Modelling continuously acquired survey data

A case study on balancing statistical and end-user considerations

Cherrybud Workshop 2006

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Agenda

1. Provide a context for surveying customer/staff/community satisfaction
2. Describe the concept of a Value Survey
3. Discuss some of the modelling issues
4. Examples

A context

How do you measure a company?

Measuring a company

Profits? Market share? Size?

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People's perceptions of the company

…i.e. the *impact* the company has on people

Measuring a company

Profits? Market share? Size?

Stakeholders' perceptions of the company

…i.e. the *impact* the company has on people

Who are the stakeholders?

- **Owners of the business**
- **Customers and prospective customers**
- **People - staff and prospective staff**
- **Strategic partners - key suppliers, …**
- **Community**

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How do they view our performance now?

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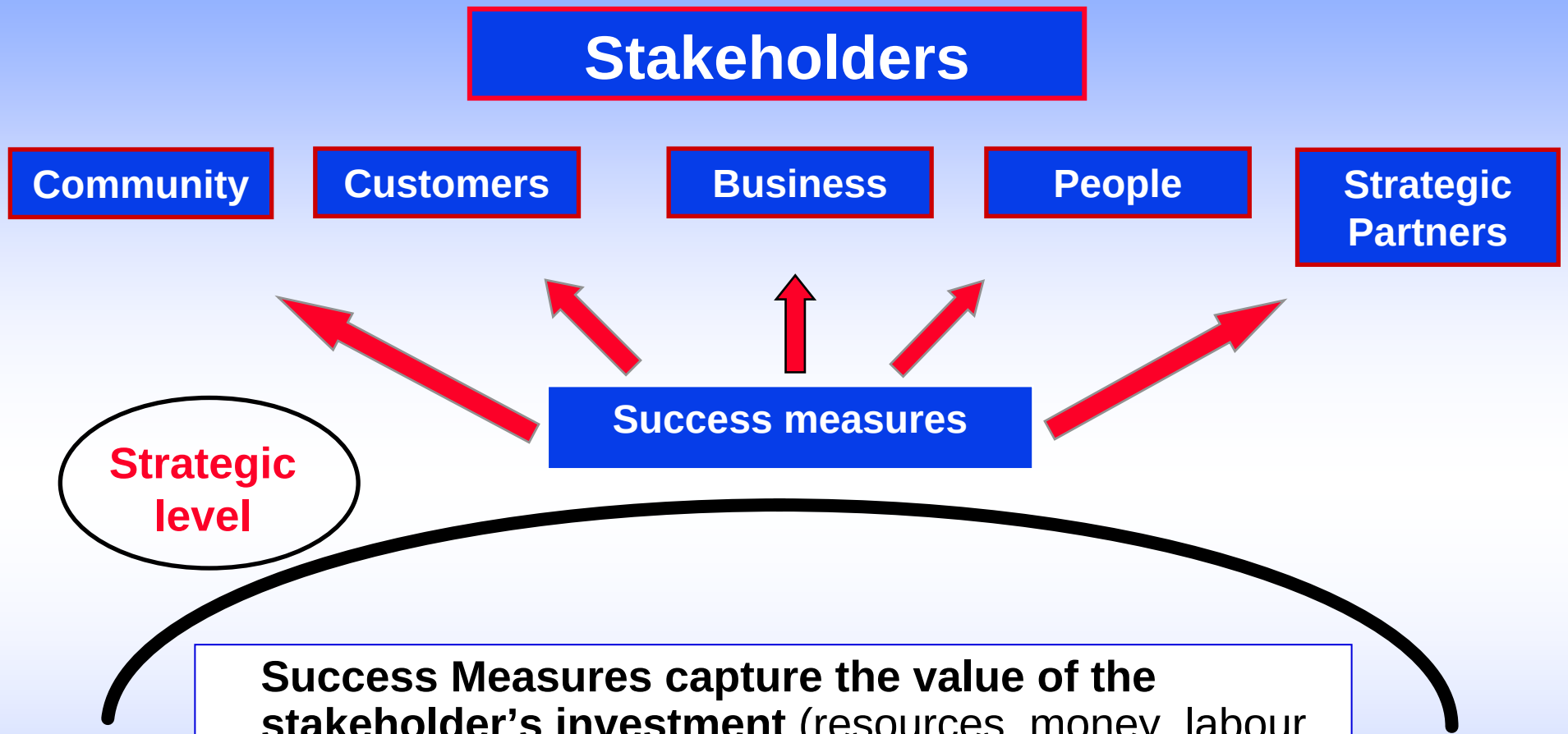
How do they view our performance now?

How are they likely to view our performance in the future?

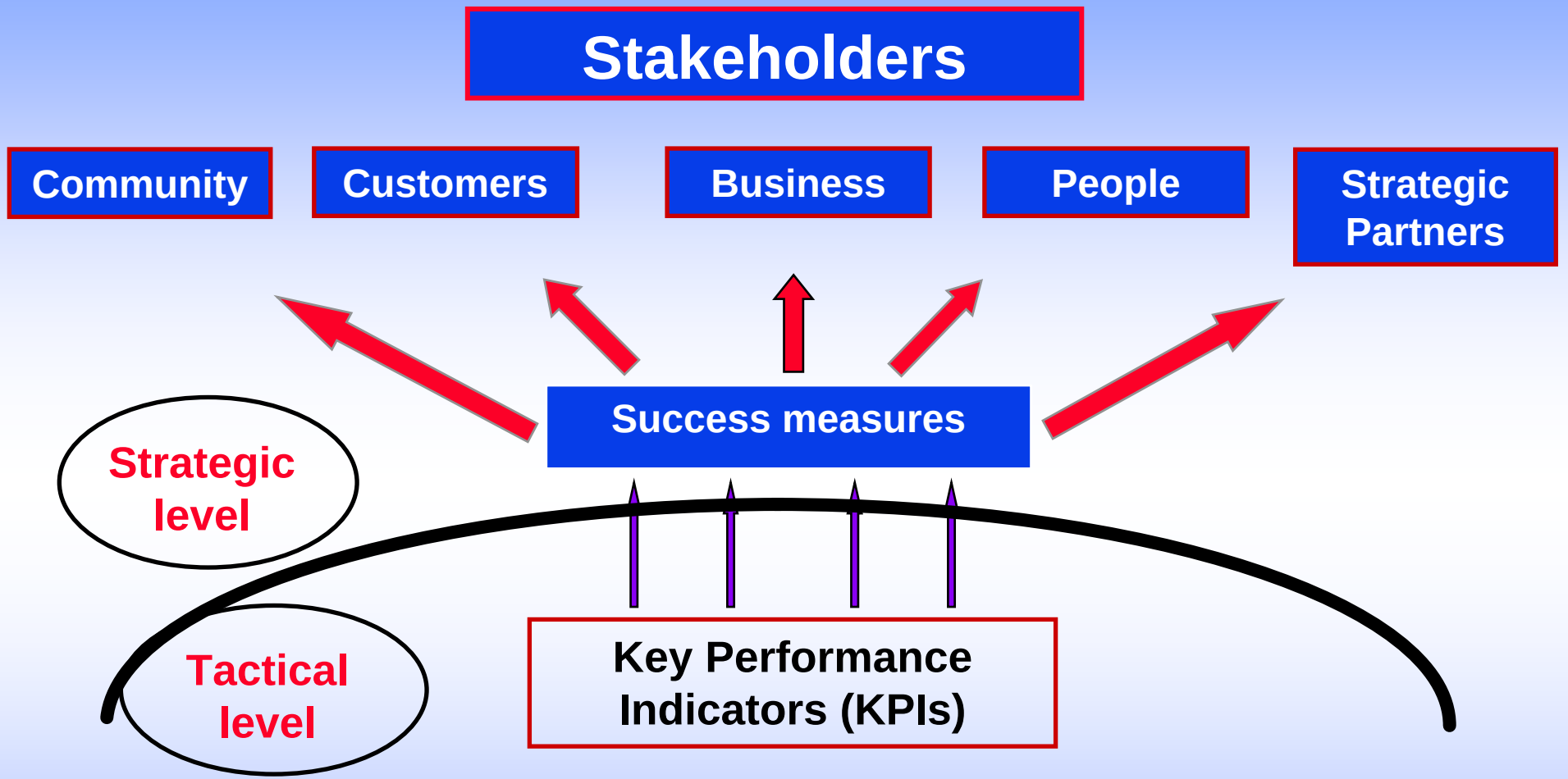
First level of business measures – Success Measures



Success Measures capture the value of the stakeholder's investment (resources, money, labour, …) **in your business, *compared with an alternative investment***

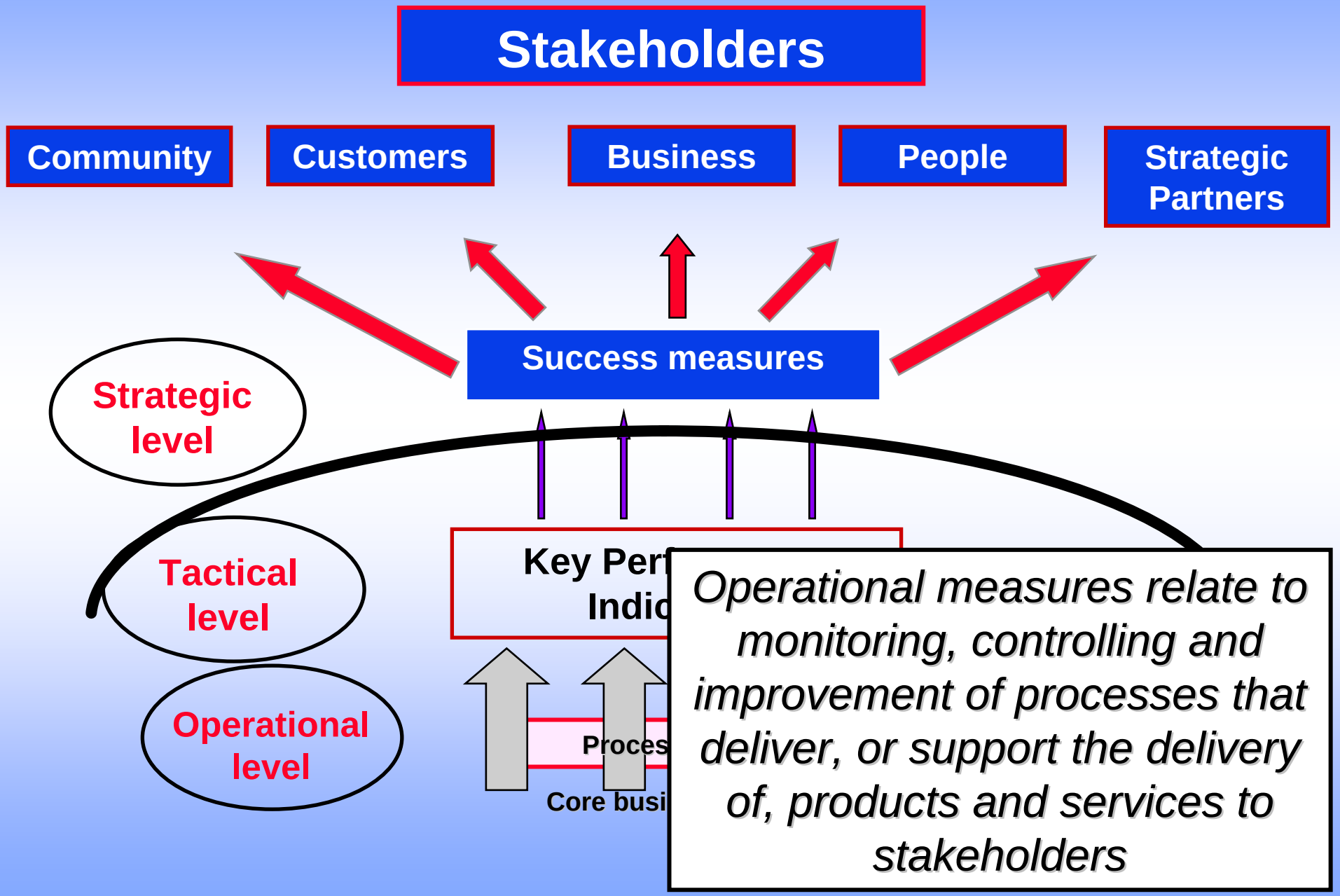
Need to keep all stakeholders happy, to ensure long-term sustainable success of the business

Second level of business measures – KPIs



Key Performance Indicators are a set of organisational-level measures used by the executive to help manage the business.
They are lead indicators of Success Measures

Third level – Operational measures

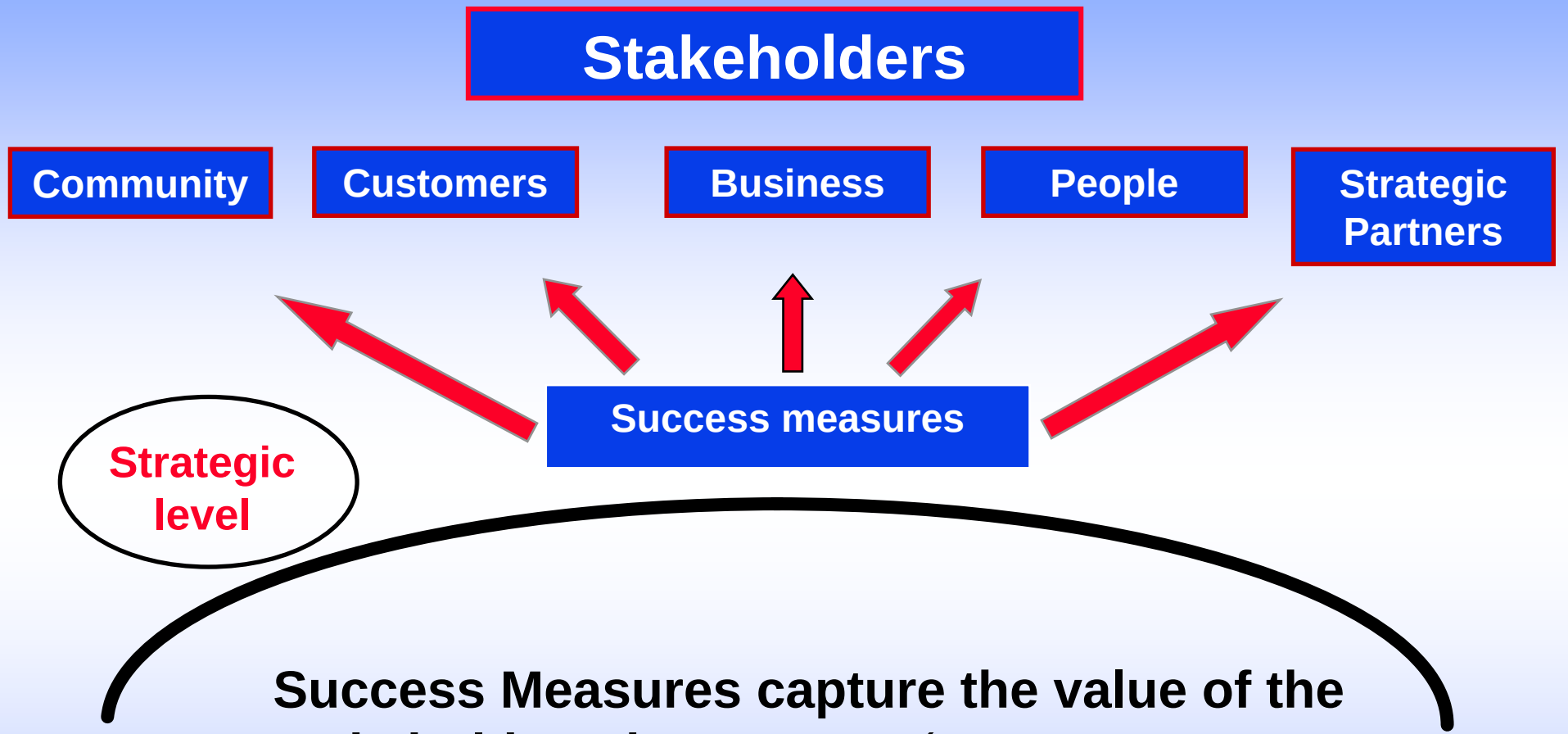


How do we obtain these three sets of performance measures?

Use and adapt an existing methodology:

Customer Value Analysis

- **proven process … used by leading organisations world-wide**
- **lead indicators of business results**
- **actionable Board and senior executive reports**
- **identifies priorities with biggest impact on business**



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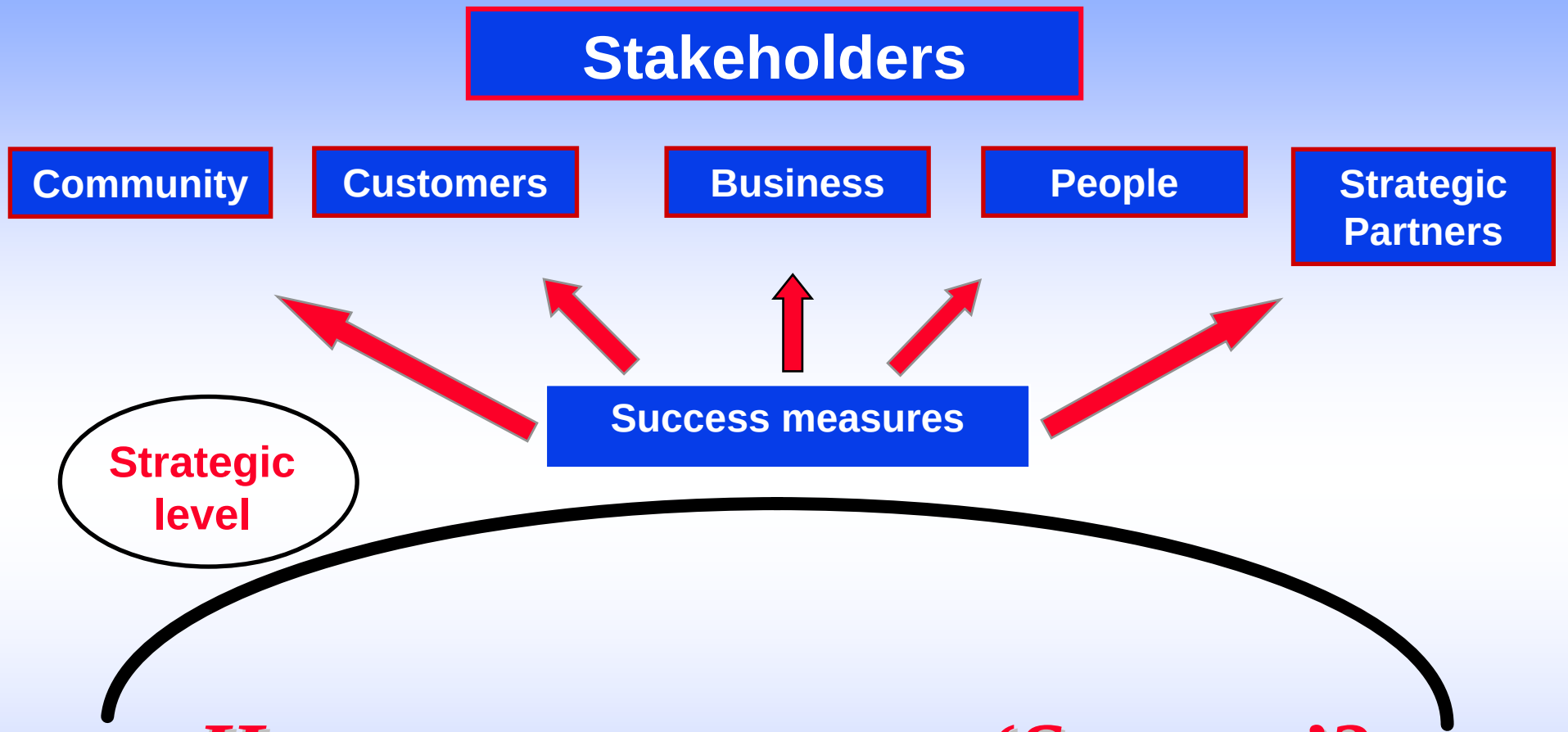


How can we measure 'Success'?

Example: measuring Success for Customers

Use the notion of *Customer Value Added*:

Aim is to provide products and services to customers ***that are of greater value*** than they could expect from purchases from competitive companies in similar markets

The process of *Customer Value Analysis* provides a way of implementing this ...

Customer Value Analysis

Quantify the ***Value*** an enterprise adds for its customers using

- **Satisfaction with *Quality of product or service received***

and

- **Satisfaction with *Price paid***

Definition of Relative Value, or Customer Value Added

$$CVA = \frac{\text{Overall worth of your offer}}{\text{Overall worth of competitive offers}}$$

How do we measure overall 'Worth' or 'Value'?

Basis for measurement of Value

Use a Value Survey

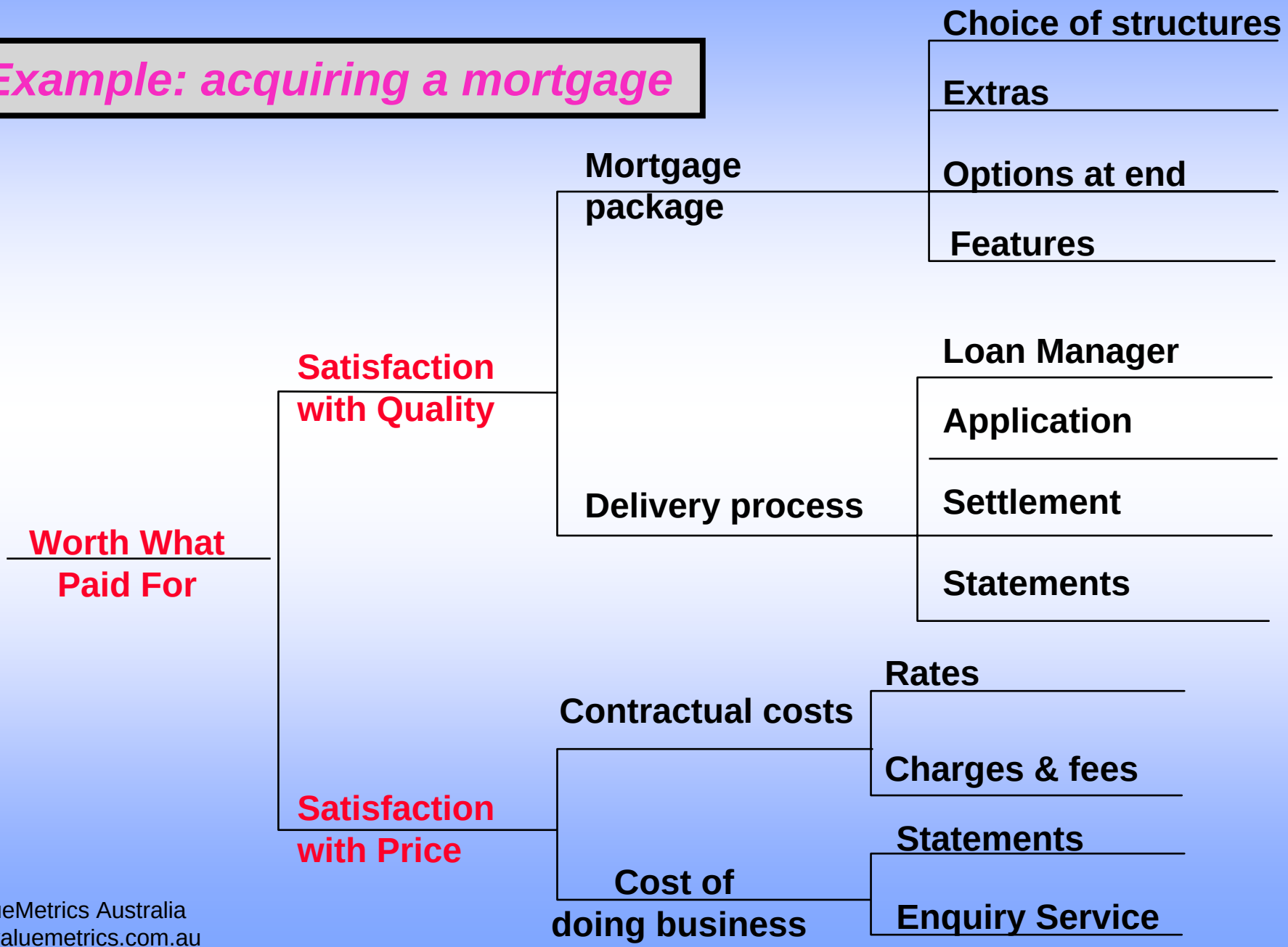
- **Survey the decision makers** … *i.e*. the people who make the purchasing decisions … who are not necessarily the actual users
- **Make regular surveys of the whole market** … not just your own customers
- **Focus on the most important questions**

Example* … obtaining a mortgage

*due to Ray Kordupleski

Structure of Value survey

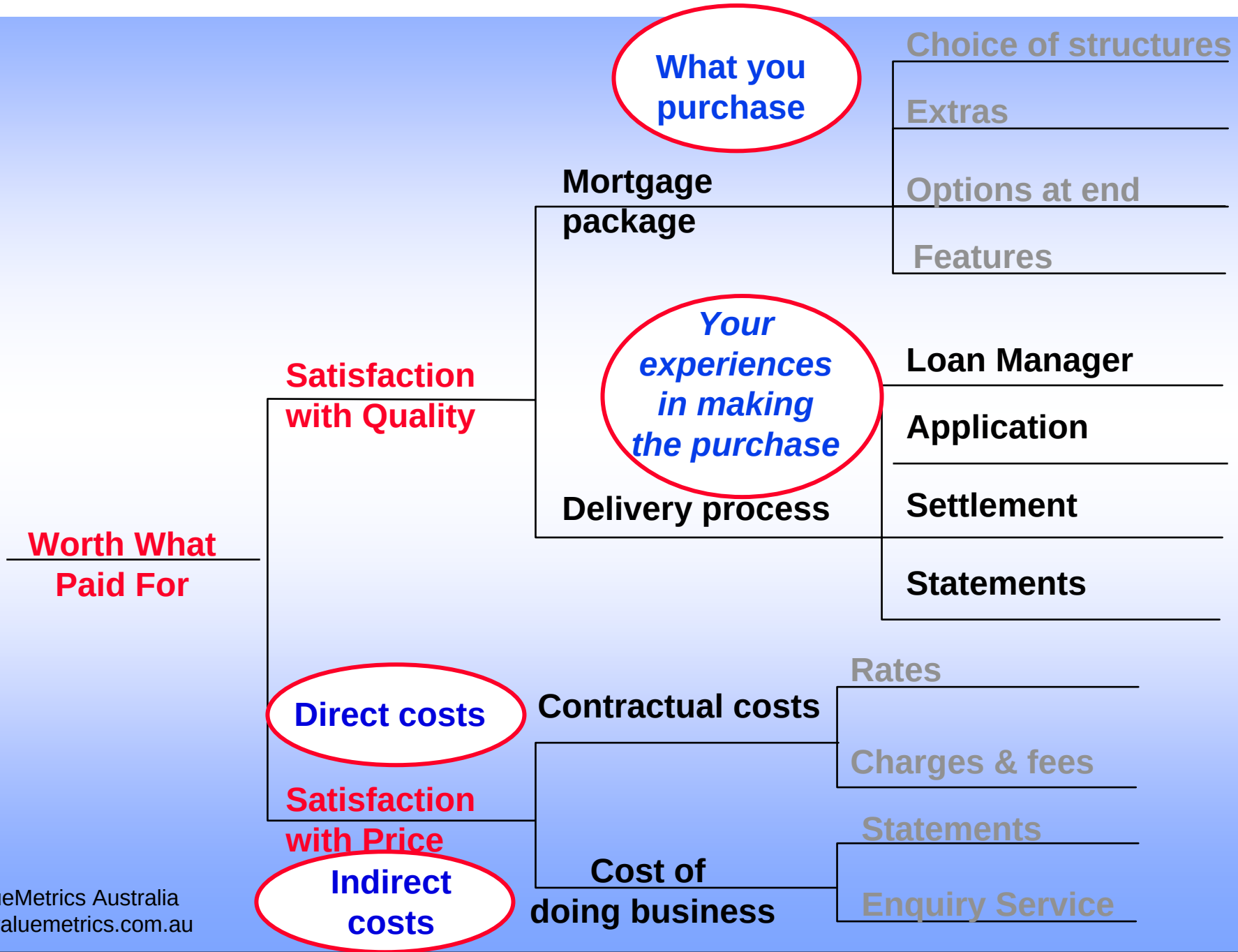
Example: acquiring a mortgage



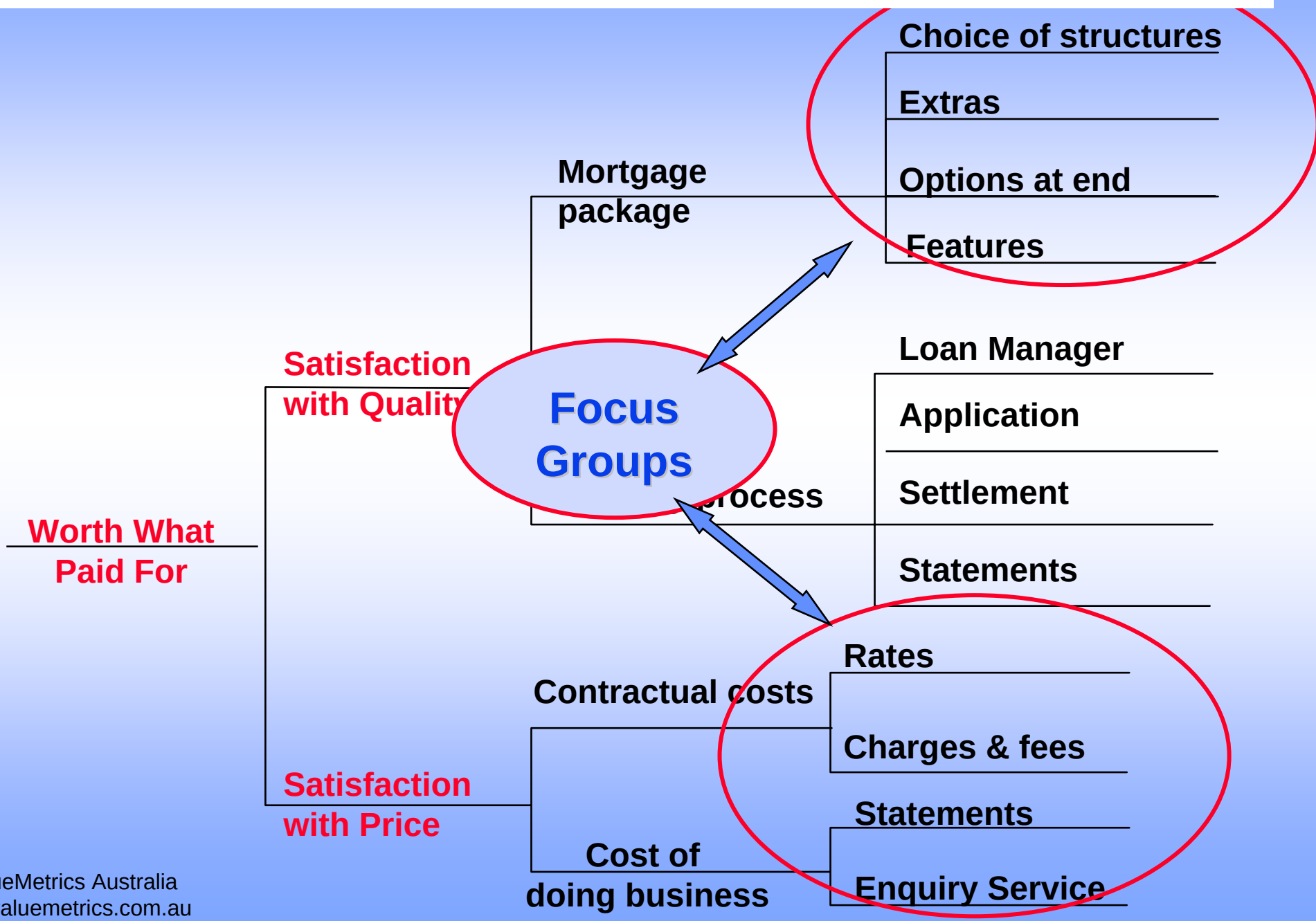
What's Value?

- Satisfaction with Quality
  - Mortgage package
    - Choice of structures
    - Extras
    - Options at end
    - Features
  - Delivery process
    - Loan Manager
    - Application
    - Settlement
    - Statements
- Satisfaction with Price
  - Contractual costs
    - Rates
    - Charges & fees
  - Cost of doing business
    - Statements
    - Enquiry Service

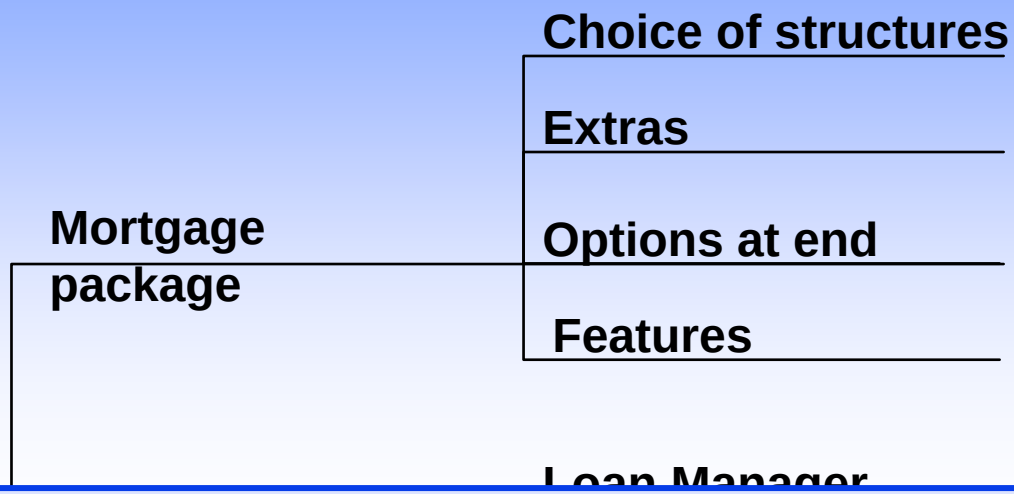
What are the major drivers of satisfaction?



What are the main attributes of these drivers?



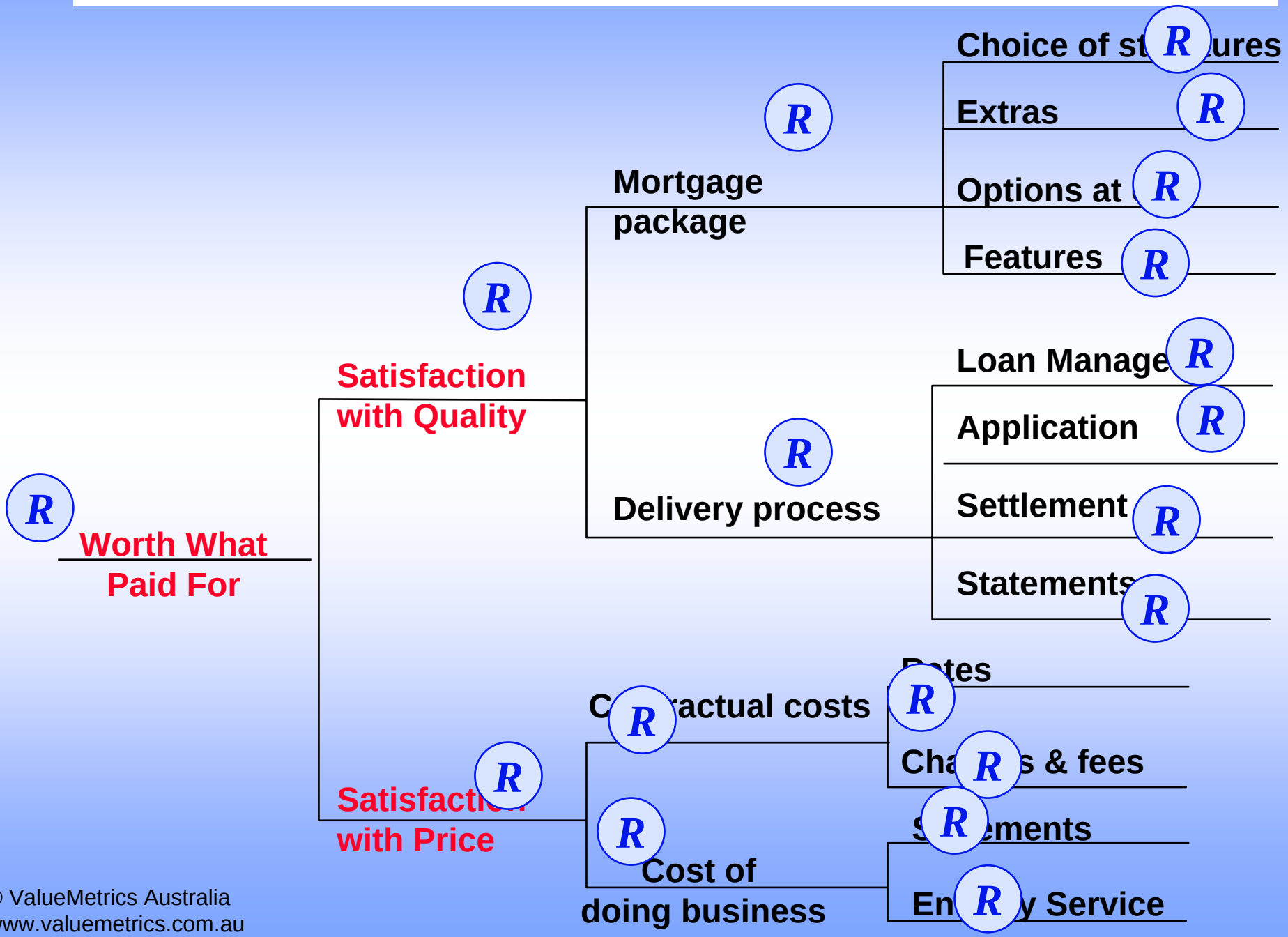
How are the data obtained?



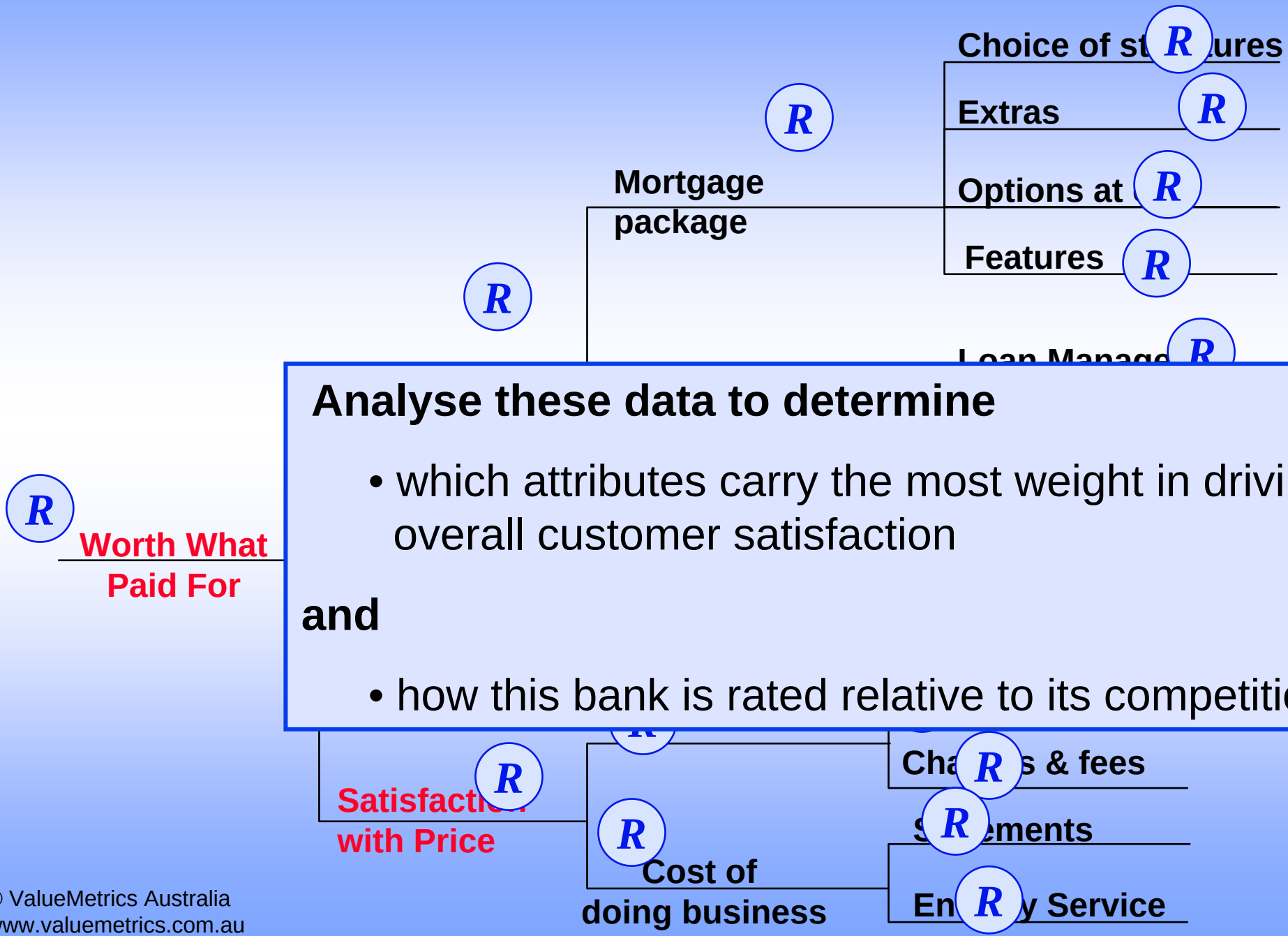
- On a scale of 1 to 10, where 1 = *Poor* and 10 = *Excellent*, how do you rate this bank's product on
  - *Choice of structures?*
  - *Extras*?
  - … ?
- Overall, how do you rate this bank on the Quality of its Mortgage Package ?
- …
- …
- All things considered, how do you rate this bank on the Value of its Mortgage ?

Worth What Paid For

Tree structure of basic Value Survey data



What's needed from the analysis?



Analyse these data to determine

- which attributes carry the most weight in driving overall customer satisfaction

and

- how this bank is rated relative to its competition

Mortgage Quality Profile

Key Purchase Criteria	Importance Weight %	Your Company	Competition	Ratio (%)*
Mort. Features	25	9.0	8.6	105
Loan Manager	20	8.1	8.1	100
Applications	12	8.5	8.5	100
Settlement	14	7.8	8.1	96
Statements	29	7.0	8.0	88
Overall:	**100**	**8.0**	**8.2**	**97**

*98 – 102 represents “parity” with competition (95% CI)

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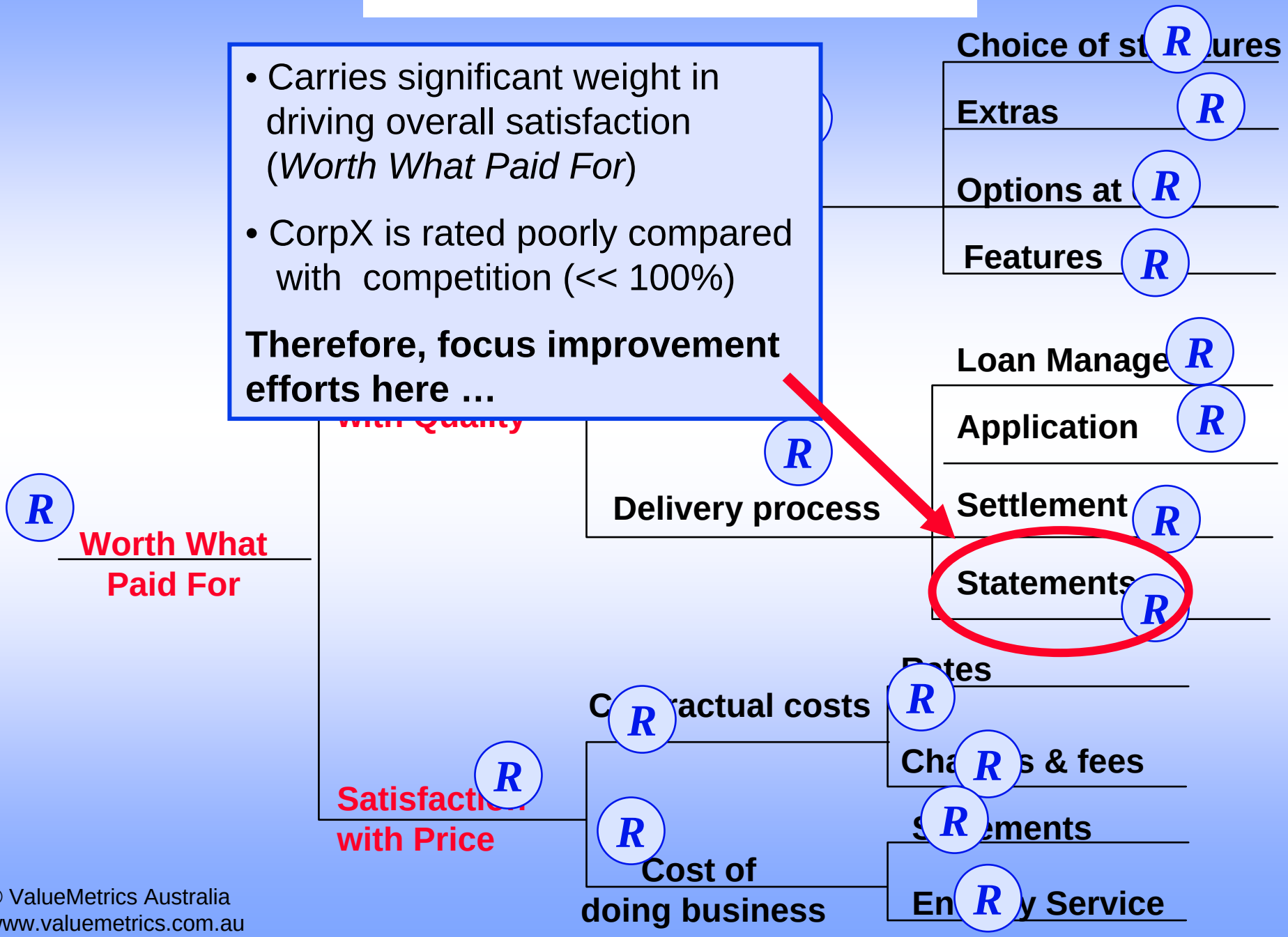
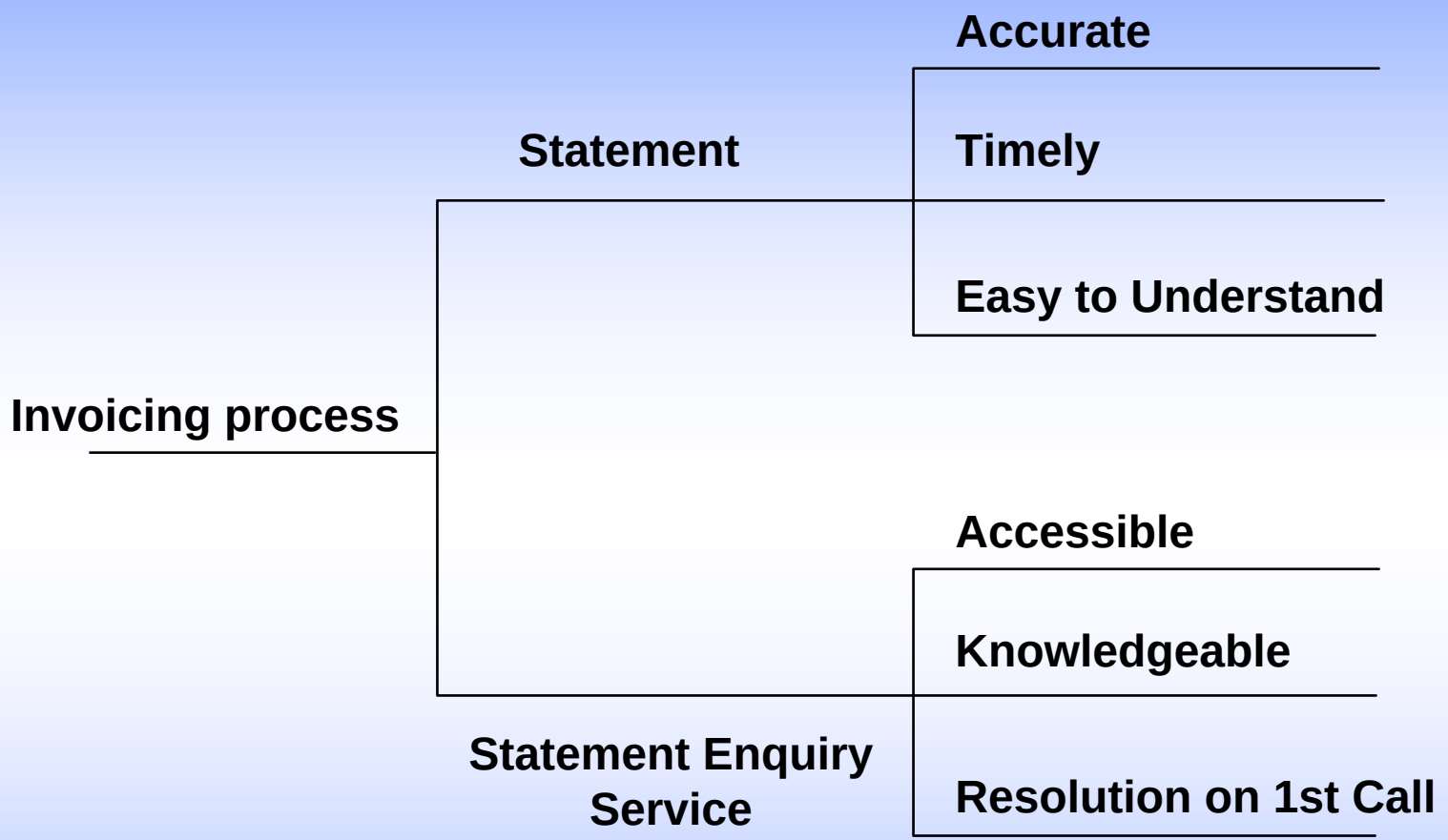
What happens then?

- Carries significant weight in driving overall satisfaction (*Worth What Paid For*)
- CorpX is rated poorly compared with competition (<< 100%)

Therefore, focus improvement efforts here …



Perform low-level survey focused on the user …



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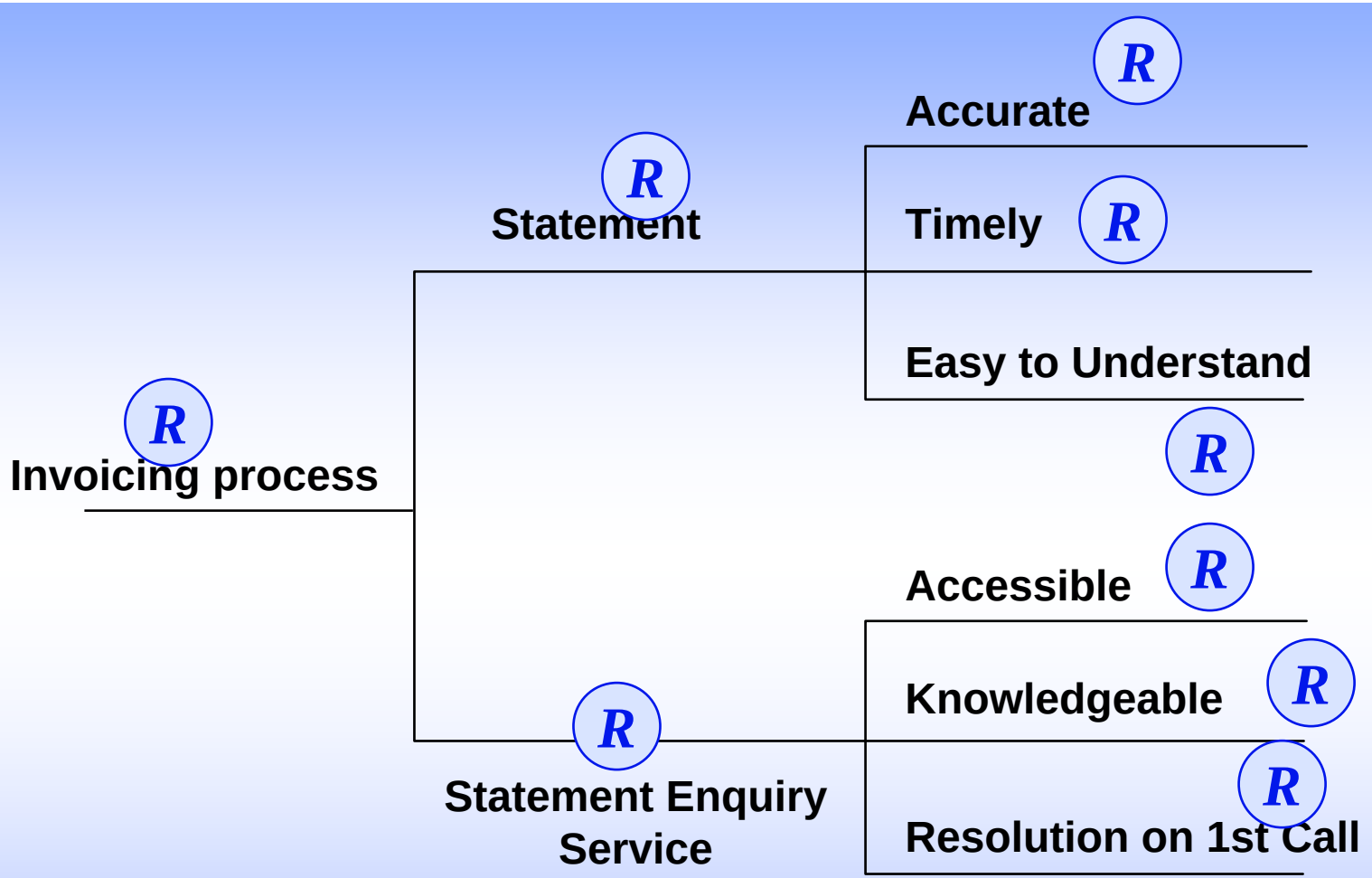

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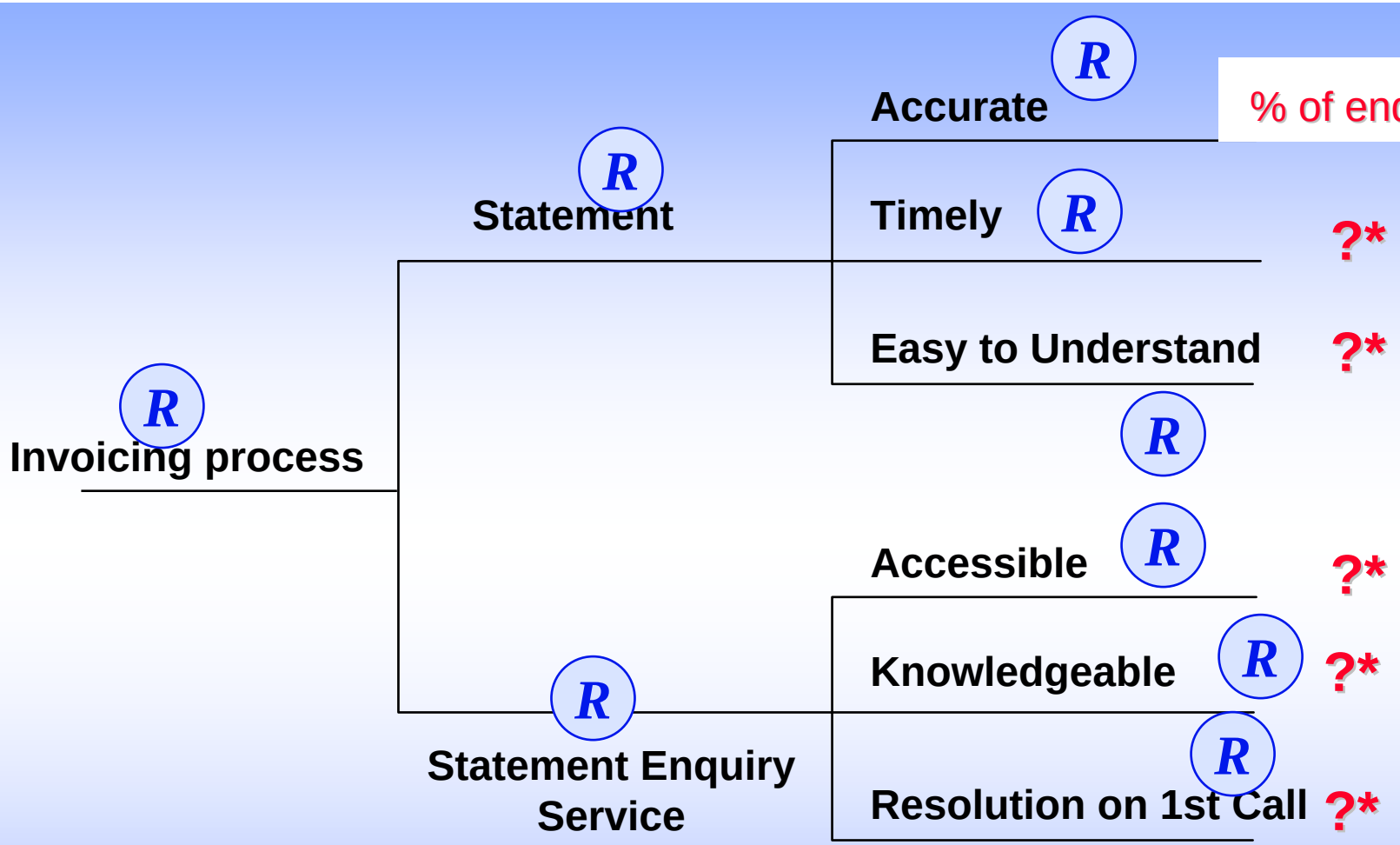

Now

- **put** appropriate metrics* in place
- **make** the appropriate business process improvements
- **communicate** the improvements to the market

Does it work?

Market Share (% Sales) and Value

Communications Equipment

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Communications Equipment

Agenda

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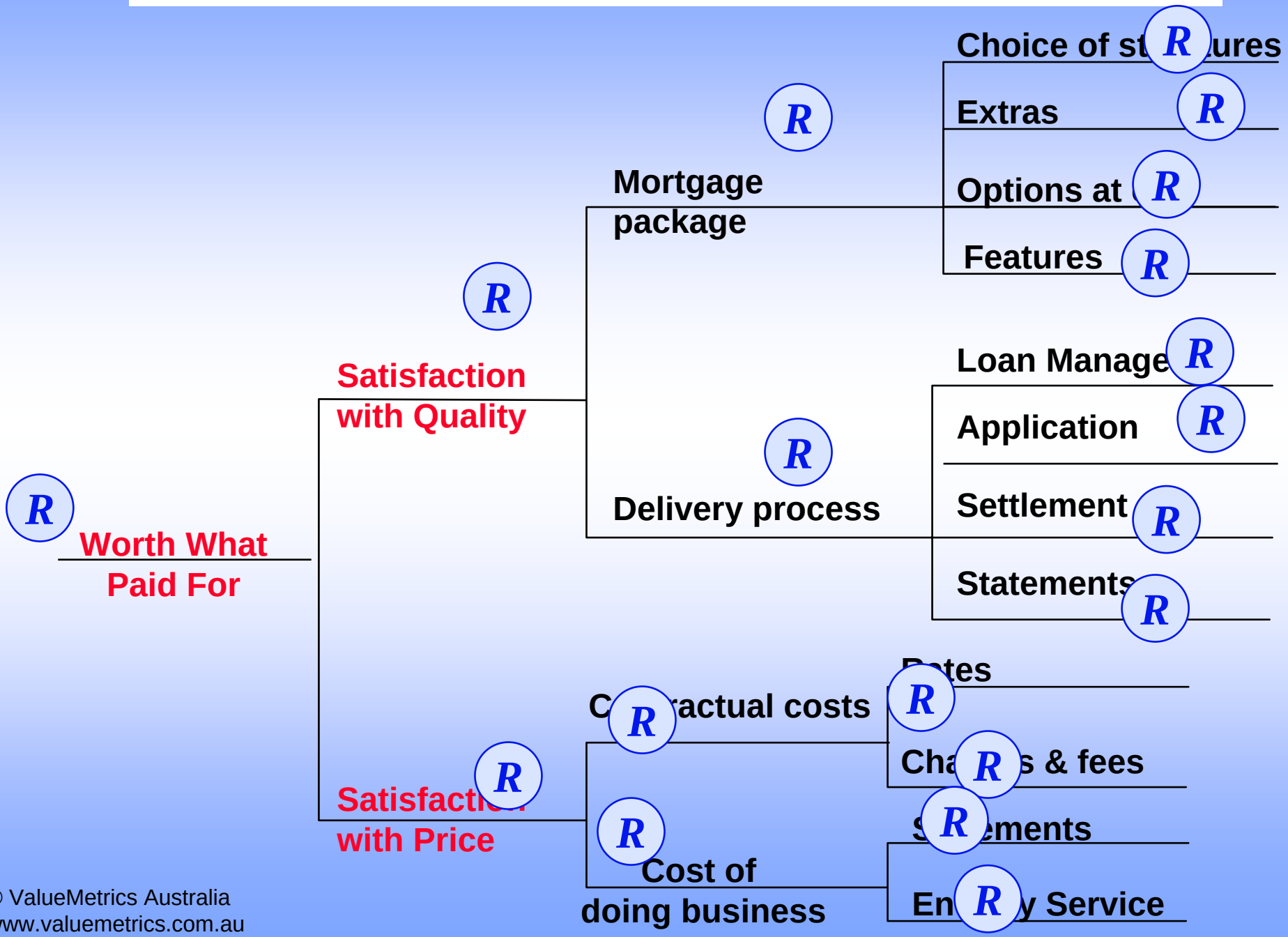
3. **Discuss some of the modelling issues**
4. Examples

Let’s look into the issues relating to modelling and analysing Customer Value survey data …

Basic structure of Value Survey data



What are the goals of the modelling and analysis ?

- Obtain results that can be presented in such a way that management can take action
- Capture as much of the information in the data as possible
- Understand which factors carry the most weight in driving overall satisfaction - *Worth What Paid For*
- Enable managers to play “What if?” games

Modelling and analysis

- Typical CVA campaign: market research data acquired from survey company at regular intervals, *e.g.* every three months.
- Each 3-monthly data set comprises approximately 150 tree-structured measurements for given company and for each targeted competitor.
- Two current approaches to analysis:
  - DeNicola - Kordupleski
  - Lucent

DeNicola - Kordupleski approach

- Entire data set modelled as a set of hierarchical regression models
- **Weights** obtained from regression coefficients
- Modelling and analysis usually restricted to the data for current quarter
- Produces actionable summaries …

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DeNicola - Kordupleski approach: benefits and issues

- Helps selection of improvement priorities, leading to improved CVA scores and improved business performance
- Helps managers themselves, at all levels in organisation, **understand and use their own customer value data**
- **Question:** Can **more information** be extracted from data without losing these two critical benefits?

Lucent approach

- Hierarchical Bayes simultaneous time series model for whole data set
- Transformation applied to data to improve modelling and analysis
- Modelling covers all survey periods
- Results presented in terms of trellis graphics to highlight even subtle differences in complex markets

Lucent approach: benefits and issues

- Entire data set used
- Careful empirical validation of all modelling assumptions
- Modelling very effective in explaining the various components of variation in the data
- **Question:** Can information be presented in a form suitable for interpretation and action **by management themselves?**

Another approach

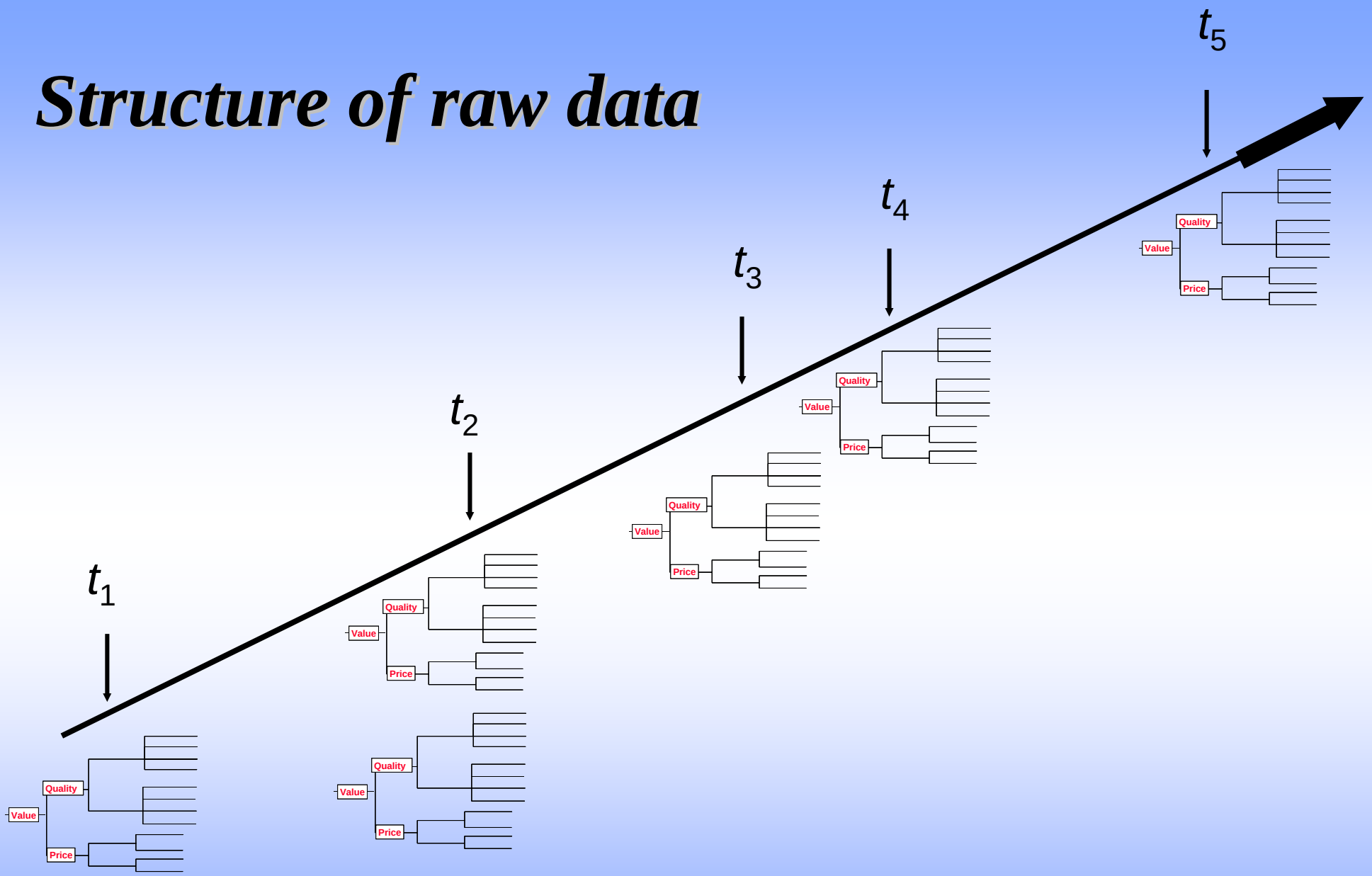
Re-define the problem!

- Typically, data for a 3-month period are collected **during** the period, not just at the end
- Collect data uniformly over the survey period, and **utilise the date** when each respondent is interviewed
- Develop a continuous-time model for ***all*** the data

Modelling objectives for continuous data

- Obtain results similar to those in the table
- Detect ‘interesting’ temporal changes in ratings or relative weights
- Provide readily interpretable trend charts for ratings and weights

Structure of raw data



Modelling these data

- Carry out (some form of) hierarchical regression modelling
- Allow for temporal structure in ratings and weights …

Model for any level of data

$$Y = w_{1t}D_1 + \ldots + w_{kt}D_k + w_tD$$

where

- weights $w_{it} \geq 0$, $w_{1t} + \ldots + w_{kt} + w_t = 1$
- $D_1, \ldots, D_k$ are drivers (explanatory variables) for Y
- D is an unobserved driver … represents all the unmeasured factors that affect Y
- Y, $D_1,\ldots,D_k$ and D all measured on a 1-10 scale

and

$w_{1t}, \ldots, w_{kt}$ and w_t change with time

How to estimate the weights?

Approach 1: State-space modelling

- **Allow for time-varying weights** by fitting a state-space model and estimate the coefficients using the Kalman filter.
- **Leads to time sequences of estimates of** $\mathbf{w}_{it}$ for each term D_i in the regression, which can be smoothed (*e.g.* loess) to reduce noise inherent in Kalman filtering process, for presentation purposes.
- **Problem:** as with Kordupleski - de Nicola approach, doesn't necessarily produce weights satisfying $w_{it} \geq 0$, $w_{1t} + \ldots + w_{kt} + w_t = 1$.

How to estimate the weights?

Approach 2: Constrained least squares (CLS)

- Adopt an estimation procedure that enforces the constraints $w_{it} \geq 0$, $w_{1t} + \ldots + w_{kt} \leq 1$
- $\{w_{1t}, \ldots, w_{kt}\}$ estimated from all data obtained at times $s < t$ by weighted constrained least squares with exponentially decaying regression weights of the form C^{t-s}, $0 \leq C \leq 1$.

See C. L. Lawson & R.J. Hanson, *Solving Least Squares Problems*, Philadelphia: SIAM.

Monte Carlo evaluation of methods

- Studied performance of CLS and Kalman for a range of plausible models for changes in impact weights.
- Consider simple situation, involving Value, Quality and Price …

$$Y = c\,\{\,a\,Q + (1 - a)\,P\} + (1 - c)\,R$$

a represents the 'trade-off' between Quality and Price

c represents 'goodness of fit' of the model

- Typical scenarios for parameter ***a*** :
  - no change over 12 months
  - steady downward linear drift
  - step change
- Q, R, P simulated from Power Binomial model
- Tuning parameters set to 'reasonable' values

Model fitting

- Obtain initial estimates of weights from a preliminary survey analysed using (constrained) hierarchical regression modelling
- Use either CLS or Kalman filtering to update estimates of weights each time a new observation is obtained
- Produce plots of
  - weights changing in time
  - loess smooths of time sequences of ratings

How does it all work in practice?

- Example: application to Staff Satisfaction surveys
- Typical approaches to Staff Satisfaction surveys:
  - Huge one / two / three-yearly survey
  - Quarterly 6 binary questions (Motorola)
  - Quarterly Fedex 360º 20-question survey
- We can use the same approach as with Customer Value Analysis: in other words, *actively manage* ***People Value***

What are the benefits of this approach?

1. Retains key features of both previous approaches
2. Provides timely information to management about important trends in
   - ratings
   - relative importance of different factors
3. Provides improved links to business drivers
4. Works well as a Web-based instrument
5. Can be used to survey other important groups – Community, Suppliers.