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Improved Method for Estimating Input to Decision Models for Technical Projects

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Abstract

All project selection and portfolio management decisions ultimately depend on the estimations of probabilities or likelihood made by human judgements. So the quality of human judgements directly affects the accuracy of these management decisions. The research questions have been formed based on who and how the best estimations will be obtained. The literature review suggests that the individual judgements are biased, particularly expert. Losses have also been found in group's interaction and cognitive processes.

By linking a historical case study and observation of group working in BT into literature, an overall framework has been developed along with an estimation procedure and related guidelines for the guidance of making better estimations. The list of guidelines provides the best practices for each process in the framework. The hypothesis also suggests that the combination of a facilitator and a group is the best source for estimation. It also emphasize on the holistic view of estimation making processes.

Six well experienced practitioners were carefully selected and interviewed. The contents of hypothesis were also assessed by them individually. It was proved to be acceptable and useful. These practitioners also gave their suggestions on the framework. Modifications were also made on the overall framework based on these suggestions.

The value of the research is not only to guide the people in the industry what to do when you want to make estimations in technical projects, but also to tell them how and why to do this.

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Content

List of Figures

1.0 Introduction

1.1 Background

The literature on technology investment abounds with formal procedures and sophisticated decision models for project evaluation and selection (Baker, 1974; Cetron, Martino & Roepcke, 1967; Gear, Lockett & Pearson, 1971; Tritle et al, 2000 & 2001). All project selection and portfolio management decisions ultimately depend on probabilities or likelihood of future events as inputs to these decision models; particularly (but not exclusively) on estimates of the size and likelihood of future financial costs and benefits. For instance, in decision trees, the probabilities of technical success or predictions of the market size for the technology are required. Because these estimations are heavily based on human judgements, their subjective character entails a series of problems which may have contributed to the low acceptance rate of these models (Rubenstein & Schröder, 1977).

Empirical research has shown that such judgements are notoriously subject to bias and inaccuracy arising from personal factors, group dynamics, company politics or even the way the question is framed. For example, when psychologists study human judgement of probability, judged probabilities do not conform to the equations of probability theory. Many scholars have found it disturbing to think that humans might have been rational enough to invent probability theory but not rational enough to use it in their daily thoughts (Birnhaum, 1990).

On the other hand, organisations have been largely using focus groups or some form of working groups to take decisions and make estimations. It has been suggested that in some circumstances the views of a wide range of people, appropriately combined, may be more accurate than the opinion of several experts (Surowiecki, 2004).

No accessible and comprehensive guidance is available for managers in selecting the best management process for assembling estimates in a particular case and it is the aim of this project to provide this.

1.2 Research Questions

Two important issues in securing more accurate estimates from the human beings are Who & How. These initial questions have suggested the direction of this research:

1. Under what circumstances are estimates of magnitudes and probabilities of future events best made by: Individual reflection; Group consensus; or some combination of the two? What management techniques maximise effectiveness in each case? What can go wrong? What management techniques can be used to overcome this?

2. What management processes can be used to allow individuals to take on board additional information, such as the views of colleagues, without introducing bias.

In order to make better sense to people in industry and to allow easier transformation from the theoretical knowledge to real world practice in the later stage of the research, the research questions have been refined to:

- Which is the best source to obtain these subjective probabilities, individuals or groups, or asking several experts or groups with appropriate diversity of knowledge?
- How to build the group (Group Composition)?
- How to manage or facilitate the group (Group Structuring)?
- How to present the tasks?
- How to frame the questions to gain human estimations?

1.3 Research Design and Methodology

The design for this research is different from traditional research approach. Traditionally, researchers will follow these processes: 1. Literature Review; 2. Formalising Research Questions; 3. Evidence Collection; 4. Analysis of Evidence; 5. Conclusion of the Research. But this research has formalized research questions before literature review.

As the special nature of this research, it has been designed to start with devoting large amount of effort into literature review, case study and field study. Then an overall framework along with guidelines including best practice and references have been developed based on literature and analysis of case study and field study. Thirdly, semi-structured interviews have been carried out with experienced practitioners to review the framework and guidelines for acceptability in practice. The reason for using a combination of work and interview based model rather than an experiment based model to test the hypothesis for this research is because that the tasks for experiments are often selected ad hoc to represent certain simplified purposes. As result, experiments approach can restrict the outcome from testing the whole framework. It seems to be more reasonable to justify it by experienced practitioners. Finally, modifications of the framework and guidelines have been made based on the interview outcomes.

The following diagram (Figure 1.) explains the designed processes for the research,

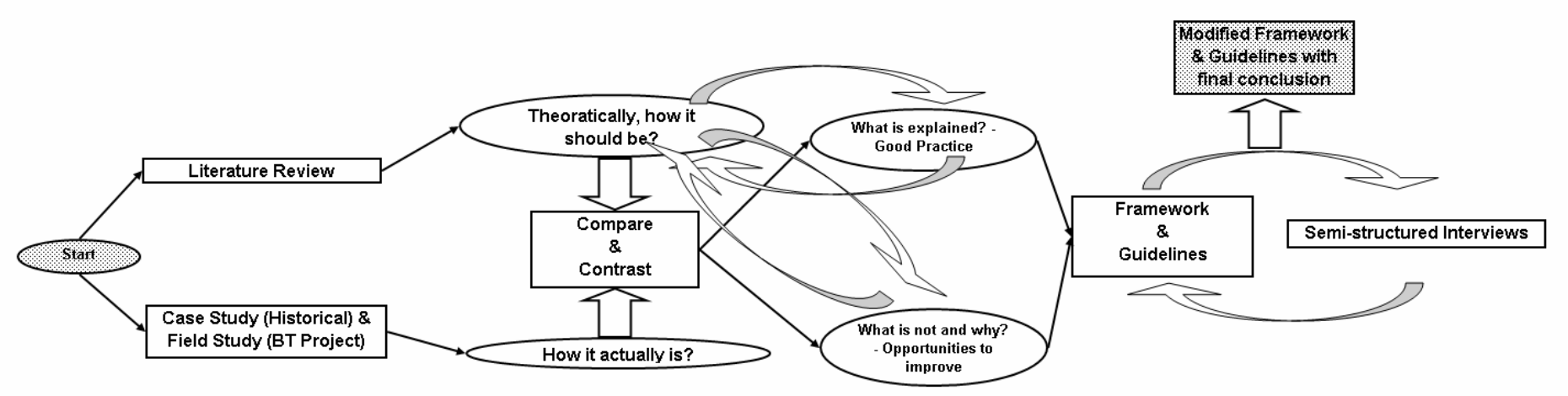

Figure 1. Research Design and Methodology

1.3.1 Interview Design

The selection of interviewees was also influenced by a wish to investigation of a range of different industrial sectors (telecommunication, pharmacy, electrics, etc.) and also their functionalities (management consultant, managing director, R & D, etc.) within an organisation. (see Appendix A)

Semi-structured interviews were carried out within six experienced participants. All of them had more than 20 years experience in the industrials.

A questionnaire was also prepared in order to model the interview and gain key elements of the research. (see Appendix B)

1.4 Research Objective and Agenda

This research aims to review current literature on individual judgement, the pros and cons of group thinking, structuring methods of groups or the combination of two. The literature is compared and linked with real life scenarios and experiences to determine which elements provide best input (from human estimations) to decision models. An overall framework along with guidelines is developed in order to assist busy managers to gain the best estimation from individuals or groups by bringing awareness of some crucial elements.

Research work started by looking at estimation making processes. These processes can in principle guide the further research activities considered in this project.

A literature review has been carried out, detailed in the next section, focusing on (see Appendix C):

- **Decision Making processes and Problem Solving processes** (Because there is a tendency in the literature and in the real word to view decision making and problem solving as identical activities (Huber, 1986).
- **Judgement** (Kahneman, Slovic & Tversky, 1982)
- **Group, Group Decisions, Group Support** (Janis, 1972; Klein, 1963; Park, 1990)
- **Probability Theory** (Kranz, Luce, Suppes & Tyersky, 1971; Hogg & Craig, 1965)

This discusses the knowledge embedded in psychology, economics, mathematical statistics, operations research, political science, artificial intelligence and cognitive science.

At the end, the integrated overall framework and guidelines will suggest ways for managers to gain the maximum benefits from the research.

2.0 Literature Review

The literature review was carried out by reviewing the estimation making process, to identify the cause of errors. This led to decision modelling and problem structuring methods (PSMs) which would help to improve the accuracy of estimations. These methods and models also contributed into the framework and guidelines development in the later stage of the research. For instance, the PSMs are commonly developed by using an individual to facilitate a particular group, which stimulated the idea where that the manager him/herself could work as facilitator to gain a better estimation from a group.

In the real world, managers tends to use experts or groups to help collect more information, knowledge and experience in order to make better estimations. Group related literature was also studied; for example, group structuring techniques, group task selection and group composition.

2.1 The Estimation Making Process

When Herbert A. Simon approached decision making and problem solving by looking at how people process information, he distinguished the two by their unique activities. Fixing agendas, setting goals and design actions are called problem solving. Evaluating and choosing are called decision making (Simon, 1986). These five activities (Fixing agendas, setting goals, design actions, evaluating and choosing) map on to estimation making process precisely. The final activity in the process is "choosing" which is based on human judgements.

So there are at least three different types of processes involved in estimation process: 1. Judgement Processes; 2. Decision Making processes; 3. Problem solving processes;

By looking at the relationship between these three processes:
Judgement processes entail the assessment of values – either quantitative or qualitative – for particular variables of interest. Judgement can either be a component of a large task e.g. estimating probabilities and utilities of outcomes of alternative

actions as a precursor to making a choice between alternatives, or can be an end in itself e.g. predicting Japan's GNP next year (Bolger & Harvey, 1998). On the other hand, decision making processes normally involve selecting between two or more options, although there are some decisions, e.g. where a new policy is adopted, which are difficult to classify in this way. This may involve judgement, as in the previous example, or may not, as in the case of habit, e.g. choosing the forecast method one normally uses.

Although decision making and problem solving are not interchangeable (Shull, Delbecq & Cummings, 1970), they are often closely related (Braverman, 1980). Moreover, the terms are found often to be used interchangeable (Costello & Zalkind, 1963).

Theoretically central to the body of prescriptive knowledge about decision making has been the theory of subjective expected utility (SEU). This a sophisticated mathematical model of choice that lies at the foundation of most contemporary economics, theoretical statistics and operational research. Prescriptive theories of choice such as SEU are complemented by empirical research that shows how human actually make decision and research on the processes of solving problems (Simon, 1986).

In summary, it is proposed that judgement, decision making and problem solving processes should be viewed as a coherent whole. All of these directly affect the quality of the estimations made by human beings and are discussed in more detail in the following sections.

2.2 Judgement Making Processes

Is the true value of human judgement "…superb piece of work! Noble in reason! Infinite in faculty!" as Shakespeare believed, or "errors of judgement…often systematic rather than random, manifesting bias rather than confusion", causing us to "suffer from mental astigmatism as well as myopia" (Kahneman & Tversky, 1979)?

So, how good are people making these judgements?

2.2.1 Individual Judgement

Human judgmental biases and limitations have been extensively studied for repetitive decisions when inputs can be quantified and compared to those corresponding to decision rules. (Makridakis & Gaba, 1998)

- Heuristics and Biases -

Psychology research has shown that human judgements contain the use of heuristics (rules of thumb) (P126, Schoemaker & Russo, 1989). Human beings develop simple shortcuts, or heuristics to manage complex information. (Tversky & Kahneman, 1973). These heuristics are generally useful, and lead to accurate judgment much of the time. (Gigerenzer et al). They can, however, lead to mistakes in judgment. Because people develop mental shortcuts to address particular choices and judgments they must make, when they apply these heuristics in novel settings, they can make mistakes in judgment. The three main heuristics are representativeness, availability and anchoring (Kahneman & Tversky, 1972, 1973 & 1974). (see Figure 2.)

Representativeness bias refers to the bias incurred in posterior-probability estimations by not properly utilizing information sources such as base rate.

Availability bias refers to the phenomenon that the frequency or probability of events is estimate by the ease with which instances or associations come to mind. Ie, we base on memorable insurance!

And **Anchoring heuristic create bias** from human's first impression of information. For example, a random number generator produced a number between 0 and 100. People were then asked to asked to estimate the percentage of African countries in the United Nations and to indicate whether the estimate was greater or less than the random number. People given high random numbers produced higher estimates than those given low numbers. Modifications of the estimated are always too small because of the anchor effect as well. (Kahneman, D. Slovic, P. & Tversky, A., ed., 1982)

Figure 2. Heuristics and Biases

- Experts Judgement -

Managers always go to experts for estimations, because they believe their judgements are quicker and more reliable. Is this conventional wisdom true?

Well, experts often develop new, task-specific heuristics that give them fast, efficient, and accurate ways of processing complex information. **They do not merely possess better information than novices, they possess more accurate ways of evaluating and using relevant information** (Guthrie & Rachlinski, 2004)**.** Guthrie & Rachlinski propose after their research, that experts also possess better cognitive skills that enable them to process information in a more unbiased fashion than novices.

But, it is also not difficult to find evidence of error and biases in expert judgement (Ayton, 1992). Estate agents' valuations have been found to be influenced by an irrelevant anchor – information that they deny the relevance of (Northcraft & Neale, 1987); doctors have been found to assess the likelihood of disease according to how representative of the disease the symptoms are – ignoring the base rates (Eddy, 1982); Wagenaar & Keren (1986) found over-confidence in lawyers' attempts to predict the outcome of court trails in which they represented one side.

As a glance, it seems that there is a conflict in the current theories However, this is not true. (Guthrie & Rachlinski, 2004)'s conclusion was drew by presenting materials designed to test for the influence of several cognitive processes that are known to mislead novices to insurance claims adjusters and reinsurance executives. It was the way the tests were structured that unconsciously reduced opportunities to lead the experts onto errors and biases.

This is also the notion that it is not always clear what the proper basis is for evaluation of judgement. In a series of articles, Gigerenzer (e.g. 1991; 1994; 1996) has argued that although people may appear poor at making the judgements required in the problems that have been devised to measure judgement, this may be a misleading picture of judgemental competence. Gigerenzer draws attention to demonstrations of tests of over-confidence, base-rate neglect and the conjunction fallacy where changes in the mode of presentation of the problems produce significant improvements in performance.

These heuristic and biases related topics have been studied extensively and well documented(e.g. Gigerenzer, 1991; 1994; 1996; Kahneman & Tversky, 1972, 1973 & 1974; etc.). More information will not be repeated in the paper.

As we shall see, such studies allow fine-grained analysis of human judgement but suffer from the potential criticism that their results have little to do with real-world decision making. (Goodwin & Wright, 1991)

To summarize above, researchers have identified a whole series of such flaws/biases in the way we think in making decision. Some like the heuristic for clarity are the sensory misperceptions. Others take the form of biases. Others appear simply as irrational anomalies in our thinking. What makes all these traps so dangerous is their invisibility. Because they are hardwired in to our thinking process, we fail to recognize them – even as we fall straight into them. (Hammond, Keeney & Raiffa, 1998)

- Decision Traps -

Schoemaker & Russo has concluded the decision research from last two decades has shown that people in numerous fields tend to make same kind of decision-making mistake (Schoemaker & Russo, 1989). They also highlighted the most common errors into ten "Decision Traps". What has been really valuable about their work is that they have given the dry and hard-understanding psychology studies and terminologies a good practical value and applicability. (see Figure 3.)

1. **Pump In:** Beginning to gather information and reach conclusions without first taking a few minutes to think about the crux of the issue you are facing or to think through how you believe decisions like this one should be made.
2. **Frame Blindness:** Setting out to solve the wrong problem because you have created a mental framework for your decision, with little thought, that causes you to overlook the best options or lose sight of important objectives.
3. **Lack of Frame Control:** Failing to consciously define the problem in more ways than one or being unduly influenced by the frames of other.
4. **Overconfidence in Your Judgement:** Failing to collect key factual information because you are too sure of your assumptions and options.

5. **Short sighted shortcut:** Relying inappropriately on "Rule of thumb" such as implicitly trusting the most readily available information or anchoring too much in convient facts.
6. **Shooting from the Hip:** Believing you can keep straight in your head all the information you've discovered, and therefore "winging it" rather than following a systematic procedure when making final choice.
7. **Group Failure:** Assuming that with many smart people involved, good choices will follow automatically, and therefore failing to manage the group decision-making process.
8. **Fooling Yourself About Feedback:** Failing to interpret the evidence from past outcomes for what it really says, either because your are protecting your ego or because you are tricked by hindsight.
9. **Not Keeping Track:** Assuming that experience will make its lessons available automatically, and therefore failing to keep systematic records to track the results in ways that reveal their key lessons.
10. **Failure to Audit Your Decision Process:** Failing to create an organized approach to understanding your own decision making, so you remain constantly exposed to all the above mistakes.

Figure 3. Decision Traps

Similarly, Hammond, Keeney & Raiffa have also concluded some hidden decision traps, for instance, the anchoring trap, the status quo trap, the sunk cost trap, the confirming-evidence trap, the framing trap, etc. (Hammond, Keeney & Raiffa, 1998)

Other management scientists has also contributed, for instance, problem/information evolving methods known as humble decision making (Etzioni, 1989), "Even Swap – A Rational Method for Making Trade-off" (Hammond, Keeney & Raiffa, 1998), "When to trust your gut?" (Hayashi, 2001), etc.

So this chapter is really about how bad are individuals' judgements. Are the groups' better?

2.2.2 Group Judgement

It was the group who believed that the earth was flat; it was the group who thought the earth was the centre of the universe……

There are people who believe in the "madness of the crowd" (De la Vega, 1688; Mackay, 1688; Fridson, 1996), but there also people believe in the "wisdom of the crowd" (Surowiecki, 2004).

How crowds can, as it were, go mad, and what allows them to succumb to delusions?

- Group Decision Making -

Gentleman, I take it we are all in complete agreement on a decision tree… Then I propose we postpone further discussion of this matter until our next meeting to give ourselves time to develop disagreement and perhaps gain some understanding of what the decision is all about. **(Alfred P. Sloan, Jr.)**

No matter how brilliant group members are, groups aren't superhuman. Groups are likely to outperform individuals only to the extent that productive conflict arises among their members and such conflicts get resolved through balanced debate and carefully intelligence-gathering. When that happens, a group is likely to understand the issues better than an individual, and more likely to choose widely. When that does not happen, groups are just as likely to error as individuals – and sometimes more so.

- Groupthink -

"Groupthink" the name comes from the title of a book by Janis, which analysed and documented the errors were committed in the decisions that led to: John F. Kennedy after his administration's invasion of Cuba had been defeated at the Bay of Pigs; U.S. underestimation of Japan's belligerence before Pearl Harbour; U.S. Mismanagement of Vietnam War, etc. (Janis, 1971) They didn't fail because they were stupid. They failed because they followed a poor process on arriving at their decisions. They allowed the group's internal cohesiveness and loyalty to dominate the decision-making process. Ideas that conflicted with the group's preconceptions got little attention (Schoemaker & Russo, 1989).

Group judgements, an important facet of organisational activities, are also prone to these biases. Although de-biasing methods and effectiveness have been examined in

contexts involving individuals making judgements (e.g., (Elseasser, 1989; Wright, 1983)), no parallel effort seems to exist for group judgements.

- The rationale of using groups – Process Gain -

Why do people meet for discussion in groups? It is, of course, an enjoyable activity: hearing others give their point of view stimulates our ideas. But, also, people want to make up their mind and so come to a conclusion. This conclusion is likely – more than is perhaps realized at first – to be a social matter. A man does not only want to make up his mind; he wants to be of one mind with others. (Klein, 1963)

After all the group shall process at least the same amount of information and knowledge as its most knowledgeable member, and will usually process more. Additionally, the group environment can provide opportunities for the resolution of ambiguous and conflicting knowledge, the facilitation of creativity and the enhancement of individual commitment. Combining individual judgements through the use of groups may therefore lead to "process gain" (Sneizek & Henry, 1989), in which the group actually out-performs its best member in term of the quality of judgement.

Process Gain (Turban et al, 2005)

- Groups are better than individuals at understanding problems
- Less pressure because the responsibilities have been distributed in to a number of people
- Group members have their egos embedded in the decision, and so they will be committed to solution
- Groups are better than individuals at catching errors
- A group has more information (knowledge) than any one member. Groups can combine knowledge to create new knowledge. More and more alternatives for problem-solving can be generated, and better solutions can be derived (through simulation)
- A group may produce synergy during problem-solving
- Working in a group may stimulate the creativity of the participants and the process

- A group may have better and more precise communication working together
- Risk propensity is balanced. Groups moderate high risk takers and encourage the conservatives

Figure 4. Process Gain

Empirical studies have attempted to determine the relative merits of group vs. individual procedures. Group judgement have generally been shown to be better over a wide range of tasks and circumstances, and over both qualitative and quantitative performance criteria (e.g. Hill, 1982; Ferrell, 1985). Further more, a number of studies have found that interacting groups may occasionally perform at the level of their best member and beyond (e.g. Eihorn, Hogarth & Kelmpner, 1977; Uecker, 1982; Sniezek & Henry, 1989)

- The rationale of NOT using groups – Process Loss -

Although performance up to and beyond best member level has been demonstrated, group judgement has generally been shown to fall short of this standard (Hill, 1982; Miner, 1984; Hastie, 1986). These result suggest that in most circumstances groups fail to use fully the knowledge and expertise of their members and perform below their potential, exhibiting "process loss" (Steiner, 1972)

Process Loss (Turban et al, 2005)

- Social pressures of conformity may result in group thinking (people begin think alike and not tolerate new ideas – yielding to conformance pressure).
- It is time consuming, slow process
- May lack of coordination of the meeting work and poor meeting planning
- Inappropriate influences (dominate group member)
- Tendency to produce compromised solutions of poor quality
- Information overload
- Attention blocking
- Attenuation blocking
- Concentration blocking
- Slow feedback

Figure 5. Process Loss

Process lose might also occur as a consequence of the frequently conflicting motives of the individuals in a group and their need to "win", or at least not to "lose face" (Hoffman, 1965). Other mechanisms of the group process that might lead to impaired group judgement have also been identified, for example, in "groupthinking" (Janis, 1972; Park, 1990) and in group "polarization" (Lamm & Mysers, 1978).

Thus, to improve the group performance, issues need to be concerned: the aptness of the model of group judgement and decision making that assumes that it is a logical procedure, unaffected by cognitive biases and limitations, or by factors such as personal prerogatives, social pressures and political necessities?

2.2.3 Individuals Versus Groups

It seems that both individuals and groups have pros and cons in judgement tasks, but which one is better, individual or group? Even when the conventional wisdom tells us that a group of brilliant minds shall give better outcomes.

Kerr, MacCoun & Kramer (1996) have categorized the existing literature on individual versus group bias. (see Figure 6.)

The central question of their paper has been, "Which is more likely to make a biased judgment, individuals or groups?" They confirmed that the relatively small and diverse empirical literature suggested that there was no simple empirical answer to this question. Even when they restrict their attention to particular bias phenomena (e.g., framing effects, preference reversals), there was frequently little consistency in the direction and magnitude of observed relative bias. Although there appeared to be no simple and general empirical answer to the question, the present theoretical analysis based on the social decision scheme model has revealed many partial answers, all of which begin with "Well, it depends …" Even under the simplifying assumption that the same basic group process characterizes all groups, they have shown that (and how) it depends jointly upon several factors. In particular, it depends on:

1. The size of the group: Generally, as group size increases, the sign of relative bias is unaffected, but its magnitude increases. (It can also be shown that the latter

relationship between group size and relative bias is a monotonic, negatively accelerating one; cf. Latané, 1981).

2. The magnitude of individual bias: All other things being equal (and most particularly, under any one of several possible group processes), both the direction and magnitude of relative bias can vary as one varies only the magnitude of individual bias.

3. The location of the bias: All other things being equal, both the direction and magnitude of relative bias can change with the location in the response domain of an individual bias of constant magnitude.

4. The definition of the bias: All other things being equal, one can come to diametrically opposite conclusions about relative bias depending on how bias has been defined.

5. The normative ideal: As the ideal judgment shifts, relative bias can change both sign and magnitude, even if individual preference and group process remain constant.

6. The nature of the group process: Most important, all other things being equal, different group processes can produce dramatically different relative biases. If the particular judgment task determined group process completely (and, as much research has shown, task features such as how judgmental-intellective the task is appear to have profound impact on the nature of the group decision-making process), then this factor at least would not contribute to variance in relative bias for any particular bias phenomenon.

But since such situational, group or personal factors as the importance of the task, the importance of intra group harmony, or the judge's general level of uncertainty may also influence the nature of the group process, it is not safe to presume that group process is fixed by task demands.

As above, individuals and groups are all biased on certain levels under different circumstances. **Are there a practical remedies for judgemental biases?**

Phenomenon	Studies	General effect of discussion
	Sin of commission	
Framing	Tindale et al. (1993)∅[1] Kameda & Davis (1990)∅[1] McGuire et al. (1987)↑ Paese et al. (1993)= Neale et al. (1986)↓	Mixed: Group discussion amplified bias in McGuire et al., attenuated bias in Neale et al., no effect in Paese et al.
Preference reversal	Mowen & Gentry (1980)↑ Irwin & Davis (1995)↓	Mixed: Groups more susceptible to choice/rank reversals but less susceptible to choice/match reversals than individuals.
Theory-perseverance effect	Wright & Christie (1990)↓∅[2]	Attenuation: Theory-perseverance effect eliminated in group-discussion and yoked-transcript conditions (but see Note ∅[2]).
Weighing sunk costs	Whyte (1993)↑	Amplification: Groups were more influenced by the existence of past, sunk costs than individuals.
Extraevidentiary bias in juror judgments	Bray, Struckman-Johnson, Osborne, McFarlane, & Scott (1978)∅[2] Carretta & Moreland (1983)∅[2]?[1] Hans & Doob (1976)↑ Izzett & Leginski (1974)∅[2,3] Kaplan & Miller (1978)↓ Kerwin & Shaffer (1994)∅[4] Kramer et al. (1990)↑ MacCoun (1990)↑ Thompson et al. (1981)= Zanzola (1977)↑	Mixed: Amplification is more common than attenuation.
Joinder bias in juror judgments	Tanford & Penrod (1984)= Davis et al. (1984)=	Mixed: No clear effect of group discussion.
Biasing effect of spurious attorney arguments	Schumman & Thompson (1989)↑	Amplification: Groups more susceptible than individuals.
Hindsight bias	Stahlberg, Eller, Maass, & Frey (1995)↓	Attenuation: Groups slightly less susceptible than individuals.
	Sin of omission	
Insensitivity to base rates	Argote, Seabright, & Dyer (1986)↑?[2] Argote, Devadas, & Melone (1990)↕?[2,3] Nagao, Tindale, Hinsz, & Davis (1985)↕?[2]	Mixed: Good evidence that groups rely more heavily on individuating information, but no direct evidence that they rely less on base-rate information (and some to the contrary; see ?[3]).
Dispositional bias in attributions	Wright & Wells (1985)↓ Wittenbaum & Stasser (1995)↓	Attenuation: Appears that group discussion attenuates dispositional bias.
Underuse of consensus information in attributions	Wright et al. (1990)↓	Attenuation: Only group participants were affected by consensus information.
	Sin of imprecision	
Conjunction error	Tindale, Sheffey, & Filkins (1990)↕ Tindale, Filkins, Thomas, & Smith (1993)↕	Mixed: Groups made more conjunction errors than individuals when individual error rates were high, but fewer when individual error rates were low.
Use of representativeness heuristic	Stasson, Ono, Zimmerman, & Davis (1988)↟	Amplification? Individuals outperformed groups on one problem; no difference for second problem.
Use of availability heuristic	Stasson et al. (1987)↓	Attenuation?: Groups (especially when unanimous) marginally out-performed individuals.
Overconfidence (miscalibration)	Dunning & Ross (1992)↑ Sniezek & Henry (1989)↓ Plous (1995)=	Mixed: Groups are generally more confident than individuals, but whether this reflects overconfidence varies between studies.

Note. Amplification signifies a stronger bias among groups (or following group discussion) than among individuals (i.e., $RB > 0$). Attenuation signifies a weaker bias among groups (or following group discussion) than among individuals, $RB < 0$. Mixed signifies an inconsistent pattern of findings, such that for certain studies or analyses $RB > 0$, for others $RB < 0$.

↑ signifies that group discussion amplified individual bias.

↓ signifies that group discussion reduced or corrected individual bias.

↕ signifies that there were results indicating that group discussion both amplified and corrected individual bias.

= signifies that the magnitude of bias was comparable for individual and group judges.

∅ signifies that although the study employed both individual and group judges and examined the bias phenomenon, the study's results are not informative for assessing the degree of relative bias for one of the following reasons:

∅[1] Groups were not homogeneous with respect to exposure to potentially biasing information.

∅[2] No clear bias effect for individuals for key dependent variables.

∅[3] Bias observed only on dependent variable for which purported biasing information is not normatively proscribed.

∅[4] The experimental design did not include a low-bias condition.

Overstruck (e.g., ↟) or paired (e.g. ∅ =) symbols signify combinations of the preceding conditions.

Symbols accompanied by question marks (?) reflect the following methodological or other ambiguities that cloud interpretation of the results:

?[1] Results might be attributed to differential power of statistical tests ($df_{error} = 255$ for individual bias tests but $df_{error} = 30$ for group tests).

?[2] Groups were more prone to use individuating information than individuals, a result that was interpreted as indicating that groups were also less sensitive to base-rate information. However, if the individuating information is diagnostic, one could alternatively conclude that groups make better use of this diagnostic information.

?[3] Access to base-rate information manipulated. When the individuating information was not diagnostic, groups were more likely to use base-rate information; when such information was diagnostic, no reliable effects on relative bias were observed.

Figure 6. Classification and Summary of Empirical Literature (Kerr, MacCoun & Kramer, 1996)

2.3 Improvement of Human Judgement

Kahneman & Tversky (1979) argued that one way to avoid the biases of subjective probability implied by heuristic account was to take an external rather than an internal view, by contemplating the target event in relation to a reference class of similar events and considering the distribution of likelihoods for the whole class events. This has been amplified and extended by Kahneman & Lovallo (1993), who argue that people have a strong tendency to see problem as unique when they would be more advantageously viewed as instances of a boarder class. They claim that the nature tendency in thinking about a particular problem, such as the likelihood of success of a business venture, is to take the "inside" rather than the "outside". In the real world practice, it can be interpreted to "open up the boundaries and look for more alternatives".

This has also confirmed the emergency of systematic thinking, that people should accept that the rich complexity of the world cannot be assumed to consist of systems which can be modelled, let alone optimized. Rather, systems concepts can be helpful in structuring our thinking and learning about problematic situations and we should aim for debate and accommodation about the nature of problem, rather than its solution. (Checkland, 1985) People are often too solution driven, but when facing uncertainties, the only way is trying to build some kind of models to evolve. (Further explanations will be presented in the Problem Structuring Methods and Field Study section later in the paper.)

As above, psychologists and social scientists are interested in human (individual) judgement, heuristics and biases. They also recommended methods to avoid these from happening, but these methods are often lack of practical experience.

On the other hand, Management scientists have done large amount of work to apply these theories to the real-life. But the most theories have developed upon their own experience. It is rather ad-hoc and sometime difficult for managers to apply into his/her own real world situation.

Although the judgement processes are problematic, people are still try to use modelling techniques for the decision making processes and structuring methods for the problem solving processes in order to debias.

2.4 Decision Making Processes – Modelling

- Learnt from a Bayesian Calibration Model -

(Robert & Kenneth, 2002)'s Bayesian calibration model provides a way to debias expert probability assessments based on past performance data. Their approach provides a way to adjust expert judgments after the fact. This is an "ex-post" approach to debias; modeling a population of experts provides important inferential advantages: Any inferences about a single expert benefit from all the data, and the model enables the analyst to perform a preliminary calibration of a new expert before any specific performance data are available for that expert. It may rarely be used in the real world situations, but the lesson can be drew from it is how to revise judgements in the light of new information. So it may worth a while to discuss some knowledge based on Bayes' Theroem. Bayes'theorem is normally used as a normative tool, telling us how we should revise our probability assessments when new information becomes available.

The steps in the process which we have applied are summarised below (Goodwin & Wright, 1991):

1. Construct a tree with branches representing ***all the possible events*** which can occur and write the prior probabilities for these events on the probabilities.
2. Extend the tree by attaching to each branch a new branch which represents the new information which you have obtained. On each branch write the ***conditional probability*** of obtaining this information give the circumstance represented by the preceding branch.
3. Obtain the joint probabilities by multiplying each prior probability by the conditional probability which follows it on the tree.
4. Sum the joint probabilities.
5. Divide the 'appropriate joint probability by the sum of the joint probabilities to obtain the required posterior probability.

This paper is not going to put forward a mathematical proof of Bayes' Theorem or show how a probability tree be used to review prior probabilities, but try to explain how it shall be developed intuitively.

New information can remove or reduce the uncertainty involved in a decision and thereby increase the expected payoff. Application to Bayes' theorem to a decision problem: a process which is sometimes referred to as posterior analysis. (Swinburne, 2005)

These steps in the process are not only the tool to work out the overall result, but also reminding us the best practice to structure you decision making processes.

What I am also interested in is an "ex-ante" approach. This would be to develop elicitation methods that counteract the expert's natural biases in the first place. Fischhoff (1982), Morgan & Henrion (1991), and McClelland & Bolger (1994) all discuss ex-ante debiasing techniques. For example, analysts can use counterfactual reasoning to push experts to consider extreme scenarios in order to debias experts' over confident. Another promising approach arises from the Brunswikian approach to probability assessment that has been recently promoted by Gigerenzer and others (see Gigerenzer 1991, Gigerenzer et al. 1991). This approach stresses the importance of asking an expert questions that are consistent with those typically encountered in his or her domain of expertise. Asking such questions is said to be "ecologically consistent" with the expert's experience and can improve calibration. In addition, framing assessment questions in terms of relative frequencies can improve calibration in comparison with the "degree of belief" framing typically used for subjective probability judgments.

All of these show that it is important in estimation making tasks that we need to take care of **breaking down the task** into different criterion via a certain model, flexible enough to absorb new information for adjustment, and also **locate the right resources** (e.g. individuals, experts or groups) to gain estimates. For instance, define the diversity of knowledge and further experience for the estimation making.

There have been many other attempts to apply models to support decision making. For instance, in recent years this has led to the creation of new research areas, particularly Multi Criteria Decision Making (MCDM). The subject now appears at most conferences and many events are devoted to the topic (e.g. Lockett & Islei, 1998; Goicoechea et al., 1991). However, although many theoretical approaches have been developed, the reported applications are still comparatively rare (Tavana, 2003), and even in these cases the methods are nearly always very simple (Saaty, 1980; Islei & Lockett, 1988; Belton, 1993). Although the researcher see the problem in context (French, 1984), most of the work concentrates on developing ever-increasingly complex models. They appear to be unwilling to come to terms with the organisational dimensions in any meaningful fashion. Researchers from a variety of disciplines are looking for similar types of problems and equally taking a unidimensional view. This paper do not aim to criticise the excellent work that is being done in order to give us great understanding, but to suggest that for managers to gain the maximum benefit from the research, the out comes need more integration.

2.5 Problem Solving Processes – Problem Structuring Methods (PSM)

Mingers & Rosenhead (2004) have edited and published a series problem structuring methods to tackle issues on making and taking decisions, solving problems, design and re-designing systems in conditions of unprecedented complexity and uncertainty. More details will be discussed later in this chapter.

One of the earliest classics of the operational research literature (Churchman, Ackoff & Arnoff, 1957) contained the following aphorism:

> *There is an old saying that a problem well put is half solved. This much is obvious. What is not obvious is how to put a problem well.*

Thus, problem solving methods development has always been focused on how to structure issues, problems and decision situations, rather than "solve" them. (Rosenhead, 1989)

This trend has also emphasised the importance of "Systematic Thinking". As my understanding, it is all about managing uncertainties to see them a coherent whole (known as 'Weltanschauungen'- in German which means the view of the world) and being open to other alternatives (Checkland & Scholes, 1991). This is also the ways to reduce the biases.

Most widely used methods are strategic options development and analysis (SODA) (Ackermann & Eden, 1994), soft system methodology (Checkland & Scholes, 1991) and system dynamics (Wolstenholme, 1990). The selection of the method is based on the relation between methods characteristics and problem situations. The combinations of them are also being widely used in practical applications.

Although they are methods with different characteristics, they all require model-based assistant – a modeller. The modeller has dual responsibilities, both for the development of a 'requisite' Model (Phillips, 1984), and for the constructive management of the dynamics within the workshop group. He/she become a facilitator of the group's work.

Although these methods may also be used by individuals, PSMs realized their potentials most fully in use with groups in workshop format. Indeed PSMs have been called 'wide-band group decision support systems', where 'wide-band' indicates their ability to handle problems that have not been pro-formulated and may have quite diverse structure (Eden, 1995).

Practices of PSMs (the combination of individual and group) have shown their advantages. (e.g. Ackermann, Eden & Williams, 1997; Friend, 1994; Checkland & Scholes, 1991; Thunhurst et al., 1992; Ormerod, 1996)

However, PSMs do not indicate of group composition. Although they require awareness of categorization of knowledge of the group, they do not have relevant details for different sectors. They also haven't given great attention of how the facilitator shall frame the questions, design the model and present the information. They fully depend on the quality of facilitator. For example, cognitive mapping in

SODA, the way the facilitator designs the model, breaks down the tasks, frames the questions directly affects the quality of the output.

Also when facilitating a group, the behaviours and dynamics in group activities are also important. Tuckman (1984) desicribed four stages for group activites: Forming, Norming, Storming and Performing.

What techniques do we need when facing group working?

2.6 Group Structuring Techniques

- Group Techniques -

A variety of solutions to the problems associated with interacting groups have been proposed, ranging form simply providing groups with guidelines for behaviour, to the specification of a number of techniques (e.g. Eils & John, 1980) A number of studies have obtained similar results showing the advantage of instructed groups over naturally interacting ones (e.g. Hall & William, 1970; Hall & Watson, 1971; Nemiroff & King, 1975)

There are also a number authors, for example Belbin (1993), having concerned with identifying good practice and developing strategies to implement such practice in organisational groups and teams.

The bulk of research in the area of improving group performance has focused on the development, application and assessment of a number of structured group techniques.

The nominal group technique (NGT, also known as the “estimate-talk-estimate” procedure) (Delbecq & Van de Ven, 1971) is one of such technique. This idea behind NGT is that, while interaction among group members may prove dysfunctional during the generation phase of problem solving, verbal interaction during the assessment or evaluation phase may be valuable in allowing the clarification and justification of generated items, leading to improved judgement and decision making.

Studies have also reported NGT to perform fairly well in comparison with a variety of alternative techniques, although accuracy improvements have been small (e.g. Fischer, 1981)

A similar technique, variously called the "estimate-feedback-talk" or " consensus after majority vote" procedure (e.g. Holloman & Hendrick, 1972; Miner, 1984), differs from the NGT only in allowing the final group judgement to consensually derived rather than based on mathematical aggregation. A number of studies have found that group using this procedure have significantly outperformed conventionally interacting groups (e.g. Holloman & Hendrick, 1972; Miner, 1984; Herbert & Yost, 1979).

The Delphi technique (Dalkey & Helmer, 1963) is perhaps the most formalized and studied of the structured group approach. Four necessary features characterize a Delphi procedure, viz. anonymity (achieve through questionnaires), iteration (refine opinions for several round), controlled feedback and the statistical aggregation of group response.

There has been some controversy concerning what the Delphi technique is all about, with a number of authors arguing about the appropriate benchmarks for the evaluation of the technique and indeed, whether it is desirable or even possible to evaluate Delphi effectiveness. (e.g. Linstone & Turoff, 1975; Coates, 1975). These concerns have been examined by comparing Delphi with other structured group techniques. It is not going to be repeated here.

- Group Decision Support Systems -

The idea of extending Delphi beyond a paper-and-pencil questionnaire based technique through the use of computer technology has been around for some time (e.g. Hiltz & Turoff, 1978). These developed techniques have been generically referred to as Group Decision Support System (GDSS). For example, Decision Conferencing is one of the approach to support the meeting by using of computers (Reagan-Cirincione & Rohrbaugh, 1992).

Chapanis, Frick & Williams (1951) studied that humans are better at: Perceiving patterns; Improvising and using flexible procedures; Recalling relevant facts at the appropriate time; Reasoning inductively; and Exercising judgement. And Computers

are better at: Responding quickly to control tasks; Repetitive and routine tasks; Reasoning deductively; and Handling many complex tasks simultaneously.

Thus, computer based GDSSs have also been designed to deal with process losses, such as air-time fragmentation, conformance pressure, etc. (Benbasat & Lim, 1996)

Group Decision support systems (GDSS) Process Gain (Turban et al, 2005)

GDSS technology: 1. in a special-purpose decision room, 2 at a multiple-use facility, and 3 as web-based groupware with client running wherever the group members are.

- Support parallel processing of information and idea generation
- Enables the participation of larger groups with more complete information, knowledge, and skills
- Permits the group use structured and unstructured techniques and methods
- Offers rapid, easy access to external information
- Allows parallel computer discussions
- Help participants frame the big picture
- Anonymity allows shy people to contribute to meeting
- Anonymity helps prevent aggressive individuals from driving the meeting
- Provides for multiple ways to participate in instant, anonymous voting
- Provides structure for the planning process to keep group on track
- Enable several users to interact simultaneously
- Records all information presented at the meeting

Figure 7. GDSS Process Gain.

As above, GDSSs were designed to enhance participation and encourage group member interaction primarily through the electronic channel of computer keyboards and monitors in an effort to reduce communication problems. (Nunamaker et al, 1991).

Despite the documented success of GDSS with creativity of tasks (sometimes termed "brainstorming", "idea generation" tasks) that require divergent thinking in groups, there is little evidence to suggest that any group process intervention has enabled

group to converge on solutions to judgement tasks that are as accurate as estimates provided by their capable members working alone (Gallupe, 1990).

As the literature shows, individual decision analytical tools and group techniques have been used to combat problems on both cognitive processes and interaction processes. The research will be continuous focusing on improving the accuracy of estimation by tackling the problems associated with “process loss”.

3.0 Locating Missing U.S. Submarine "Scorpion"

- A Case Study for the real world is used to examine the theory from the literature.

3.1 Background (Sontag & Drew, 2000; Surowiecki, 2004)

Date: May 27, 1968

Incident: USS Scorpion (SSN-589) Submarine was missing. It is a 3,500 tone, 252 foot long nuclear attack submarine with 99 crews due back in Norfolk, Virginia, USA.

Mission/task: To locate the missing submarine.

Challenge: Although the navy knew the submarine's last reported location, it had no idea what had happened to the Scorpion, and only the vaguest sense of how far it might have travelled after it had last made radio contact. As a result, the area where the navy began searching for the Scorpion was a circle twenty miles wide and many thousands feet deep.

3.2 Estimation Making Processes

Mission was first of all handled by a crowd of captains, admirals and other officers in controlled pandemonium of the war room surrounded by top ranking military man. One man started scrutinizing a huge wall char mapping Scorpion's assigned track, but the group was intimidated by the top ranking officers and dared not to talk. Hence, **the hierarchy setting for face-to-face estimation making was bad. This also proved evidence of some for the judgemental barriers causing "process loss" mentioned in previous sections.**

Also, no one in the group had knowledge or experience in locating a loss submarine. So a first solution would be to track down three or four top experts on submarines and ocean currents, asking them where they thought the Scorpion was. **So relative knowledge is important, but is the diversity of knowledge is also vital in group composition?**

John Craven (JC): Navy's top deep water scientist, who had similar successful experience in using "Halibut"(a special operation submarine) to retrieve Soviet

missile pieces from deep sea water had joined team and assign for the leadership of the task (as a manager). He then used a different approach to assemble and facilitated the group.

- Breakdown the task -

JC breaks down the task into

- Prediction of possible events that could make the submarine sink (e.g. other soviet submarine attack, internal explosion, etc.).
    - **a.** What caused it?
    - **b.** What information can prove the judgement (obtain the background logic and avoid subjective opinions)?

Once the cause was identified,

- Estimation on submarine's speed, direction and steepness of its descent.

The reason for breaking down the task was to form an estimation model in order to absorb different information and locate relevant recourses. Who would have the information affects who would be in the team.

- Group Composition -

The task was open to any information from any discipline. The way JC handled new information confirmed the fundamental idea of Bayes' Theroem which was introduced in the literature review. The team knowledge and experience covered by deep water experts, a former electrician on the submarine, experts from ocean graphic laboratory, submarine experts, acoustic experts, a submarine captain, computer simulation experts, salvage man, torpedo experts and mathematicians. As you can see, no person could tell JC where the submarine was, but by inputting their prediction/estimation into the model formed by breaking down the task. JC could build a composite picture of how Scorpion sunk.

- Making Estimations -

Individual

What caused of the submarine to sink was the key issue in the estimation. Most military experts thought it was due to the soviet submarine's attack. This idea showed an anchoring bias within people's judgement. It was the cold war period, so it was

more likely to be attacked. This bias has been avoided by looking into more details of Scorpion's travel route and the background of mission. It showed there was no chance for such attack.

JC proposed his idea that the submarine had made an 180 degree turn in direction due to a torpedo failure called "hot run". Although experts and submarine captains confirmed that the only reason for a submarine to turn 180 degree is the "hot run", no one wanted to reach this conclusion even by consensus. Reasons could vary (e.g. Political). So JC created a similar scenario, simulated by computer and using a participant, who was a submarine captain. In this way, he successfully recreated the whole scenario and proved his prediction.

Group

During the final estimation on speed, direction and steepness of descent, JC used an interaction group with a good diversity of knowledge and simple voting techniques. He supplied questions with a range of choices (e.g. what speed could Scorpion glide down to the ocean bottom, between 30 and 60 knots? The group of submarine experts and salvage experts estimated it could glide downward at between 40 and 50 knots). To make things interesting, the estimates were in the form of wagers, with bottle of Chivas Regal as a prize. More importantly, turning the estimations making into making bets, meant that people would be cautious to change (this caused by motivation of wining) which would reduce influences on each other.

Facilitation

As the owner and facilitator of this team, JC didn't easily buy-in by anyone's opinion, even his own. He kept himself open to other alternatives and new information. Most importantly, he used a "cold" analytical process to drive the group work.

Final Estimation

JC finally took all the estimates and used Bayes' Theroem to estimate the Scorpion's final location. In other words, not one of the members of the group had a picture in his head that matched the one JC had constructed using the information gathered from all of them. It was also a very accurate estimate. Five months after the Scorpion

disappeared, a navy ship found it. It was 220 yards from where JC's group had estimated it would be.

3.3 Summary and Discussion

The case presented illustrates the structure of a good practice example where the theories in the literature have been applied unconsciously.

John Craven used decision modelling, group techniques and awareness of problems in human judgements. He also structured a cold analytical process through the whole group activities in order to improve the accuracy of group judgement.

Lots of the estimation making processes or new information has been seen as driven by opportunities, because of the novel structure of the case study. But in real life we should not be driven by opportunities, we should prepare for the opportunities. The next section develops an overall framework for managers to use in making estimations.

4.0 BT Somerset Joint Venture Shared Service Bid

Declaimer: Some of the information contained in this section or any of its appendices may be privileged or confidential and is intended for the exclusive use of the addressee. Any unauthorised reference or use may be unlawful.

4.1 Background

Organisation: BT plc. – Local Government & Shared Services; Somerset County Council.

Background:

In order to develop more business opportunities with local governments, Glenn Miller was asked by the head of BT Local Government Sector to look into potential solutions/opportunities in the Shared Service Sector.

At mean while, one opportunity turned out that BT would be bidding for Somerset County Council joint venture in May. Shared Service could be one of the best solutions to win the bid.

The Bid Challenges:

- 42 companies attended the supplier briefing
- Main players are seen as Capita, IBM and Cap Gemini, (lesser IBM & Fujitsu)
- Opportunity placed at being £35m pa operational budget ~£350m to £500m over 10 to 15 years

A group was then formed with people from these two sectors (Local Government & Shared Service). They were responsible for transformation of a number of services (e.g. Public Access, Finance, Revenues and Benefits, ICT, HR Payrolls, etc.) provided by the council into new joint venture company to re-provide these services. (see Chart 1.)

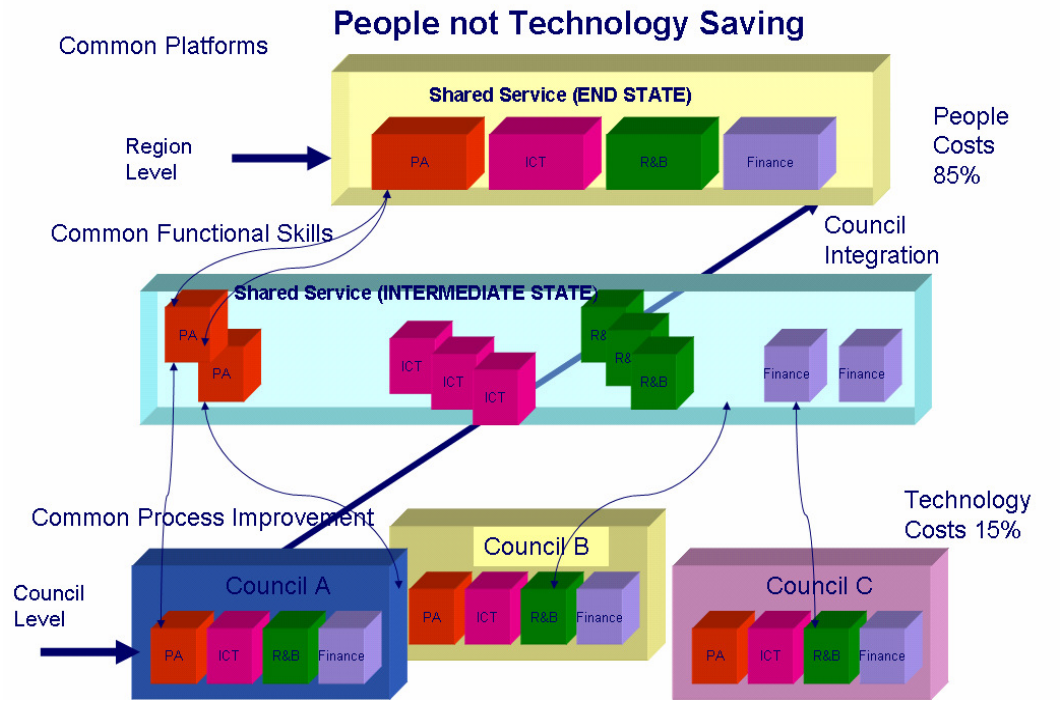

Chart 1. Shared Service Business Model

I was observing on the first stage of their work, the scopes were

1. To support the bid team to win the Somerset County Council Joint Venture Shared Services bid at the end of April.
2. Build potential solution in order to present in front of BT senior management team by the end of April (Business Case Level).

Team Member and Knowledge Diversity (defined by function roles):

- Steve Hart (SH) – Senior Deal Architect
- Glenn Miller (GM) – Senior Deal Architect (Project Manager)
- Don Cleeve (DC) – Finance (Potential Benefit, Business Scenarios)
- Tony Chaplin (TC) – Business Architect
- Sima Mistry (SM) – Similar Area as DC
- Ann Liu (AL) – HR platform expert (Platform Implementation and Transaction)
- Sean McGettrick (SMcG) – Programme Manager (Project Planning)
- Dave Wilson (DW) – Shared Services (ICT)
- Richard Piatek (RP) – Network Technologies Expert
- Vince Huntley (VH) – Transformation expert (Worked in the similar project in Suffolk)

The Group Challenges:

1. Business wise, to satisfy both Somerset CC and BT (Potential investment by BT would be 30-50 million pounds).
2. Short time scale.
3. Huge uncertainties involved in the solution.
4. Most team members never worked together.

4.2 Estimation Making Processes

The early stage of the project contained large varieties of estimations, predictions and modelling tasks, for example, estimations of investment cost of each service unit, predictions of the size, population, number of shared service centre, districts and people to be served, etc. But these estimations could not be made until the potential overall solution was built.

Thus, this estimation making processes started with overall model formalisation.

- Overall Model -

The overall models (see Chart 1, 2, 3, 4 & 5) were built based on pervious experience in Suffolk County Council. Somehow this model was not proved to be correct or successful because the Suffolk project was still under going.

The purposes of them were to create the possible solutions to answer possible problems could happen in the future. It also encouraged the group members to use their functional expertise address certain potential problems.

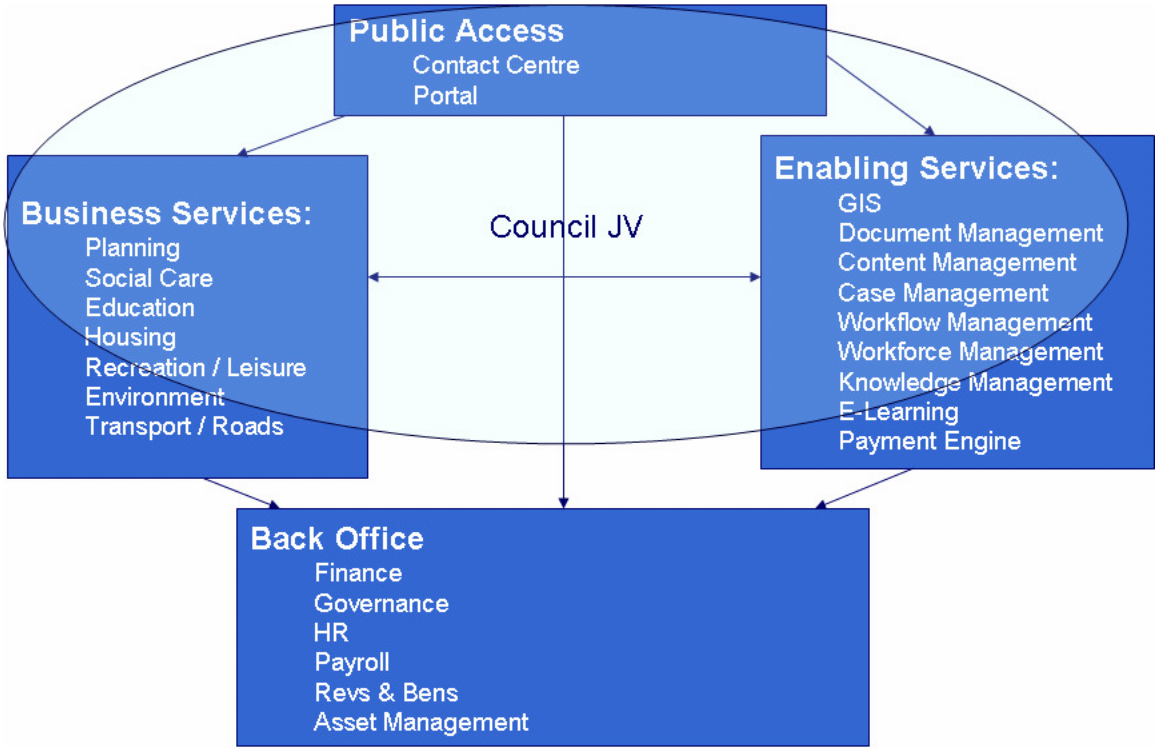

Chart 2. Concept – Stage 1 Transformation

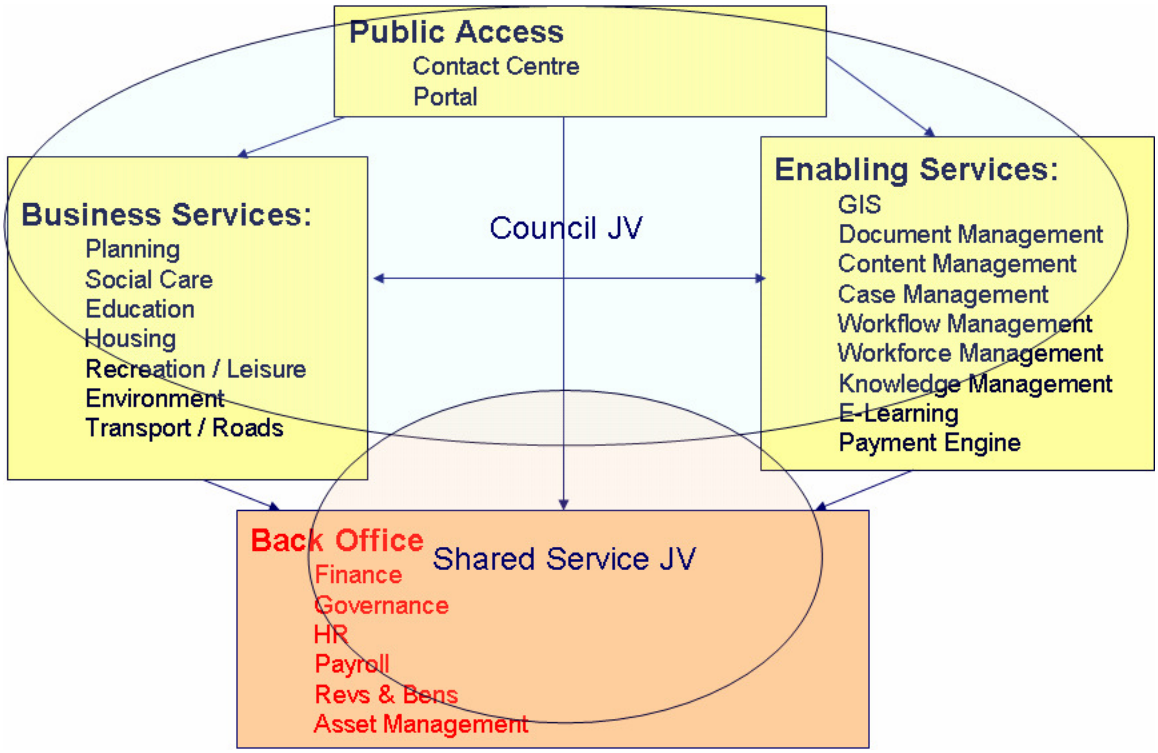

Chart 3. Concept – Stage 2 Transformation

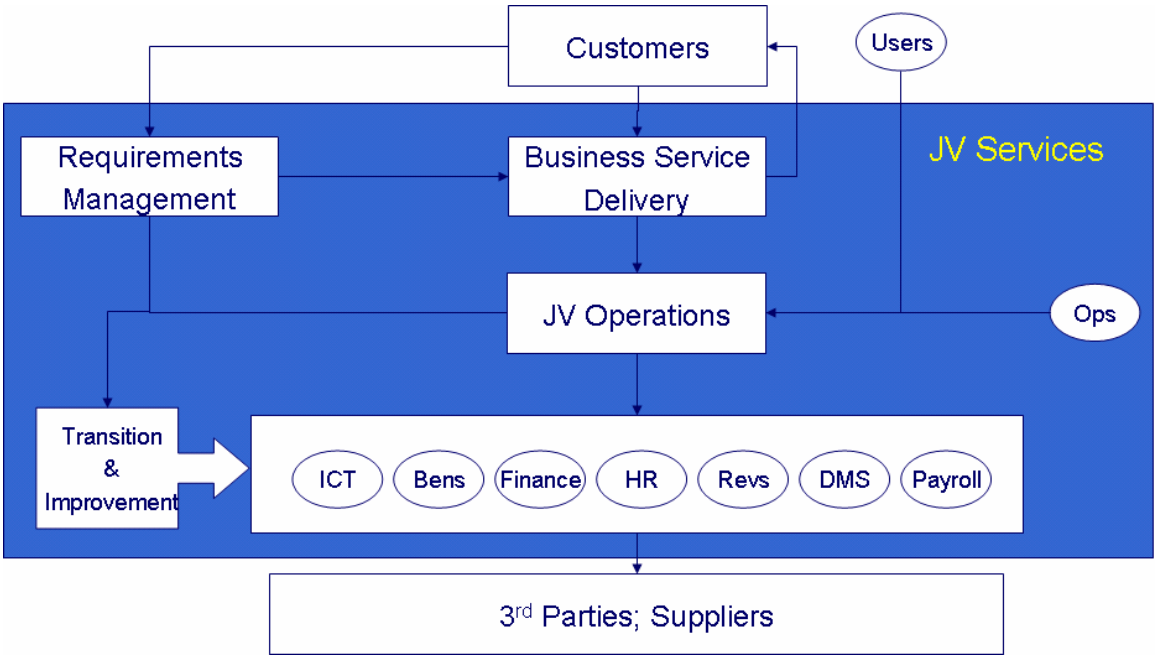

Chart 4. Outline Business Model

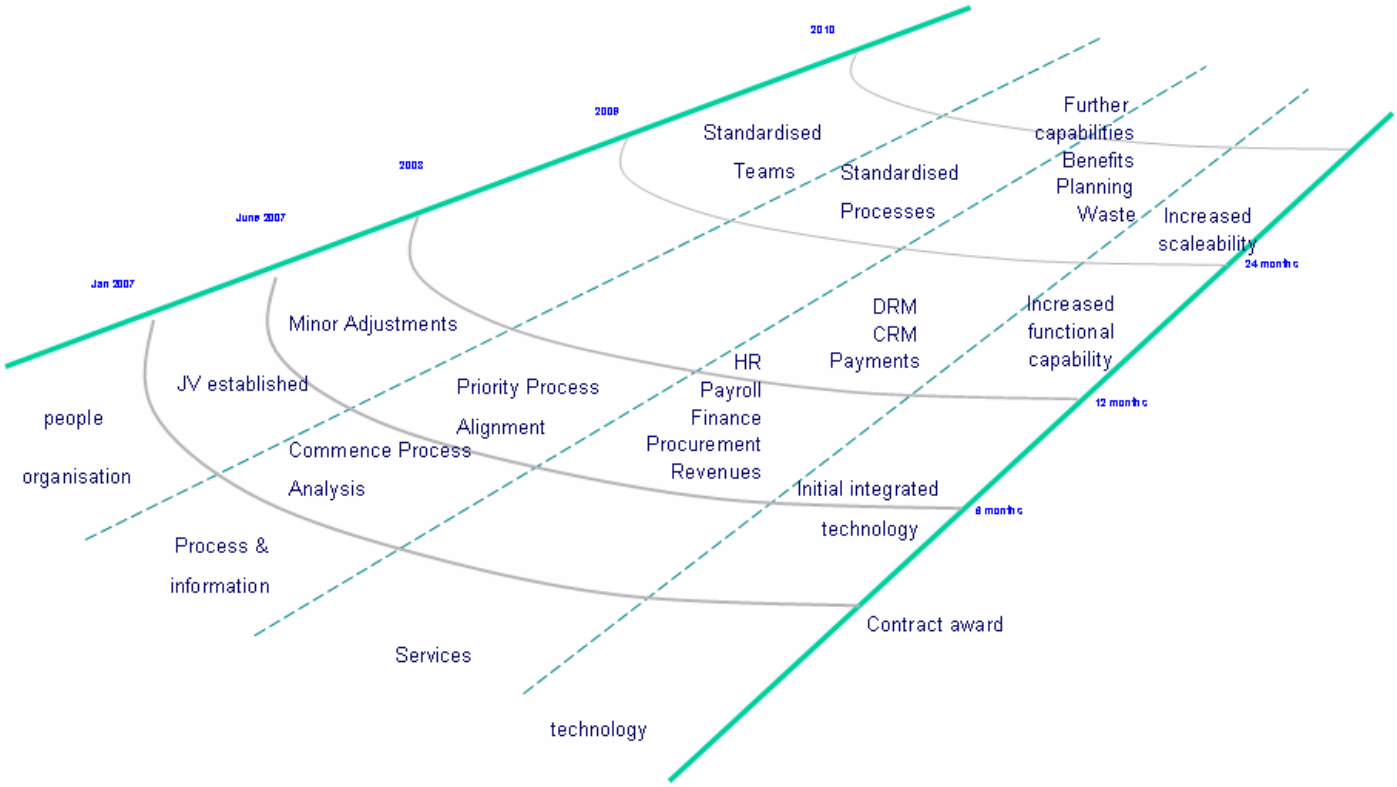

Chart 5. Overall Timeline

- Breakdown the task -

The overall models were then breaking down into different processes. (see Chart 6 & 7)

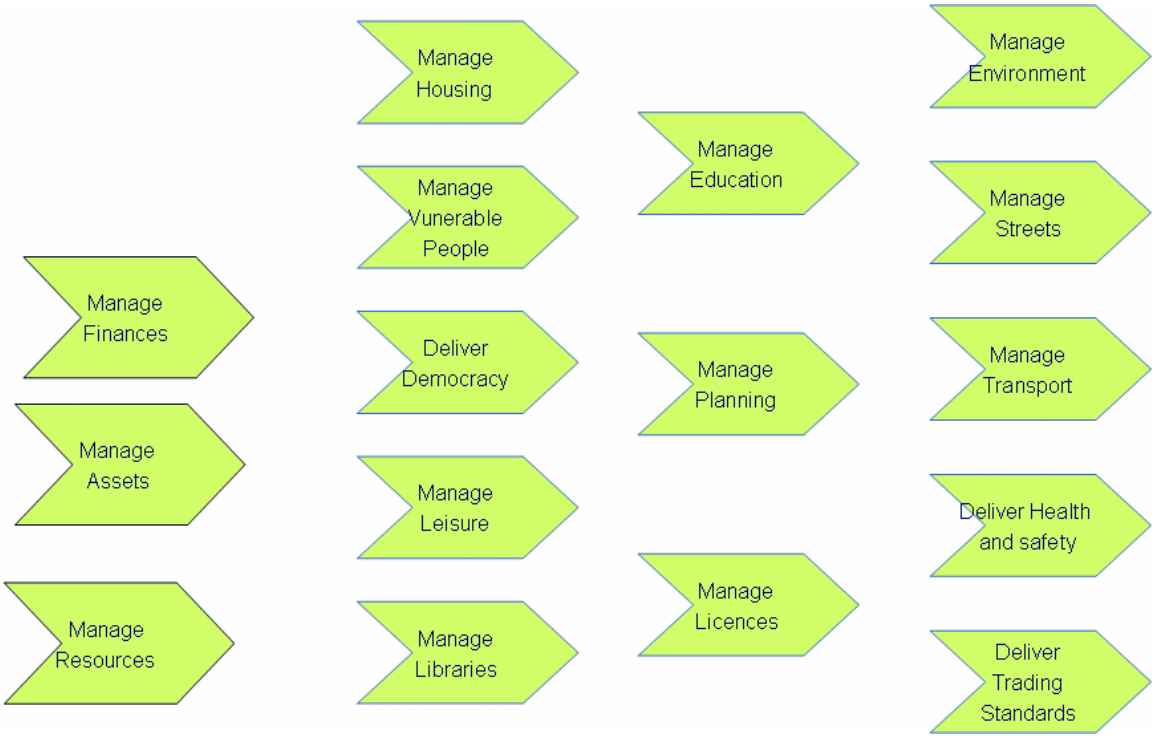

Chart 6. Process Overview

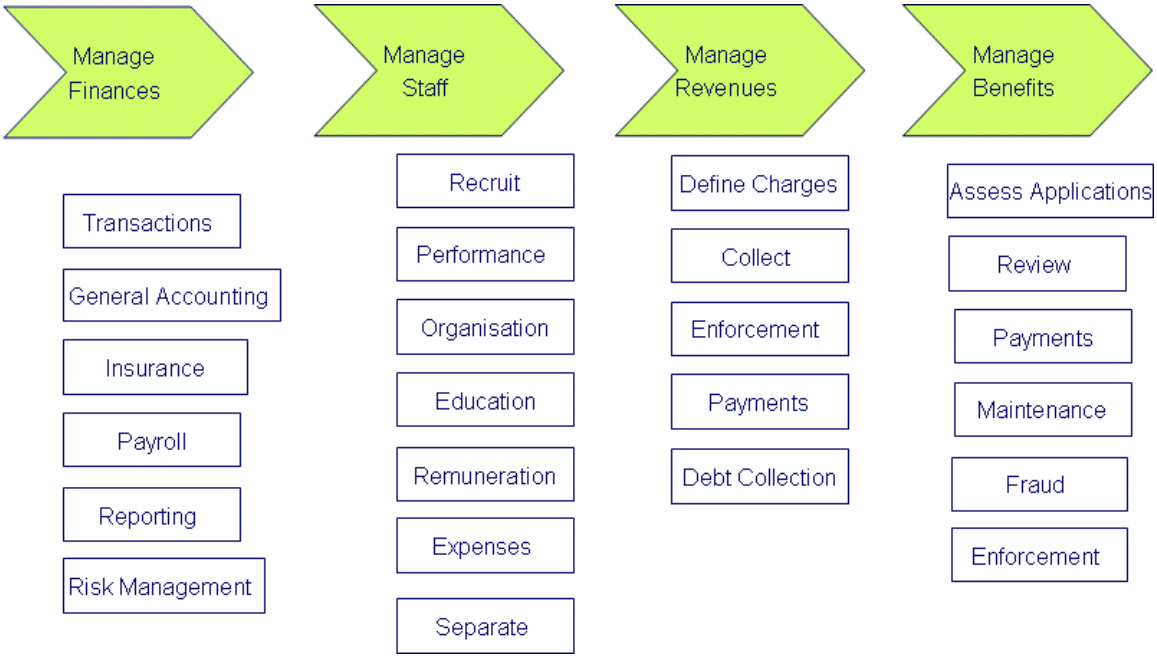

Chart 7. Secondary Level Processes

These secondary level processes were again breaking down into primary supported processes, for example, the finance transactions were breakdown into "Manage

Accounts Payable, Manage Expenses, Manage Accounts Receivable, Manage credit and collections, Manage Payroll."

By breaking down the overall model, the group members were not only familiar with Somerset County Council's current processes, but also able to identify the input for the estimations (e.g. how many staff should work in each section of the service centre, what grade of staff would be needed) (see Appendix D).

- Group Composition -

The initial group members were put together from two different functional sectors: Local Government and Shared Services. It purely developed from functional roles (as people's knowledge diversity pre-defined by their function role in the organisation) and pulled out from organisational charts.

As the progressing of the project, new knowledge and expertise were needed. The normal way to recruit new group members in BT was based on: who do you know, who are interested in the task and who are available? Another way to locate the resource was via BT Human Resources Pool, but that would be a choice in 35,000 people.

It was also found in early developing stage, the group members who did the modelling, estimations and solutions would be the only people who understand the solution and other details. Thus the rationale for group recruiting and composition was also involved the elements of growth, which meant that part of the team would continue to stay and implement the solution.

- Making Estimations -

Individual

Each group member took up the ownership of some estimations in his/her expertise areas. These estimations would be presented and agreed by other members in the group.

Group

The main group activities were Group Review Meeting (every two weeks), Friday Conference Call (Weekly) and Focus Group for Estimations.

From observation (example See Appendix E), there were process gain and process losses (both in interaction and cognitive).

Major process losses was summarized,

- Group members used different terminologies for same object which caused misunderstanding.
- Meetings were long and not well organised.
- In conference calls, the mis-usage of the IT facilitation caused delay.
- Group member had different methods for estimating his/her own responsible areas which caused difficulties in inputting into overall estimation model.
- Group members too much concentrated on his/her own areas which created boundaries of thinking and estimates could be over-confident.
- The lack of communications caused by the involvement of two functional sectors boundaries in data flow.

Although, there were action points agreed and documented after each meeting, the next meeting were almost sure to spend a long time to re-negotiate the previous agreements again. This caused relatively low efficiency of the group working.

Facilitation

These process losses were mainly caused by lack of facilitation in the group.

There was small amount facilitation work, mainly based on administration side (arrange meetings, setting timetables, making sure work delivered on time, etc.) There were lack of facilitation on group communications, meeting activities and group thinking.

The group members were not dedicated to the project. Most of them had his/her other daily assignments and objectives need to be achieved. This was another reason caused low group performance.

4.3 Summary and Discussion

A broad view of estimation was drew from this field study, the true estimation processes started right from breaking down the task and ended in group consensus. It would be not enough to be only aware of the processes to gain final outcomes. The qualities of breaking down task, group composition, group facilitation were all matters to secure the accuracy of final estimations.

It was also a good study on group behaviour. People should not be boxed in his/her functional roles, but open to other alternatives.

The facilitation of the group should not only concentrate on the professional looking of the process, but also pay more attention on group interaction and thinking issues in order to gain better estimations.

5.0 Development of Overall Framework and Guidelines

5.1 Overall Framework

Based on the review of literature and analysis of the case study and field study, an overall framework in the form of flow chart, has been developed to facilitate managers to achieve better estimation for input into predefine decision making models. (see Figure 8.) This model emphasizes the need for someone (e.g. manager him/herself) as facilitator to take ownership of the estimation task and provide analytical processes on the back stage of the whole estimation activity.

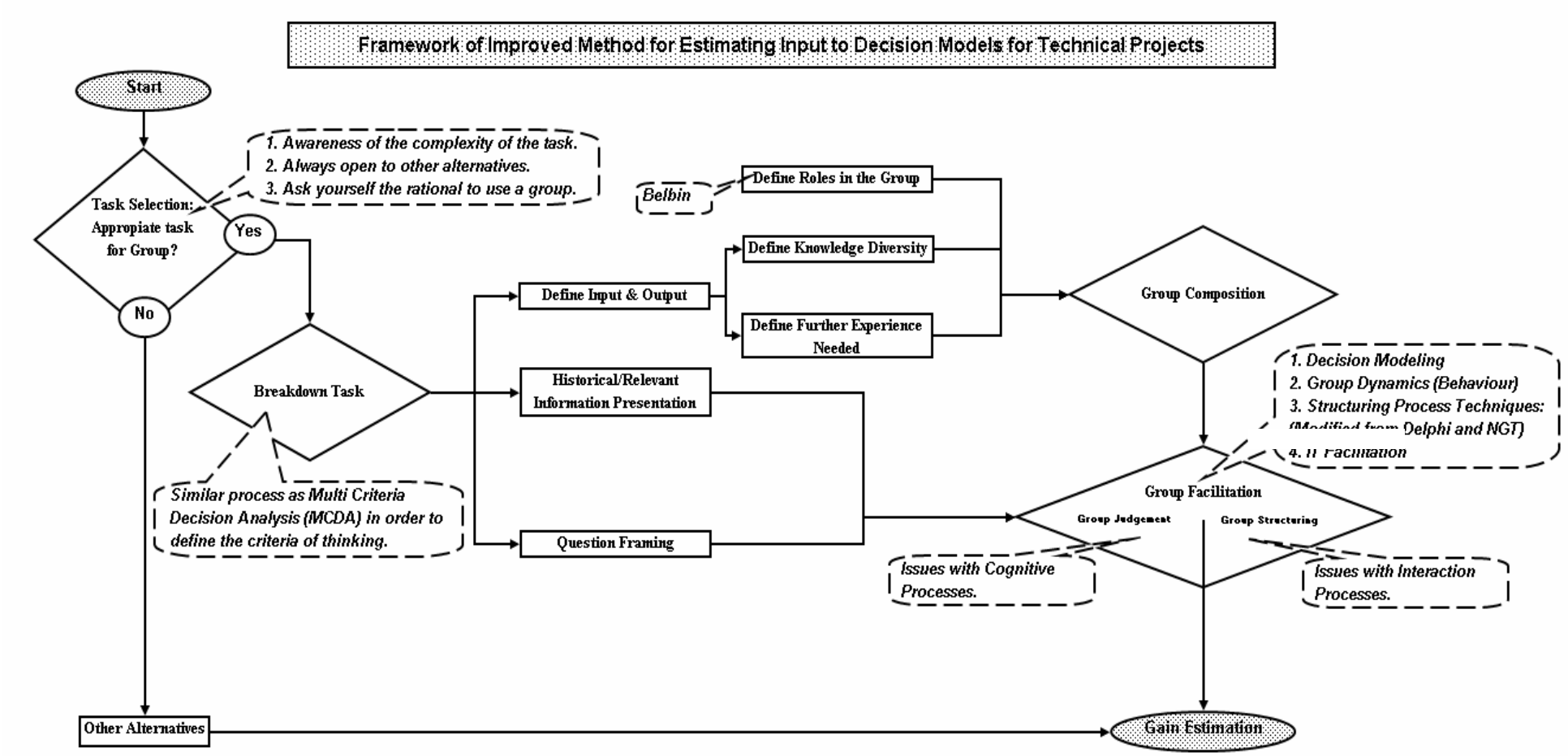

Figure 8. Overall Framework

5.1.1 Whole Flow of the overall Framework

This overall framework suggests that estimation process will be facilitate by a manager and start at "task selection". Task selection defines and structures in the most appropriate way for groups estimations. The facilitator needs to ask three questions, what level of complexity is this task, is there any better way than putting a group together, what is the rationale to use a group? This can be built up by thinking why better to use a group ("process gain") versus what can go wrong when using a group ("process loss"). For example, Kahneman & Tversky used a group to estimate Turkey's Population and explained the availability biases. The argument is why use a group to gain this kind of estimate, there are other alternatives which will be much better (e.g. UN's Report, Internet Search, etc.). Another example is that there is no point to gathering large group of people to gain estimate of the Temperature on Mars, as only small amount of experts will have expertise on such a question.

Once the task has been identified, the framework moves onto "breakdown task". This process is similar to model building processes. The model can be based on Bayes' Theroem, decision tree, Multi Criteria Decision Making, problem structuring techniques, etc. You must aim to build a systematic approach in order to lead to your final estimation. For example, the task on estimating the market size for a certain technology. It can be a breakdown based on the new product lifecycle, which is known as the "S" curve. The task can now breakdown into: how many people will be the first adopters (at the front of the product lifecycle), how many people will then be influenced (when technology has reasonable amount of market share), and how many people will buy it only when the technology getting really mature (end of the lifecycle). Even lower scales of input to the model can be identified, for instance, product type, similar products' data, marketing investment, technology usage, frequency of technology upgrades, etc. As we can see the outcome from the process will be the definition of input and output (final estimation) of the model, looking for historical/relevant information might be available (this should be presented carefully, in case creates heuristic and leads to availability or recency biases), and framing of the questions to gain the inputs.

From the input and output of the model, the facilitator will then have some ideas of locating the resources (who will be in the group), based on the diversity of knowledge and experience of the people. Together with their knowledge of the people (their characteristic; e.g. Belbin's team roles: shaper, investigator, plant, chairman, etc)
, they will then form the group. This is known as "group composition" process.

The reason that the manager should be aware of the characteristics of the potential group members is not only because it can affect the group behaviours, but also research shows that people who have strong characters (e.g. shaper or chairman) will rarely change their perceptions (Lockett & Naudé, 1995). In other words, they are not good at accepting new information and revising their estimation. On the other hand, people who have less strong characters will easily change their estimates under influence by others. This will affect the accuracy of final estimation, particular when you use interaction (face-to-face) group techniques.

Once you have built the group, the group estimation work should be facilitated. Again, by using decision modelling, by understanding the group behaviour, by structuring the group using group techniques, by adopt IT facilitations in order to eliminate cognitive processes (e.g. group judgement literatures - debiasing) and interaction processes (e.g. group structuring techniques) losses.

The holistic view of this framework is very important, as most people in the industrial will not recognize the value of the preparation work before the main estimation making activates. The pre-estimation processes of "task selection", "breakdown task" and "group composition" are often done unconsciously.

5.1.2 Facilitated Group Work Procedure

A group estimation procedure has been developed to support the framework based on "estimate-feedback-talk" or " consensus after majority vote" procedure (e.g. Holloman & Hendrick, 1972; Miner, 1984; Reagan-Cirincione, 1992) in order to give a closer look of how a manager as individual shall take a group step by step to gain estimations on each input of the overall model. (see Figure 9.)

Facilitated Group Work Procedure		
	Individual	
Research	Obtain objective evidence/information from (Marketing Research, Selected Statistic, Report, etc)	Facilitator and Individual Group Member
Estimate	Intuitively estimation (first estimation)	Individual Group Member
	Group	
Feedback	Display of reconciled estimation	Facilitator and Individual Group Member
Talk	Facilitated Group Discussion	Facilitator and Individual Group Member
Estimate	Facilitated specification of estimation; Facilitated holistic judgement	Facilitator and Individual Group Member
Feedback	Statistical aggregation and Display	Facilitator
Talk	Facilitated Group Discussion	Facilitator and Individual Group Member
Estimate	Facilitated specification of estimation; Facilitated holistic judgement	Facilitator and Individual Group Member
Feedback	Statistical aggregation and Display	Facilitator
Talk	Facilitated Group Discussion and final consensus of estimation	Facilitator and Individual Group Member

Figure 9. Facilitated Group Work Procedure

Research shows that this "estimate-feedback-talk" procedure incorporates good features for reducing both interaction processes and cognitive processes losses. (Reagan-Cirincione, 1994)

Improving interaction processes: A critical feature of this procedure is the presence of a facilitator (can be the manager who owns the project) who monitors the dynamic processes of group interaction. The function of the facilitator is to ensure that all group members are able to participate fully in the process and that the group session is not dominated by a minority of group members (Keltner, 1989). By assigning this role to a facilitator, group members are able to focus directly on substantive issues without wasting energy on group development tasks; in principle, no member is lost to role of process maintenance (Moore & Feldt, 1993).

Interaction processes are also supported through use of the decision model. Modelling improves interaction by providing common language that group members can use regardless of their substantive backgrounds, a framework that enables group members to create a shared social reality, and a set of task-relevant procedures that keeps the group attuned to workable agenda (Phillips, 1984). The model-building process provide a common bond that encourage teamwork and, ultimately, allows convergence a consensus judgement.

Improving cognitive processes: The facilitator supports cognitive processes in the group by providing a structure in which the group is encouraged to operate. In this role, the facilitator enables the group to match a complex modelling technique to a complex problem relative ease (Ackermann, 1990). The facilitator also attempts to improve rationality in judgement by eliciting explanations for differences in perspectives, reminding the group of task parameters as necessary, and identifying potential inconsistencies in judgement when appropriate (Eden, Jones & Sims, 1983). Without a facilitator as guide, the group may become lost in the complexity of their working environment – difficulty of the problem, the details of the model, or the features of the software (e.g. how to use the IT aids).

This new procedure has been divided into individual and group. The individual part emphasizes that individuals should bring his/her estimates in group with the research

on background logic. Individuals should be not only able to provide opinions, but also the evidences to support the opinions or estimates.

The group part of the procedure is made up of two loops using the "estimate-feedback-talk" procedure. The first loop is the learning loop and the second loop is the estimation loop. Finally, the group reaches consensus and draw the estimation. The first loop aims to settle and discuss all the information in the group, let all ideas spread. Then the second loop aims to reach final consensus.

- Why Making Consensus? -

There is a conflict on whether simply using statistic aggregations of all group members' estimates to gain final estimations or by group consensus.

The statistical approach eliminates the human interactions and takes the average of a collection of individual estimates. If one assumes that the individual estimate for a particular problem can be describe as a "truth plus error" model, the statistical approach might have decent accuracy because the random errors can be averaged out. Is it true that the larger the group is, the better the result will be?

In most real world scenarios, organisation will not always have the luxury to select a large group of random individuals to gain their estimations.

Also from the literature, unfortunately, the individual estimate is more likely to be a "bias plus error" model (Rowe, 1998). The statistic method can not eliminate the flaw in human judgements.

The best way to debias within a group is over facilitated debates or negotiations and then reaches the consensus.

Other benefits of group consensus will be: 1. Obtaining more supports from group members; 2. Every group member understand and follow the agreed direction if there are further estimations need to be made.

5.2 Guidelines

Guidelines have been formed in the concept of "Best Practice", "Problem to Avoid", "Why it happened?" and relevant "References" for each process in the overall framework. So it identifies potential problems at each stage to improve awareness for facilitators/managers. (see Figure 10)

Task Selection			
Best Practice	**Problem to Avoid**	**Why it happened?**	**Reference**
First of all, always looking for the best alternative. For example, estimating "Turkey's population" (example used in (Kahneman, Slovic & Tversky, 1982)) , best way is using the census from UN's database, NOT a Group.	Thinking that "With many good minds working together, an excellent decision will surely emerge."	Biases caused by various reasons: successful experience with group before; feel confortable to share resposibilities with others; lack of knowledge in the area, etc.	McGrath, 1984
Awareness of the processes towards the top goal/objective. What is the information yon really needed from a group? Only select the task which can add value to the whole project.	More information give the better estimate/decision.	More choice or information may create more status quo.	Etzioni, 1989
Looking at problems that focus on the most important aspects of the questions and allow other aspects appropriate attention.	Frame Blindness - Setting out to solve the wrong problem because you have created a mental framework for you decision, with little thought, that causes you to overlook the best options or lose sight of important objectives.	Represetativeness Heuristics.	Russo & Schoemaker, 1989; Kahneman, Slovic & Tversky, 1982
Breakdown Task			
Best Practice	**Problem to Avoid**	**Why it happened?**	**Reference**
Open the boundaries when you frame the decision/estimating tasks. Before you breakdown the task, try to draw a whole picture, especially aware the "Unknown" areas.	For example, top managers of a certain department in an organisation often view the problem from his own expertise.	Typical experts' biases caused by heuristics.	Kahneman, Slovic & Tversky, 1982
Awareness of the accuracy and relevance of the task to the scope/goal. They must be checked and examined.	We can distinguish between useful and irrelevant information.	Effect of Anchors - Using first impression to judge the information. And the judgement is often wrong. Irrelevant information can be the cause of reducing the accuracy of decision making.	Ayton, 1992
Realize the cycles exist and that not all ups or downs are permanent. Consider the fundamental factors that affect the event of interest not most recently.	The most recent events dominate those in the less recent past, which are downgraded or ignored.	Recency Bias	Makridakis & Gaba, 1998
Group Composition			
Best Practice	**Problem to Avoid**	**Why it happened?**	**Reference**
Awareness of the diversity of Information. Making sure they are not redundant (that is come for the similar sources); Make sure appropriate knowledge diversity of the group.	The more information we have, the more accurate the decision.	Overconfidence - The amount of information does not improve the accuracy of decisions, instead it increases our confidence that our decision will be correct.	Browne & Curley, 1998
Ask people with different backgrounds and experience to independently suggest solutions.	People tend to see problems in term of their own background and experience.	Selective Perception Bias	Makridakis & Gaba, 1998
Collect disconfirming evidence. Have someone play devil's advocate.	People search for and remember information is in accord with their beliefs and opinions.	Searching for supportive evidence.	Makridakis & Gaba, 1998

Group Facilitation			
Best Practice	**Problem to Avoid**	**Why it happened?**	**Reference**
Provide assessment of the probability of success by a third objective, party. Provide facilitation of group working.	Assuming that with many smart people involved, good choices will follow automatically, and therefore failing to manage the group decision/estimate-making process.	Process loss.	Hoffman, 1965; Russo & Schoemaker, 1989
Formalize the decision making process, create decision-making rules to be followed.	Inability to apply the same decision criteria in similar situation.	Inconsistency Bias	Makridakis & Gaba, 1998
Monitor for changes in the environment and build procedures to take actions when such changes are identified.	Failure to change or change slowly.	Conservatism Bias	Makridakis & Gaba, 1998
Present complete information. Present information in a way that point out all sides of the situation being considered.	Reliance upon specific events easily recalled from memory, to the exclusion of other pertinent information.	Availability Bias caused by availability and representativeness heuristics.	Kahneman, Slovic & Tversky, 1982
Start with objective information (e.g. forecasts) Ask people the types of changes that are possible, also ask for reasons when changes are being proposed.	Predictions are unduly influenced by initial information which is given more weight in the estimating process.	Anchoring Bias	Kahneman, Slovic & Tversky, 1982
Weight equally the information provided by various people/sources.	The more confident we are about the correctness of our decision, the more accurate our decision will be.	Miswighting/ "Shout Loud" issues - There is no relationship between how confident or more experienced someone is and how accurate his/her decision is.	Steiner, 1972
Introduce objective procedures to end a project, even if large investments have been made, when the chances of success become small.	We often think we can decide rationally when it is time to quit.	Sunk of Cost - We feel we have invested too much to quit.	Hammond et. Al, 1998
Verify statistical significance of patterns. Model relationships, if possible, in terms of changes.	Belief that patterns are evident and two variables are usually related when they are not.	Illusory Correlation Bias	Shearer, 1994
Do not punish mistakes, instead encourage people to accept their mistakes and make them public so they and others can learn to avoid similar mistakes in the future. (This is how Japanese companies deal with mistakes)	Success is attribute to one's skills while failure to bad luck, or someone else's error. This inhibits learning as it does not allow recognition of one's mistake.	Attribution of success and failure./Losing face.	Hoffman, 1956
Estimate uncertainty objectively. Consider many possible future events by asking different people to come up with unpredictable situations/events.	Neglect the risk assessment.	Underestimating uncertainty.	Argyris, 1998
Looking at problems that focus on the most important aspects of the questions and allow other aspects appropriate attention.	Frame Blindness - Setting out to solve the wrong problem because you have created a mental framework for you decision, with little thought, that causes you to overlook the best options or lose sight of important objectives.	Represetativeness Heuristics.	Russo & Schoemaker, 1989; Kahneman, Slovic & Tversky, 1982
Awareness of the diversity of Information. Making sure they are not redundant (that is come for the similar sources)	The more information we have, the more accurate the decision.	Overconfidence - The amount of information does not improve the accuracy of decisions, instead it increases our confidence that our decision will be correct.	Browne & Curley, 1998
Be assertive and not fear of disagreement.	For the sake of consensus. Give up the opinion just for the sake of "move on" or "compromising"	Can not be bothered to argue, shy or fear of authority in the group.	Klein, 1963

Figure 10. Guidelines

5.3 Simplified Procedure of the Estimation Work with Short Time Scale

The framework and estimation procedure in the previous section have been develop for rather big, complex and long time scale estimation tasks. But in the real world, managers will sometime receive estimation tasks with short time scales.

Thus a simplified version of the framework and procedure has been developed in order to meet the requirements of busy managers with quick estimation tasks.

5.3.1 Simplified Framework

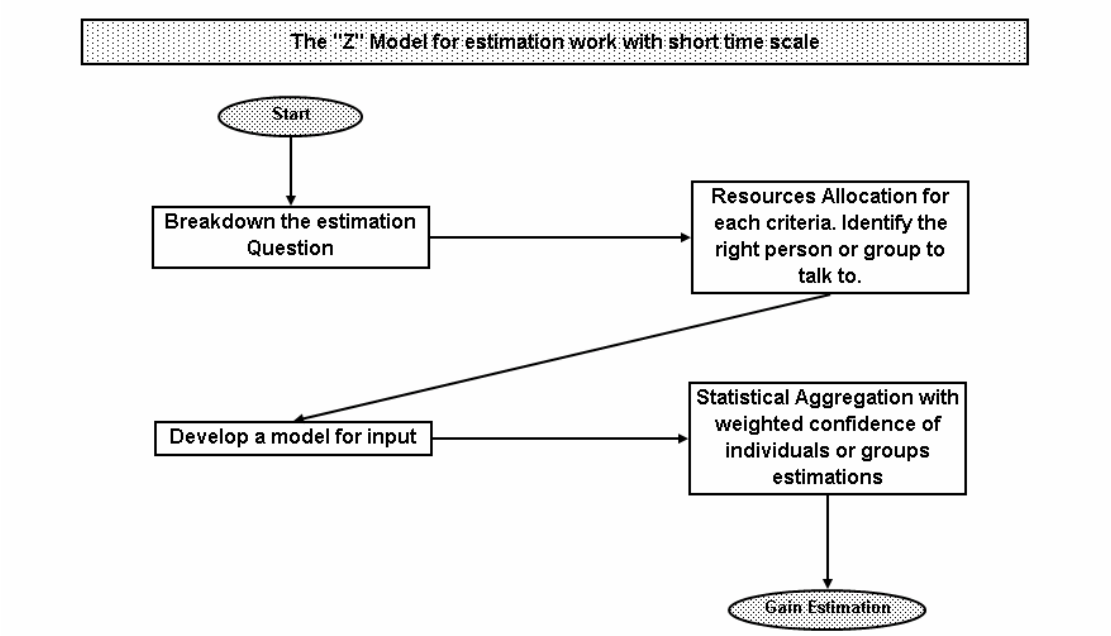

Figure 11. Simplified Framework ("Z" Model)

The simplified framework is the "Z" model because the shape of the framework. Since a task has been assigned, there is no task selection. Similarly, it starts on breaking down the estimation question in order to locate the resources. Resources location will be based on knowledge and experience needed. Then, a model shall be built based on the input you will gain from the individuals. Finally, use this model to gain the estimation statistically.

5.3.2 Procedures

A small size of focus group can be set up if time allows or the collection of estimations can be gain over conversation, or other forms of communications separately from the individuals.

The basic procedure will be based on Delphi techniques with some form of interaction between individuals. The survey will not only collect individuals' estimates, but also allow them to rank the confidence along the estimates. Because it normally takes longer for groups to reach consensus, here you may draw the estimation from statistical aggregation by using the collection of estimates applied different weights based on the confidence each person ranked.

6.0 Interviews

6.1 Interview Objective

These interviews' were taking in a "one-to-one" manner. It aimed to prove the applicability of the framework in real world scenarios and recommendations for modifications of the framework. As result, more empirical data has also been gathered for this research.

The recorded audio clips have also been attached with the paper.

6.2 Interview Outcomes

6.2.1 Applicability of the Framework

- Comprehensiveness –

The first half of the interview has been designed to go through a few generic questions by asking participants' experiences, lessons learnt in estimation making, issues related to individual judgements, the rationale to use a group and what is important in using a group to gain estimations.

So the participants could be aware of a framework was going to be reviewed at the end, but none of them knew any detail about the framework at first half of the interview. This design is to avoid leading the participants to a particular view or

passing on biases. So the justification and assessment of the framework will be fair and accurate.

The results have been satisfying. Every participant has proved that the framework has captured most information and processes which can be very useful in real world scenarios. The framework has also pointed out some processes which they have never practised in their work, but they think it will be value-adding if they start to look into these processes.

- Overall Value –

Most participants have also point out the overall value of the framework.

It is valuable is because that:

- it gives a broad view for the real world estimation
- it has captured information flow throughout the whole estimation making process
- it shows the awareness of human behaviours and methods can be used to avoid process loss
- it is a visible chart which can be easily followed step by step in real life
- it does not only teach people what to do, but also how to do it and why to do it

The participants have concluded in their own words:

"People might understand to use a project manager, locating resources, … for certain estimation purposes, but they don't how to think properly to do it. If you ask one person to explain how to tie his shoe lace, it is big, the alignment of eyes and hands, the co-ordination of bending, the twisting, the turning, to even turn it in the right way, … . It is a huge effort. None of us knows how we did it. The purpose of developing this framework is to fill this gap."

"I did a lot of things like this. It is only when you are talking about this from the framework, I begin to recognize that I have done this, this and this. It is a place that people can go into without thinking."

6.2.2 Selection of Interview Notes

- Frame the right question is vital for design business -

When design or develop a product or solution, people are always waiting for the customers or end users to tell them the requirements. It is wrong. The requirements shall be gain from carefully framed questions. The quality of these framed the questions is based how good objective or overall task is braked down.

- What to do if someone shout out loud -

1. Asking the person to give evidence to support his opinions or estimates;
2. By encouraging others to talk.

- Lessons Learnt -

Making sure you know the team. Here is an example from one of the participants:

He was asked to chair a focus group to predict whether the 3G or Local Wireless Network will be the future of the telecommunication sector. A group that full of experts was just not able to make consensus. At the end, he found that half of the group came from 3G network provider and another half were from local wireless network provider. So both the company had a ten years business plan for its own technology. Neither of the half would compromise to the other. He also explained how to use certain techniques to resolve this kind of situations. One technique was used called "Attractiveness and Fit Chart". (see Figure. 12, 13, 14 & 15)

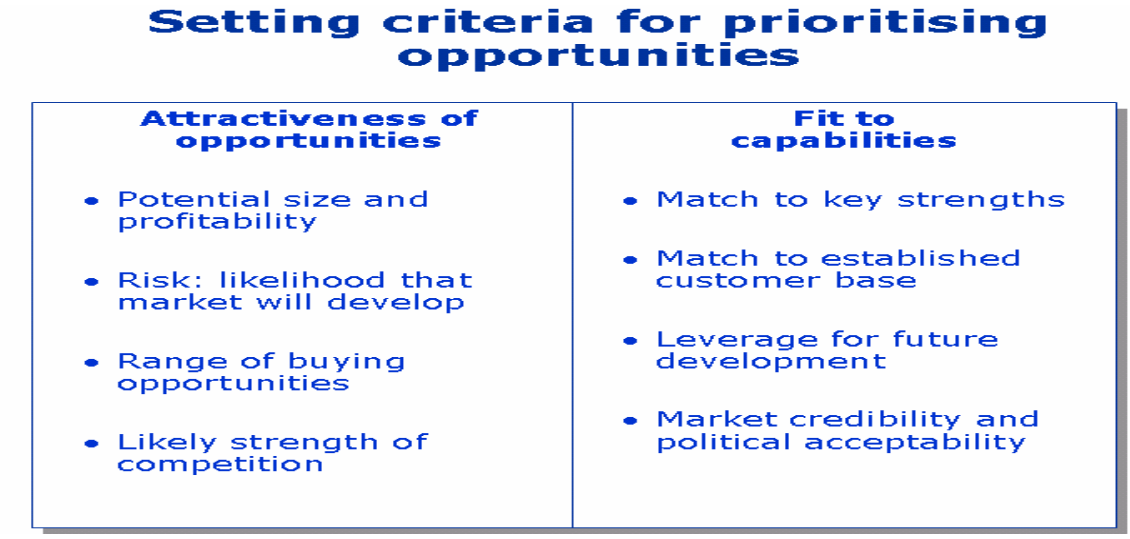

Figure 12. Attractiveness and Fit Chart 1

Defining the way that prioritisation criteria are to be applied to opportunity evaluation

Criteria	Weight	Low Score Characteristics	High Score Characteristics
Size and profitability	10	Niche, small value	Major value added market
Risk: Will the market develop	9	Market doesn't exist yet, very speculative opportunity	Market established
Range of buying opportunities	5	Very few potential buyers	Potential customers in a diverse variety of organisations
Likely strength of competition	5	Many direct competitors will become established	Few organisations will be qualified to compete
Match to key strengths	10	Does not require key strengths	Key strengths are the primary requirement
Match to established customer base	10	No presence in market, no synergy with existing markets	Will be required by most existing customers
Market credibility	8	No positioning in industry	Established positioning in key opportunity areas
Leverage for future development	8	Standalone opportunity, no identifiable linkages	Major development opportunities explicitly identified

Figure 13. Attractiveness and Fit Chart 2

There are a range of important applications you could target, in addition to your current focus

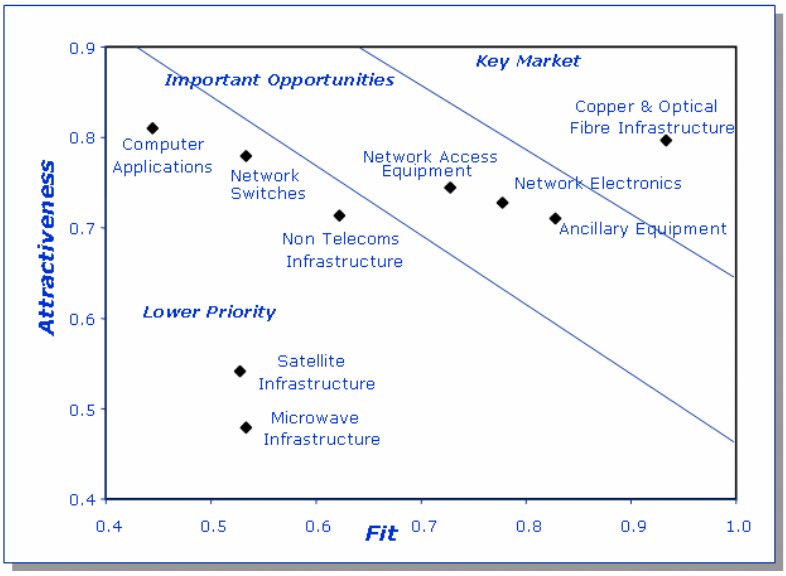

Figure 14. Attractiveness and Fit Chart 3

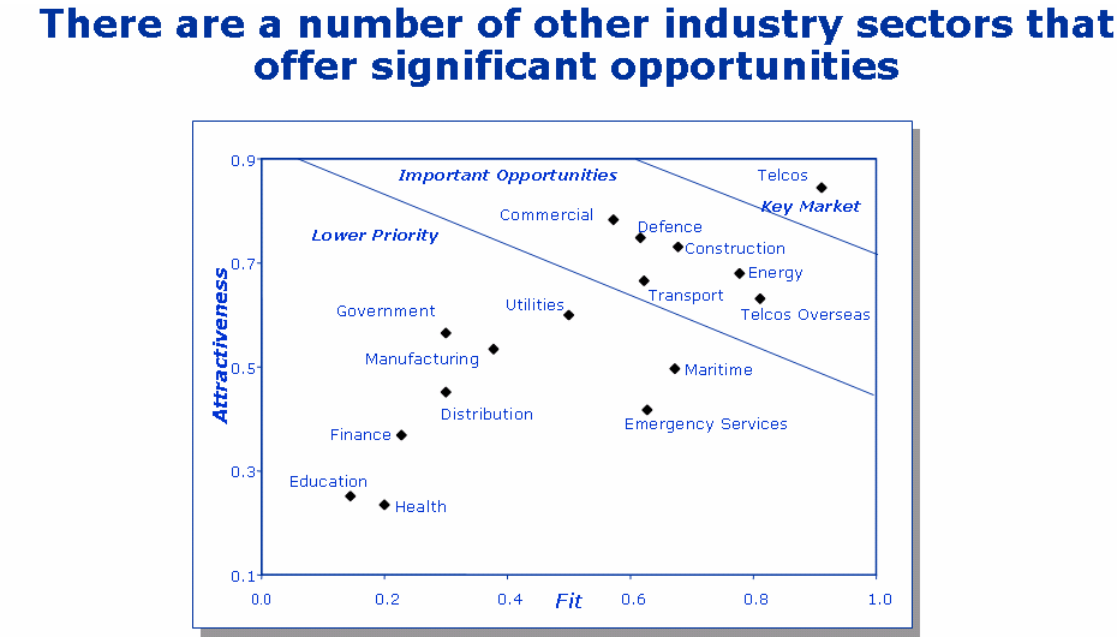

Figure 15. Attractiveness and Fit Chart 4

6.2.3 Framework Improvement Opportunities

- Learning Loop -

Lack of feedback loop of learning in the framework has been pointed out by the participants.

The learning loop has been suggested to come out from "group facilitation" to "group composition". It has always found in the facilitation that the group knowledge or behaviours are getting uneven. So the group size can be expanded or reduced based on the information generated from group facilitation.

- Political Issues -

Participant has also pointed out that group members' views are often dominated by certain level of politics within social environment or organisation culture, particularly, when ask to reach consensus. So the people should always be aware of political related issues. Politics can make things happen quicker or slower, good or bad. So it is quite important to show the political awareness somewhere in the framework.

7.0 Modification of the Framework

Based on the feedback from the interviews, the framework has been modified. (see Figure. 16)

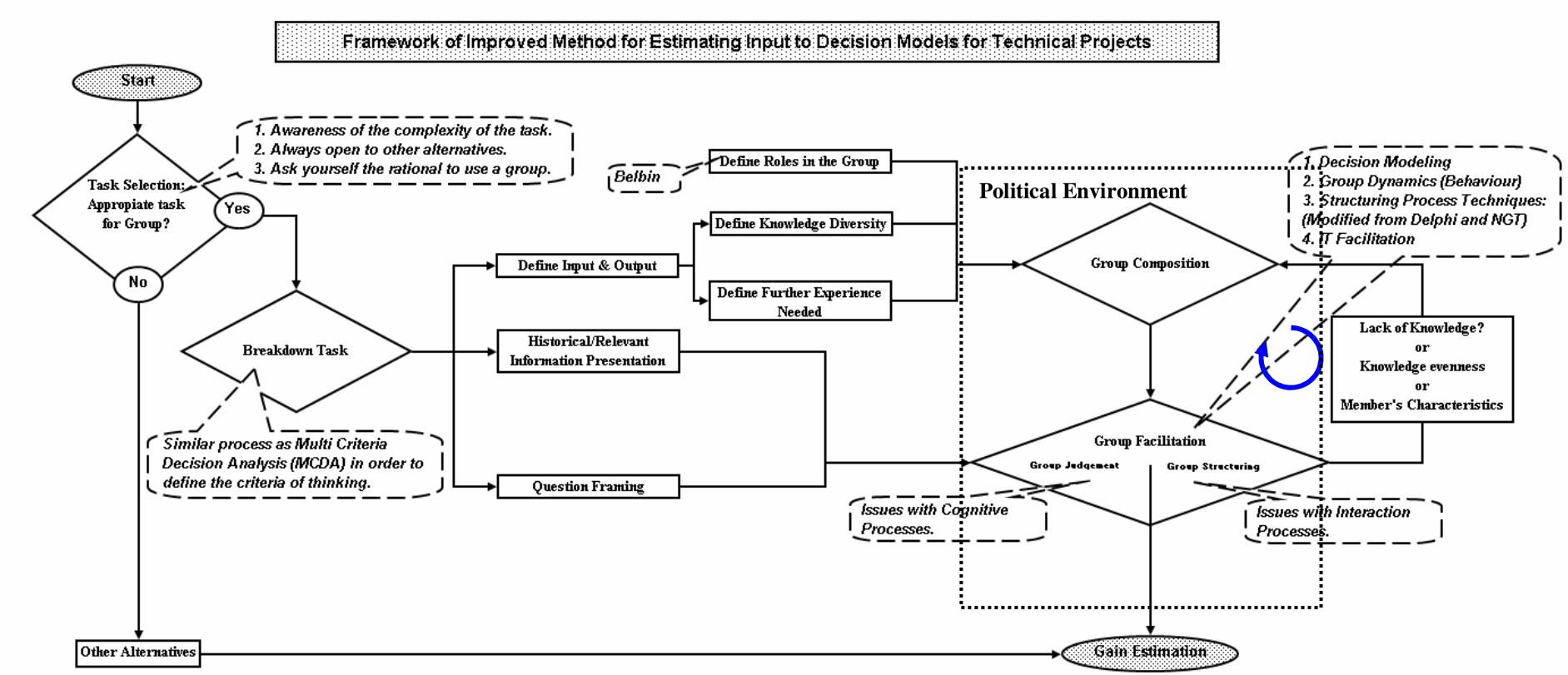

Figure 16. Modified Framework

- Feedback Loop -

The consolidations of group composition can be made by the observations from group facilitation.

By asking,

1. Is there more expertise or knowledge needed in particular areas? This can be identified when most group members are showing low confidence in particular estimations.
2. Is the expertise and knowledge well distributed? There is no point to have too a large proportion of people comes from similar backgrounds and always have same opinions. The diversity is important. This has been proved in multi-regression theory in forecasting. If two sets of data are too much correlated, you should remove one set of data. The confidence of the result will normally be increased (Shearer, 1994). This can be also applied to group composition by reducing the size of the group.
3. Is there too may strong characters or vice versa? It is only when you start to facilitate a group, you will find out the true characteristics of group members. By knowing this, you can avoid some "shout out loud" issues by changing the group composition.

- Political Awareness -

Facilitator need to aware of the political issues, especially in group composition and group facilitation processes.

Facilitator need to understand the organisational culture and how to establish the relationship with the group members. The relevant skills can been found in management consulting literature (Wickham, 1999; Block, 1999; Cope, 2003). These are not going to be repeated in this paper.

8.0 Discussion and Conclusion

8.1 Discussion

Since lots of process and structure related issues have been discussed to tackle the soft side (e.g. biases, decision traps, process loss, etc.) of the research; the hard side, particularly, modelling techniques (e.g. forecasting methods, rich pictures, systems dynamics, etc.) to be used to facilitate the processes and structures have not been forgotten. But these techniques are not presented as comprehensive as others. Further work can be done on categorizing these techniques into different processes of the framework and also related to the literature and guidelines. The further investigation can be done in forecasting methods, management consulting skills, project management skills, etc.

Another reason for not setting up an experimental group to test the contents of hypothesis (framework and guidelines) is because that there is no fundamental theory about how to measure the group performance. The measuring methods have normally been used are timing (value adding time again none value adding time) and correlation coefficient (to test the bias level in the group). More work can be done on the group performance evaluation and measurement.

There are plenty of research effort shows that the IT can reduce large amount of biases in laboratory experiments, but in real world, the evidence has been difficult to gain. This area is also worth to devote some further effort.

Moreover, some computer simulated software can also be developed against the framework in order to be used by the facilitators.

8.2 Conclusion

The empirical investigation shows that the combination of a facilitator and a group is the answer to the research question. Both literature review and interviews show that providing a cold analytical process on the back stage of any estimation making processes is important, for instance, it could eliminated the process losses in group working.

The overall framework has been developed along with an estimation procedure and related guidelines to support this combination. The hypothesis has been justified and assessed by the experienced practitioners. Modifications have also been added on to the overall framework: one feedback loop and awareness of political issues.

Despite the fact that the framework has not been tested within a traditional way, the views from experienced interviewees are strong enough to prove the value of the research. And by their experience, if the framework and guidelines are being operated precisely, it will not only help to improve the effectiveness (the accuracy) of the estimation making processes, but also gain estimates quicker (improved efficiency).

The guidelines have been divided into task selection, breakdown task, group composition and group facilitation. The research questions about task presentation and question framing are based on the ideas not to pass on any kind of biases to people. The relevant elements can also be found in the guidelines.

The purpose of the framework and guidelines is to bring the awareness of what, how and why we should do for people who want to gain better estimations. As mentioned in the literature, the invisibility of the decision traps is most dangerous. More importantly, the holistic view of the estimation making process is most fundamental to the whole developed theory.

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10.0 Appendices

10.1 Appendix A – Interview Participants Profile

Title	Name	Company	Functional Position	Expertise/Knowledge	Email
Mr.	Steve Hart	BT	Senior Deal Architect	Systematic Thinking	steve.hart@bt.com
Mr.	Don Eungblut	PA Consulting	Management Consultant	Management Consulting, Mathematician	done@mybusinesslink.co.uk
Mr.	Glenn Miller	BT	Senior Deal Architect	Change Management and Business Process Re-engineering	glennmiller@bt.com
Mr.	Vincent Huntley	BT Suffolk County Council Joint Venture	Finance Transformation Programme Manager	Organisational re-structuring Introduction of new financial system Business Process improvement in retail, finance and government sectors	vincent.huntley@bt.com
Mr.	Steve Marriott	Bochco	R&D Director	Product Development	Steve.Marriott@biochrom.co.uk
Mr.	Tim Spencer	Lawtronic Electronics	Managing Director	Electronic Engineering trained by Royal Navy	tim@lawtronic.co.uk

10.2 Appendix B – Interview Questionnaire

1. Could you please give some scenarios when you are recently using a group to estimate/predict future events? Or putting a group together for certain purposes.

2. What was the initial idea to bring this group? (Purpose: to find out why [the rationale] using a group.)

3. How did you build the group? (Purposes: to find out what are concerned in group composition) And what did you refer to, maybe tools like skill matrix or organisation chart, etc?

4. How did the group work go? Any good thing or opportunities to improve? (What matters: Behaviour, experience, knowledge, political or etc?)

5. Lessons Learnt? What you think about the most important thing in group composition? Depends on situations? Can you me some examples?

6. How do you use a group? Do you breakdown the task for them? Depends on what: time, expertise, scope, etc?

7. Any changes had been made to the group in order to meet the progress of the task? – New member joined or new focus group separated out from the original group?

8. On what level you would put a group together physically? (Purpose: in order to find out what form of the group working involves in different stage of the project. Is it wasting recourses to put a group together in any situation? Follow up with Step 6)

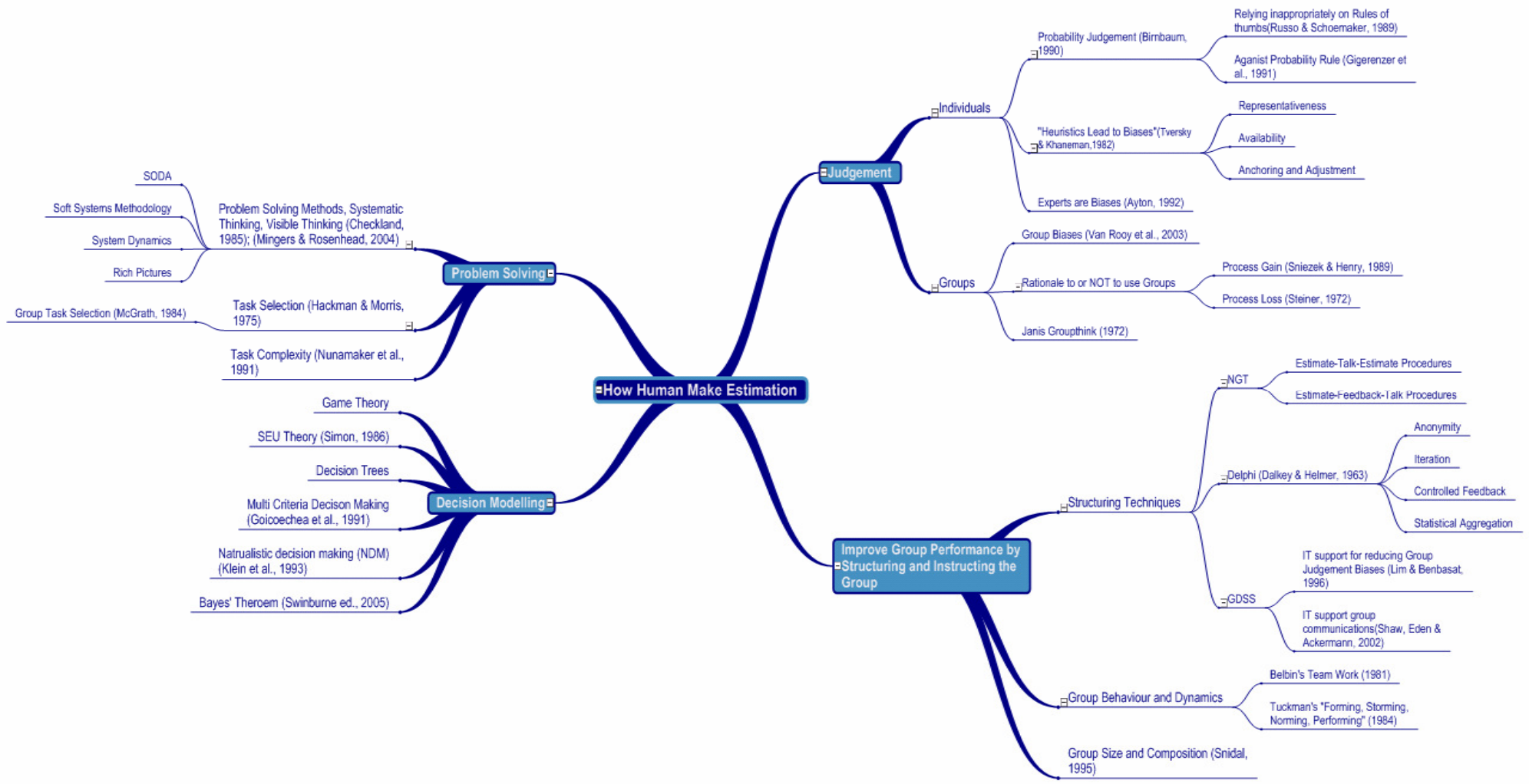
9. Any particular structure/process you are using for the group working, Delphi, NGT, combination of two, etc?

10. How you see the facilitation of a group? Have you ever facilitated a group?

If yes: How you facilitate the group? What you most aware of?
If no: Have you ever working in a group? What you try to do as a group member?

11. Move onto my guidelines and ask for advice.

10.3 Appendix C – Literature Mind Map



10.4 Appendix D – Estimation Example

Grade	Gade min	Grade max	Grade Mid point	Number staff	Total salary	Average salary
ASD01	£63,003	£77,559	**£70,281**	1	70281	**£70,281**
GRADE 2	£11,994	£14,523	**£13,259**	12	159102	**£13,259**
GRADE 3	£14,142	£17,985	**£16,064**	62	995937	**£16,064**
GRADE 4	£17,352	£22,293	**£19,823**	54	1070415	**£19,823**
GRADE 5	£21,588	£28,221	**£24,905**	22	547899	**£24,905**
GRADE 6	£27,492	£33,213	**£30,353**	11	333877.5	**£30,353**
GRADE 7	£32,334	£42,390	**£37,362**	11	410982	**£37,362**
GRADE 8	£41,436	£51,942	**£46,689**	6	280134	**£46,689**
MGR01	£49,686	£57,873	**£53,780**	2	107559	**£53,780**
TOTALS				181	£3,976,187	£21,968
Notes:						
Salaries are based on taking the mid point for each grade, not actual salaries						

10.5 Appendix E – Project Log for Observation

Project Log - Date: 29 March 2006, BT @ Brentwood

Analysis

Process Wise:

- Further Understanding of the project
- Further understanding of group negotiations. **Advantages:** Create Synthesis, examine different alternatives from different angles, bring more information to the decision, more focusing on certain issues; **Disadvantages:** Time consuming where the negotiations occur where the reference points (information) haven't been well presented ***(Terminologies was quite confusing),*** team members often use his/her heuristics to imaging what others' views. For example, when SH & GM have represented their solution on the service level at the first place, there were confusions came from the crowd. They simply want to express that they have developed the solution from the bottom level up and what are the levels. Team member come across as they propose some other service levels will be provided in the further. This fundamental controversy of ways of thinking, styles of design and diversity of background has kept on going the whole group working. Is it a good thing or bad thing, I will be able to evaluate it at the next meeting. It will depend on whether it will occur again or move onto another level.
- One new idea has drawn for the potential framework: One facilitator to a certain group (Rigid Model) or each member can be a facilitator in their areas of expertise

(Collaborative Model). Even the combination of these two (main facilitator then each person take on board if necessary).

- Group working today has started with DC introducing about the scenarios rather than reinforce the project scope again. Then, the team has spent quite long time to pull back when it recognising of the complexity vs. time scale and what is really adding value and essential. I think it is not a bad thing, because the introduction of scope in the front end might create a boundary of groupthink.
- Team members have taken ownership of the work. Team members are taking in roles that they are comfortable with.
- Some team members do shout out louder than others, but my observation of today's work hasn't shown tendency where team members making agreement just for the sake of consensus. The reason can be that team members come from different departments and no huge rank differences.

Information Wise:

- Interesting estimating work: 1. Service Resource Plan will depend on what service level assumed to sell. 2. Estimate the Derived Benefits figures for the Front and Back Offices (20% and 2%, respectively). – Experts
- Estimating the benefits for JV CC and BT of the implementation of each stages T18
- Focus on the output: for example who will be the customers and what they wanted, today's team work shows the customers are not only JV but also BT itself. To make the balance is the challenge.
- Good diversity of knowledge is really important.

Objectives for next stage:

- Further involvement in the project.
- Give feedback and BT will take on my points for some modification for their processes. Good opportunities for testing.
- What is the measurement of performance of group working???