	1.350	2.459	0.014
Fair_3	2.151	0.849	1.693	2.533	0.012
High impact_2	0.829	0.273	0.718	3.036	0.003
High impact_3	1.198	0.466	0.847	2.572	0.011
Avail_2	0.475	1.174	0.328	2.724	0.007
Avail_3	0.524	0.286	0.412	1.835	0.067
Friend_2	0.238	0.128	0.222	1.858	0.064
Friend_3	0.281	0.134	0.239	2.096	0.037

Admin_2	7.065E-02	0.123	0.056	0.576	0.565
Admin_3	0.113	0.142	0.098	0.795	0.427
Secure_2	-1.346E-02	0.166	-0.07	-0.81	0.935
Secure_3	1.285	0.252	0.781	5.093	0.000
Interest_2	-4.481E-02	0.129	-0.028	-0.347	0.729
Interest_3	2.667E-02	0.113	0.022	0.236	0.814
Salary_2	0.626	0.094	0.531	6.655	0.000
Salary_3	1.154	0.121	0.978	9.539	0.000

*All attributes at level 1 had a Beta value at zero.

*See Appendix F for abbreviated notation of the attributes.

Another example, increasing salary from level 2 to level 3 yielded a gain in utility of 70%. Since $\beta_{ij+1} = 1.154$ and $\beta_{ij} = 0.626$, the ratio of utility w_{ij+1}/w_{ij} , according to equation (11), is $\exp(\beta_{ij+1})/\exp(\beta_{ij}) = \exp(1.154 - 0.626) = 1.70$. Hence the increase in utility is 70%.

Two of the aggregate ratios on Table 4.4 had negative coefficients, implying that the corresponding utilities were less than 1. Most of the t-values of the 8 attributes were well above 1.98, especially for salary. The high t-values meant that the coefficient was significantly different from zero. The closer to zero the coefficient was, the less utility gain from moving from a lower level to a higher level, as shown in equation (11). “Salary”, having t-values at 6.665 and 9.639, offered supervisors large gain in utility by changing salary at “about average” level to “above average” level. On the other hand, “employees’ willingness to administrative work” had low t-values of 0.576 and 0.795. The corresponding β were 0.071 and 0.113, which yielded a utility increase of only 4%.

4.2 Results on Supervisees

The data received from the supervisees were treated in the same way as those from the supervisors. The average ratios, median ratios, and aggregate ratios were computed based upon the 53 valid responses. Table 4.8 summarizes these results.

Table 4.8 Summary of β and Utilities for Supervisees

	β (avg)	Exp(avg)	β (med)	Exp(med)	β (agg)	Exp(agg)
(Constant)	-0.045		0.020		-4.98E-02	
Fairness_2	1.194	3.300	1.461	4.310	1.577	4.840
Fairness_3	1.592	4.913	2.054	7.795	2.150	8.584
High impact work_2	0.519	1.681	0.710	2.034	.722	2.058
High impact work_3	0.961	2.614	1.217	3.377	1.303	3.680
Not working late_2	0.408	1.504	0.467	1.595	.522	1.685
Not working late_3	0.265	1.303	0.366	1.442	.338	1.402
Colleagues are friends_2	0.119	1.126	0.154	1.166	.148	1.159
Colleagues are friends_3	0.025	1.025	0.036	1.037	1.18E-02	1.011
Low admin. Work_2	0.166	1.181	0.261	1.299	.217	1.242
Low admin. Work_3	0.161	1.175	0.257	1.293	.237	1.267
Job security_2	0.057	1.059	0.021	1.021	8.94E-02	1.093
Job security_3	0.832	2.297	1.113	3.043	1.205	3.337
More int. tasks_2	0.551	1.734	0.570	1.768	.743	2.102
More int. tasks_3	0.430	1.537	0.498	1.646	.629	1.876
Salary_2	0.246	1.279	0.336	1.400	.343	1.409
Salary_3	0.528	1.695	0.844	2.326	.804	2.234

The differences in β for “company fairness”, “doing high-impact work”, “job security” and “salary” were large, meaning that supervisees perceived a large utility gain in having an attribute change from a lower level to a higher level. These four attributes yielded utility gain of 77%, 79%, 205%, and 58% respectively. Note that “not working late”, “having colleagues as friends”, and “receiving more interesting tasks” had decreasing coefficients from level 2 to level 3. We can further explain this with Table 4.9.

Table 4.9 Linear Regression on Results for Supervisees

Model Summary	R = 0.583	R square = 0.340	Adjusted square = 0.294	Std. Error of the estimate = 0.7101	
ANOVA	Sum of Squares	Degree of Freedom	Mean Square	F	Sig.
<u>Regression</u>	256.928	68	3.778	7.494	0
Residual	499.639	991	0.504		
Total	756.567	1059			
Coefficients	Beta	Std. Error	Standardized Coefficients	t	Significance Level
(constant)	-4.984E-02	.162		-.307	.759
Fair_2	1.577	.419	1.101	3.762	.000
Fair_3	2.150	.573	1.266	3.749	.000
High impact_2	.722	.175	.468	4.116	.000
High impact_3	1.303	.332	.690	3.927	.000
Not late_2	.522	.122	.269	4.258	.000
Not late_3	.338	.180	.199	1.879	.061
Friend_2	.148	.112	.103	1.314	.189
Friend_3	1.175E-02	.101	.007	.116	.907
Admin_2	.217	.090	.128	2.427	.015
Admin_3	.237	.101	.154	2.353	.019
Secure_2	8.936E-02	.145	.033	.618	.537
Secure_3	1.205	.163	.548	7.382	.000
Interest_2	.743	.136	.352	5.447	.000
Interest_3	.629	.091	.380	6.908	.000
Salary_2	.343	.068	.218	5.010	.000
Salary_3	.804	.102	.510	7.861	.000

For “having colleagues as friends”, the t-values were below 1.98, so the behavior could be due to noise. “Not working late or taking temporary duty” and “always receiving interesting and challenging assignments” had t-values well above 1.98, so they were significant. Respondents’ bias or misinterpretation of the question might cause the decreasing coefficients. This needs further investigation.

Table 4.11 Stepwise Regressions for Suerprivees (Aggregate)

Aggregate	Unstandardized β	Std. Error	Standardized β	t	Sig.
(Constant)	-.237	.028		-8.424	.000
SECURE_2	.685	.077	.312	8.940	.000
INT_1	1.112	.084	.527	13.189	.000
INT_2	.887	.074	.536	12.052	.000
NLATE_1	.885	.077	.457	11.523	.000
FAIR_1	1.819	.185	1.269	9.841	.000
FRIEND_2	-.270	.045	-.172	-6.025	.000
HIMP_2	1.063	.128	.562	8.330	.000
FAIR_2	1.877	.227	1.105	8.272	.000
SECURE_1	.690	.101	.258	6.796	.000
ADMIN_1	.480	.073	.283	6.540	.000
ADMIN_2	.269	.065	.175	4.123	.000
HIMP_1	.251	.067	.162	3.729	.000

Table 4.12 Stepwise Regressions for Supervisees (Average)

	Unstandardized β	Std. Error	Standardized β	t	Sig.
(Constant)	2.880E-02	.070		.410	.687
SALARY_2	.381	.121	.583	3.158	.006
SECURE_2	.399	.168	.438	2.369	.030

Table 4.13 Stepwise Regressions for Supervisees (Median)

	Unstandardized β	Std. Error	Standardized β	t	Sig.
(Constant)	7.322E-02	.083		.882	.390
SALARY_2	.581	.143	.685	4.077	.001
SECURE_2	.487	.199	.411	2.449	.025

Table 4.11 – 4.13 show the stepwise regressions for aggregate ratios, average ratios, and median ratios. The attributes selected for the regression had t-statistics above 1.98.

Chapter 5: Conclusions

5.1 Major Findings and Lessons Learned

This set of data has not yet been thoroughly analyzed, so the conclusions described below are tentative. The key findings from the analysis to date are:

1. Both supervisors and supervisees valued company fairness, opportunities to do high-impact work, and salary as very important. The respondents perceived large gains in utility in receiving these attributes at a higher level. To find out whether these attributes are valuable individually or when they are bundled together in a profile, we can check for interaction among the variables in regression. In this conjoint survey, two sets out of the four sets¹² had at least two of the attributes presented together in one profile. Five cards from one set had “company fairness” and “high-impact work” in one profile. Another five cards had all three attributes “company fairness”, “high-impact work” and “salary” in a single profile. Their interaction would affect the result.
2. The simple pairwise evaluations of full-profile stimuli did not fully engage the respondents. They might lose interest in evaluating the profiles thoughtfully after several questions. They might then begin to randomly choose a ratio, choose the same ratio for the rest of the survey, or favour a certain attribute. Therefore, we need to find ways to engage the respondents more or develop better ways to present the stimuli. For example, we can reduce the number of attributes to make the evaluations easier, replace text with graphics or other forms of multimedia to make the interface more interesting. Ultimately, the

online conjoint survey should maximize information received with minimal number of questions. This requires that subsequent web pages depend dynamically on the answers to the previous pages. For example, there are two job profiles with attributes on location and travelling. Suppose the respondent has expressed preference in spending more time with his children in earlier questions, then we can assume that the respondent will not be interested in a job that requires a lot of travelling. Thus, the online conjoint tool should omit any cards that ask about large time commitment on job or spending a lot of time out of town. Currently, commercial software such as Adaptive Conjoint Analysis developed by Sawtooth is capable of dynamically adapting what stimuli should be presented. This dynamic mechanism has *states*, meaning variables “remember” their values; however, the CGI script developed for this online conjoint analysis tool is stateless. The CGI is called every time when a respondent submits an answer, the program creates new variables. The previous values stored in the variables are lost. Since adaptive conjoint analysis requires the program to use previously entered values, the CGI script fails on this aspect. There are solutions to retain previously entered values. The CGI can look up a database for any previous values, but this method is inefficient. The best alternative of course is to develop the online conjoint analysis tool using languages that are designed specifically for web programming such as Java or Pearl.

¹² There are four sets of profiles that contained four attributes. Each set has five cards. All five cards have the same attributes, but have different levels. See Chapter 3 for a more detailed description of sets.

3. The reliability of the data depended severely on how seriously respondents take the task. In this study, 25% of the total responses were invalid and this percentage might be different if we had a more systematic method to look for invalid answers. One solution might be to insert transitivity loops in the cards to check for inconsistent data. Another solution might be to have a few “obvious” dominated choices.
4. The physical position of the profiles on the card, whether profile A should go on the left side or right side, was determined randomly. Although there was no coding errors, the program should record the format of the profiles the respondent gets for each question for checking inconsistency or careless inputs. Also, recording the time was proven to be helpful to identify some low-involvement respondents. Other non-obtrusive data collection could also be used to check data integrity.

5.2 Future Work

A lot of information is still hidden in the data set. The next step should be further analysis of the data to better explain the coefficients resulted from the regressions.

Because of the small sample size, conclusions on trade-offs between different attributes in terms of monetary values are not available. The next experiment should include a larger sample size to obtain a more accurate utility function to easier interpolation.

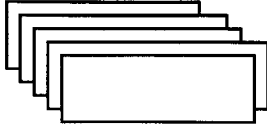
From this exploratory use of online conjoint survey, we have learned some valuable lessons on how to improve the survey design and the online conjoint analysis tool. As mentioned in the Chapter 4, reliability is an important concern. Changing the

design of the cards to engage the respondents, inserting transitivity loops in the cards or some “obvious” dominated choices and other non-obtrusive data collection would help improve reliability. It will be also informative to conduct this study on other industrial organizations as their perceptions may differ.

Appendix A: Instructions for Card Sort

DIRECTIONS FOR CARD SORT

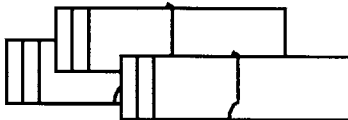
The words and phrases on these cards describe the kinds of things an organization must provide to make you a satisfied, committed and productive employee.



STEP 1: SORT THE CARDS

1. Clear a large work space and take the cards and rubber bands out of the envelope.
2. Sort the cards into piles or groups that you feel go together because of some underlying characteristic or feature or are related to each other in some way. Each phrase in a pile should be more similar to the other phrases in that pile than to those in another pile. Don't think about how **important** a phrase is - look for connections, similarities, and common themes or ideas.
3. When you have finished with all the cards, go back over each pile to be sure that all the cards still belong together. If they don't, then feel free to split a pile into two or three new piles or to move cards from one pile to another. You can put as many or as few cards in each pile as you want and have as many or as few piles as you like. On average, we find that people end up with about 10 piles, but some people have as few as 5 and some people create more than 20. When you are satisfied with the way the piles look, go on to STEP 2.

** There is no right or wrong answer; no single right way to sort the cards. Everyone thinks about things a little differently, will see different relationships or connections and will create different groupings. Ignore the numbers that are on the cards; they are there only to help us process this data.*



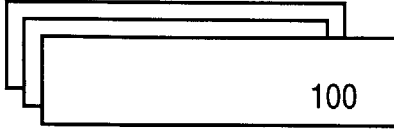
STEP 2: PICK THE "TYPICAL" CARD FROM EACH PILE

1. Look through each pile and pick the **one** card with the phrase that is most typical or is the best example of all the cards in that pile.

** It is still all right to split a pile into two or three new piles, move cards around or create new piles if you see differences in meaning.*

2. Put that "best example" card on the top of its pile and then put a rubber band securely around the whole pile. When all the piles have a rubber band around them, go on to STEP 3.

** It is very important to keep piles securely banded*



STEP 3: ASSIGN IMPORTANCES TO PILES

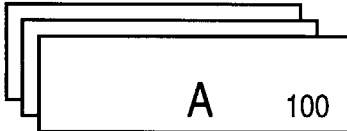
Now think about how **important** each group of ideas is as it relates to how your company can help you to be a satisfied, committed and productive employee.

1. Pick the **one** pile of cards with the phrases that are **most** important to you in determining **your satisfaction** -- the pile of cards with the ideas that are most important to you. Give 100 points to that most important pile by writing the number "100" on the top card.

** The fact that a pile may have a lot of cards does not mean anything about how important the phrases on those cards are.*

2. Now pick the pile that is **least** important to you and give it a score between "0" and "100" based on how important it is relative to your **most** important pile. For example; if it is half as important, write the number "50" on the top card. Or, if the pile is of absolutely no importance, give it "0" points.
3. Now rate each of the other piles **relative to** the ones you chose as most and least important. When you are finished, each pile should have a number between zero and 100 written on the top card. Go on to STEP 4.

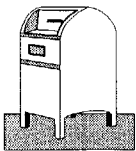
** Please use as wide a range of numbers as you wish between zero and 100, and ties are okay*



STEP 4: GRADE YOUR ORGANIZATION

In this next step, we would like you to assign letter grades (**A, B, C, D, or F**) to each pile of cards based on how well you think those needs are being met by your organization.

If you think **on average** that the needs described in the pile are being met **Extremely well**, assign the letter grade "A"; if these needs are **Not being met at all** assign an "F". When you are finished, each cell should have either an **A, B, C, D, or F** in it.



STEP 5: RETURN YOUR WORK

Please **put** the piles of cards and the questionnaire into the enclosed return envelope return it to the address below soon as you've completed the exercise. If you have any questions, please call Christine Chan at (617)253-9617 or email cwychan@mit.edu.

Room E56-345B, 38 Memorial Drive, Cambridge, MA 02142 Attention: Christine Chan

Thank you very much for your help.

Appendix B: Attributes used in Card Sort

Supervisors' deck of cards

Card Number	Attributes
819	"concierge" services (e.g. car wash, dry clean, etc.) available
828	a lot of fun activities
837	able to attend technical seminars, conferences
846	able to attract people to work for you
855	able to explore other business opportunities within the laboratory
864	able to present work or publish papers
882	assignments require low administrative work
891	avoid confrontation for bad reviews
900	be informed of what is happening in the company
919	become an expert in certain technical area
928	company is caring about its employees' personal as well as professional development
937	competent and cooperative subordinates
946	control over budget
955	co-workers are my friends as well as the people I work with
964	easily access administrative resources
973	employees are willing to spend a lot of time training to work on your projects
982	employees have good understanding of the project
991	flexible in when you can take vacation
711	flexible retirement package
721	flexible work hours
731	freedom in how to do the work
741	get on programs where you can excel or have high potential
751	good geographical location (close to city, or hometown, etc.)
761	interesting and challenging work
771	know colleagues deeper than "professional acquaintance"
781	life and work are well-balanced
791	listen to my subordinates' complaints or concerns
401	little politics within company
412	little travel requirement
423	low turn-over
434	many employees organize their schedules to be available to work on your projects
445	many employees view you as their champion
456	meals provided when working late
467	meaningful awards
478	meaningful recognition
489	more than 3 weeks of vacation
500	my engineers are loyal to my group
591	often put in a leadership role
582	opportunities in domestic and international travel
573	opportunities to promote to fellowship position (e.g. Man In the Job)
564	opportunities to promotion
555	overall fairness of the company in terms of policy, structure and people
546	performance evaluations that make you feel good
537	pleasant working environment (e.g. cafeteria, gym facilities)
528	pride of organization or company
519	reimbursement for education
600	researchers and engineers get the resources they need

390 respect from co-workers
381 retention rights
372 rewarded as a team
363 security or protection of employment
354 simple reporting structure (e.g. report to only one boss)
345 take risky projects
336 technical managers are viewed as equally important as general managers
327 transportation provided when working late
318 uniform performance objectives
309 variety of tasks within an assignment
400 well-informed of the projects available
111 work that has impact on technology, company or industry
222 your peers realize that you are in control of many resources

Supervisees' deck of cards

Card Number	Attributes
109	"concierge" services (e.g. car wash, dry clean, etc.) available
118	a lot of fun activities
127	a lot of responsibility on the project
136	able to attend technical seminars, conferences
145	able to develop contacts in other organizations
154	able to present work or publish papers
163	assignments require low administrative work
172	be informed of what is happening in the laboratory
181	become an expert in certain technical area
190	being a good team player is recognized
209	boss is comfortable with employees moving to different groups within the company
218	can carry out assignments however I see appropriate
227	can express concerns to management comfortably
236	can take courses at local universities
245	caring supervisors
254	child care available
263	company is caring about its employees' personal as well as professional development
272	competent and cooperative team members
281	co-workers are my friends as well as the people I work with
290	different assignment each time
309	easily access administrative resources
318	easy to transfer between different groups
327	employees interact outside work
336	exposure to new ideas or new technologies
345	fair distribution of assignments
354	flexible in when you can take vacation
363	flexible retirement package
372	flexible work hours
381	freedom to choose assignments
390	get on programs where you can excel or have high potential
409	good geographical location (close to city, or hometown, etc.)
418	good work is recognized
427	interesting and challenging work
436	know colleagues deeper than "professional acquaintance"
445	life and work are well-balanced
454	little politics within company
463	long distance learning
472	long-term training available
481	low temporary duty requirements or travel requirements
490	low turn-over
509	managers and supervisors stay out of the way of researchers and engineers
518	meals provided when working late
527	meaningful awards
536	meaningful recognition
545	more than 3 weeks of vacation
554	often put in a leadership role
563	opportunities in domestic and international travel
572	opportunities in promotion
581	opportunities to promote to fellowship positions (e.g. Man In The Job)

590 overall fairness of the company in terms of policy, structure and people
609 performance evaluations that make you feel good
618 pleasant working environment (e.g. cafeteria, gym facilities)
627 pride of organization or company
636 rarely repeat same assignments
645 receive good mentoring
654 reimbursement for education
663 researchers and engineers get the resources they need
672 respect from co-workers
681 retention rights
690 rewarded as a team
709 security or protection of employment
718 simple reporting structure (e.g. report to only one boss)
727 technical managers are viewed as equally important as general managers
736 transportation provided when working late
745 uniform performance objectives
754 variety of tasks within an assignment
763 very few supervisory tasks
772 well-informed of the projects available
781 work that has impact on technology, company or industry

Appendix C: Exemplary Count and Importance

Supervisors

Group 1

CARDS	EXEMPLARY COUNT	EXEMPLARY IMPORTANCE
Overall fairness of the company in terms of policy, structure and people	13	80.4
Company is caring about its employees' personal as well as professional development	12	63.3
Meaningful recognition	6	83.0
Opportunities to promotion	5	94.0
Performance evaluations that make you feel good	5	58.0
Little politics within company	3	58.3
Uniform performance objectives	3	65.0
Meaningful awards	2	77.5
Opportunities to promote to fellowship positions (e.g. man in the job)	1	95.0
Reimbursement for education	1	20.0
Avoid confrontation for bad reviews	0	NA

Group 2

CARDS	EXEMPLARY COUNT	EXEMPLARY IMPORTANCE
Know colleagues deeper than "professional acquaintance"	4	43.8
Co-workers are my friends as well as the people I work with	2	36.5

Group 3

CARDS	EXEMPLARY COUNT	EXEMPLARY IMPORTANCE
Pride of organization or company	12	85.2
Competent and cooperative subordinates	10	82.0
Able to attract people to work for you	6	60.8
Respect from co-workers	6	79.7
Employees have good understanding of the project	3	76.7
Rewarded as a team	3	28.3
Listen to my subordinates' complaints or concerns	2	40.0
Low turn-over	1	45.0
Many employees organize their schedules to be available to work on your projects	1	50.0
Your peers realize that you are in control of many resources	1	50.0
Employees are willing to spend a lot of time training to work on your projects	0	NA

Group 4

CARDS	EXEMPLARY COUNT	EXEMPLARY IMPORTANCE
Researchers and engineers get the resources they need	7	67.9
Assignments require low administrative work	3	45.0
Simple reporting structure (e.g. report to only one boss)	2	92.5
Control over budget	1	60.0
Easily access administrative resources	1	10.0

Group 5

CARDS	EXEMPLARY COUNT	EXEMPLARY IMPORTANCE
Work that has impact on technology, company or industry	13	83.8
Interesting and challenging work	12	89.9
Freedom in how to do the work	9	83.9
Become an expert in certain technical area	8	80.0
Be informed of what is happening in the laboratory	5	68.0
Get on programs where you can excel or have high potential	5	85.0
Technical managers are viewed as equally important as general managers	5	76.0
Often put in a leadership role	4	80.5
Able to explore other business opportunities within the laboratory	1	50.0
Able to present work or publish papers	1	60.0
Variety of tasks within an assignment	1	80.0
Able to attend technical seminars, conferences	0	NA
Take risky projects	0	NA
Well-informed of the projects available	0	NA

Group 6

CARDS	EXEMPLARY COUNT	EXEMPLARY IMPORTANCE
Security or protection of employment	9	80.9
A lot of fun activities	5	35.0
Concierge services (e.g. car wash, dry clean, etc.) available	4	17.5
Flexible work hours	4	52.5
Flexible in when you can take vacation	2	40.0
Flexible retirement package	2	55.0
Retention rights	2	75.0
Transportation provided when working late	1	10.0
Meals provided when working late	0	NA

Group 7

CARDS	EXEMPLARY COUNT	EXEMPLARY IMPORTANCE
Life and work are well-balanced	11	82.7
Pleasant working environment (e.g. cafeteria, gym facilities)	7	55.7
Good geographical location (close to city, or hometown, etc.)	2	60.0
Little travel requirement	1	0.0
More than 3 weeks of vacation	1	50.0
Opportunities in domestic and international travel	0	NA

Supervisees:

Group 1

CARDS	EXEMPLARY COUNT	EXEMPLARY IMPORTANCE
Concierge services (e.g. car wash, dry clean, etc.) available	5	45.6
Child care available	3	35.0
A lot of fun activities	2	60.0
Meals provided when working late	0	NA
Transportation provided when working late	0	NA

Group 2

CARDS	EXEMPLARY COUNT	EXEMPLARY IMPORTANCE
Pleasant working environment (e.g. cafeteria, gym facilities)	6	65.0
Security or protection of employment	6	85.8
Flexible work hours	5	80.0
Low temporary duty requirements or travel requirement	4	27.5
Good geographical location (close to city, or hometown, etc.)	3	41.7
Flexible in when you can take vacation	1	70.0
Flexible retirement package	1	100
More than 3 weeks of vacation	1	NA
Opportunities in domestic and international travel	1	70.0
Retention rights	1	90.0

Group 3

CARDS	EXEMPLARY COUNT	EXEMPLARY IMPORTANCE
Exposure to new ideas or new technologies	9	81.6
Able to attend technical seminars, conferences	5	64.0
Become an expert in certain technical area	4	65.0
Can take courses at local universities	3	50.0
Long-term training available	2	72.5
Reimbursement for education	2	50.0
Able to develop contacts in other organizations	1	50.0
Long distance learning	1	75.0
Able to present work or publish papers	0	NA

Group 4

CARDS	EXEMPLARY COUNT	EXEMPLARY IMPORTANCE
Get on programs where you can excel or have high potential	11	80.9
Interesting and challenging work	11	97.2
A lot of responsibility on the project	5	76.0
Variety of tasks within an assignment	5	74.0
Freedom to choose assignments	4	82.5
Fair distribution of assignments	3	50.0
Work that has impact on technology, company or industry	3	75.0
Different assignment each time	2	57.5
Often put in a leadership role	2	87.5
Can carry out assignments however I see appropriate	1	95.0
Rarely repeat same assignments	0	NA

Group 5

CARDS	EXEMPLARY COUNT	EXEMPLARY IMPORTANCE
Assignments require low administrative work	5	53.8
Managers and supervisors stay out of the way of researchers and engineers	5	69.0
Easily access administrative resources	4	30.0
Simple reporting structure (e.g. report to only one boss)	4	80.0
Very few supervisory tasks	4	12.5
Be informed of what is happening in the laboratory	3	55.0
Researchers and engineers get the resources they need	3	96.7
Technical managers are viewed as equally important as general managers	3	89.0
Well-informed of the projects available	3	70.0

Group 6

CARDS	EXEMPLARY COUNT	EXEMPLARY IMPORTANCE
Competent and cooperative team members	7	67.9
Respect from co-workers	2	92.5
Rewarded as a team	2	95.0
Being a good team player is recognized	1	1.0

Group 7

CARDS	EXEMPLARY COUNT	EXEMPLARY IMPORTANCE
Good work is recognized	10	78.0
Opportunities in promotion	8	92.0
Performance evaluations that make you feel good	3	13.3
Meaningful awards	1	90.0
Opportunities to promote to fellowship positions (e.g. man in the job)	1	80.0
Uniform performance objectives	1	0.0
Meaningful recognition	0	NA

Group 8

CARDS	EXEMPLARY COUNT	EXEMPLARY IMPORTANCE
Life and work are well-balanced	15	65.1
Co-workers are my friends as well as the people I work with	4	47.5
Know colleagues deeper than "professional acquaintance"	3	65.0
Employees interact outside work	1	10.0

Group 9

CARDS	EXEMPLARY COUNT	EXEMPLARY IMPORTANCE
Company is caring about its employees' personal as well as professional development	12	72.1
Overall fairness of the company in terms of policy, structure and people	9	87.2
Pride of organization or company	6	86.7
Caring supervisors	5	66.0
Little politics within company	5	57.0
Low turn-over rate	3	40.0
Receive good mentoring	2	80.0
Boss is comfortable with employees moving to different groups within the company	1	58.0
Can express concerns to management comfortably	1	70.0
Easy to transfer between different groups	0	NA

Appendix D: Cards used in Online Conjoint Analysis

Descriptions of the supervisors' attributes used in the conjoint survey:

Attribute	Short Description	Long Description	Abbreviation
1	Company fairness and caring	Company has fair policies, structure, people, and cares about personal as well as professional development. Good work is recognized.	fair
2	High-impact, expertise-enhancing work	High-impact, expertise-enhancing work and the freedom to do it.	Himp
3	Employees are always available	Employees are always available to work late or take temporary duty assignments in other locations.	avail
4	Colleagues are friends	Colleagues are friends, more than "professional acquaintances".	friend
5	Employees do administrative work	Employees are willing to do administrative work and update me with regular reports.	admin
6	Security or protection of employment	Security or protection of employment	Secure
7	Employees take less interesting tasks	Employees are willing to do administrative work and update me with regular reports.	int
8	Salary	Current salary +/- \$10,000	salary

*Abbreviations are used in the tables in Chapter 4.

Descriptions of the supervisees' attributes used in the conjoint survey:

Attribute	Short Description	Long Description	Abbreviation
1	Company fairness and caring	Company has fair policies, structure, people, and cares about personal as well as professional development. Good work is recognized.	fair
2	High-impact, expertise-enhancing work	High-impact, expertise-enhancing work and the freedom to do it.	Himp
3	Not working late or taking temporary duty	Not expected to work late or take temporary duty requirements in other locations.	Nlate
4	Colleagues are friends	Colleagues are friends, more than "professional acquaintances".	friend
5	Low administration work and reporting	Low administration work and minimal reporting requirements.	admin
6	Security or protection of employment	Security or protection of employment	Secure
7	Interesting and challenging assignments	Always receive interesting and challenging assignments.	int
8	Salary	Current salary +/- \$10,000	salary

The pair comparisons of the two profiles are presented the following way:

Question	Attribute(Level) for Job #1	Attribute(Level) for Job #2
1	1(B), 2(B), 3(B), 4(B)	1(C), 2(A), 3(B), 4(C)
2	5(A), 6(A), 7(C), 8(B)	5(A), 6(B), 7(A), 8(C)
3	1(B), 2(B), 6(B), 8(B)	1(C), 2(A), 3(B), 4(C)
4	3(C), 4(B), 5(C), 7(A)	3(C), 4(C), 5(A), 7(B)
5	1(C),2(C),3(A),4(B)	1(C), 2(B),3(C),4(A)
6	5(C), 6(C),7(A), 8(B)	5(B), 6(C),7(C), 8(C)
7	1(A),2(A),6(C),8(B)	1(A),2(B),6(A),8(C)
8	3(C),4(C),5(A),7(B)	3(C),4(B),5(C),7(A)
9	1(A),2(B),3(A),4(B)	1(A),2(A),3(C),4(B)
10	5(A), 6(C),7(B), 8(A)	5(C), 6(A),7(B), 8(C)
11	1(C),2(C),6(A),8(B)	1(B),2(C),6(C),8(C)
12	3(A),4(A),5(C),7(B)	3(A),4(A),5(C),7(B)
13	1(C),2(C),3(A),4(B)	1(B),2(C),3(C),4(C)
14	5(A), 6(A),7(C), 8(B)	5(B), 6(A),7(A), 8(A)
15	1(B),2(C),6(C),8(C)	1(C),2(B),6(C),8(A)
16	3(B),4(C),5(C),7(C)	3(C),4(A),5(B),7(C)
17	1(A),2(C),3(B),4(A)	1(B),2(A),3(A),4(A)
18	5(B), 6(B),7(B), 8(B)	5(C), 6(B),7(C), 8(A)
19	1(B),2(A),6(A),8(A)	1(A),2(C),6(B),8(A)
20	3(B),4(A),5(A),7(A)	3(A),4(C),5(B),7(A)

*A = "worse than average"

B= "about average"

C= "above average"

The numbers refer to the corresponding attribute in the previous page.

card	fair_1	fair_2	himp_1	himp_2	avail_1	avail_2	friend_1	friend_2	admin_1	admin_2	secure_1	secure_2	int_1	int_2	salary_1	salary_2
1	1	0	-1	1	0	0	1	-1	0	0	0	0	0	0	0	0
2	1	1	0	1	0	0	0	0	0	0	-1	0	0	1	1	-1
3	1	1	-1	1	0	0	0	0	0	0	0	0	0	0	1	-1
4	0	0	0	0	1	-1	1	0	0	0	0	0	1	-1	0	0
5	0	0	0	1	0	0	-1	0	0	0	0	0	0	0	0	0
6	0	0	0	0	0	0	0	0	-1	0	0	0	0	-1	1	-1
7	0	0	0	-1	0	0	0	0	0	0	0	1	0	0	1	-1
8	0	0	0	0	0	0	-1	1	0	0	0	0	1	0	0	0
9	0	0	0	-1	0	0	1	-1	0	0	0	0	0	0	0	0
10	0	0	0	0	0	0	0	0	0	-1	0	0	0	0	0	-1
11	-1	1	1	0	0	0	0	0	0	0	0	1	0	0	1	-1
12	0	0	0	0	0	0	0	0	0	0	0	-1	0	0	0	0
13	-1	1	1	0	0	0	-1	0	0	1	0	0	1	-1	0	0
14	0	0	0	0	0	-1	1	-1	0	0	0	0	0	0	0	0
15	1	-1	1	0	0	0	0	0	1	0	0	0	0	-1	-1	0
16	0	0	0	0	1	-1	0	1	0	0	0	0	0	0	0	1
17	1	0	0	0	-1	0	0	0	-1	1	0	0	0	0	0	0
18	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
19	-1	0	0	0	1	0	0	0	1	-1	0	0	1	-1	1	0
20	0	0	0	0	1	0	0	-1	0	0	1	0	0	0	0	0

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