MARKETING ENGINEERING

(MARKETING MODELLING & ANALYSIS)

MARKETING ENGINEERING

Computer-Assisted Marketing Analysis and Planning

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ANALYTICS

MARKETING ENGINEERING

Several forces are reshaping marketing. Marketers face rapid marketplace change and an ever-growing flood of information.

Traditional marketing was seen as an art or a science; today, it increasingly resembles engineering.

Market engineering is the systematic, theory-guided design and evaluation of markets, especially digital marketplaces, by shaping their rules, mechanisms, platform architecture, governance/legal framework, and business model to achieve desired outcomes such as efficiency, fairness, transparency, and reliability.

Market Engineering borrows concepts and methods from Economics, particularly, Game Theory, and Mechanism Design concepts, but also borrows concepts from Finance, Information Systems and Operations Research.

THE MARKETING ENGINEERING PROCESS

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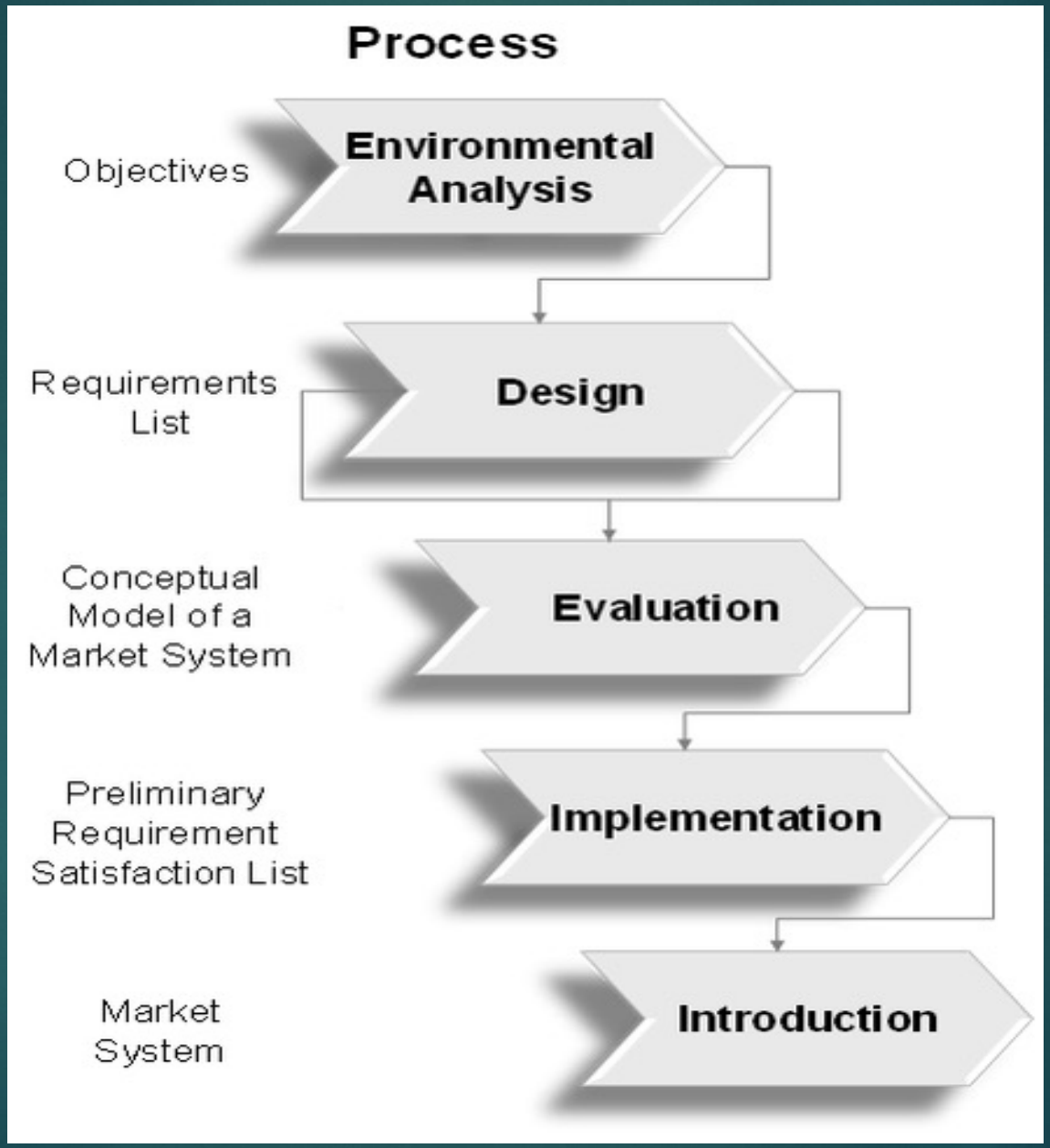


Environmental Analysis

The objective of the environmental analysis is to define the strategies and objectives of a new electronic market.

In this phase, we conduct surveys, analyze the environment (using SWOT analysis), and review the literature in collaboration with potential future market participants.

Design

The second stage of the process involves designing the market, taking into account the transaction object, market microstructure, IT infrastructure, and business model simultaneously.

Supported by tools and methodologies such as mechanism design and parametric design, the market mechanism is derived as an allocation and payment function.

Evaluation

After designing the market, it is tested for its technical and economic properties.

The evaluation stage includes functional tests of a software prototype to verify its correctness, economic tests to measure market performance outcomes, and an assessment of the business model.

Functionality tests are conducted to ensure that the prototype system operates as intended.

Implementation

In this stage, the thoroughly evaluated design is realized and implemented as a software system.

The market system can either be implemented from scratch, or the prototype developed in the evaluation stage can be enhanced through an evolutionary process.

The output of this phase is a fully implemented electronic market that incorporates the institutional rules and the business model.

Introduction

Here the model is introduced to the market.

Why Market Engineering?

- Many marketing managers succeed without relying on computer models. However the marketing environment is dynamic and has evolved and managers can no longer rely only on intuitive methods when the marketing environment is undergoing major changes.

- The following trends are fundamentally changing the marketing managers job.

High-powered computers connected to networks are becoming ubiquitous.

High-powered, networked computers are now widespread. As a result, marketing managers increasingly rely on digital tools to perform their roles.

Many use computers to access, integrate, and analyze diverse data sources to improve decision-making. Common analytical tools include spreadsheets (e.g., Excel) and related business analytics software.

Data volumes are rapidly increasing.

As available data grows quickly, managers' cognitive capacity to process and interpret it does not scale at the same rate. This creates a need for structured concepts, methods, and technologies, such as market engineering, to support decision-making in data-intensive environments.

Marketing is being re-engineered.

Firms are redesigning marketing functions and processes for the digital information age. Marketing managers increasingly work directly with marketing data and use analytics tools to perform tasks that were previously handled by support staff.

MARKETING DECISION MODELS

What is a model?

A model is a stylized, representation of reality that is easier to deal with and explore for a specific purpose than reality itself.

Stylized – don't capture reality but focus on some aspects. (simplified depictions/analogies of real world phenomenon and systems)

Representation – A model is a convenient analogy that may bear little resemblance to the physical characteristics of the reality its trying to capture. E.g. map

Specific purpose – developed with specific purpose in mind. (highlight certain aspects and ignore others. E.g. repeat purchase of a firms products.

Decision models are a special category of models that provide the foundation for market engineering, in much the same way the skeleton provides the structure of a human body.

CHARACTERISTICS OF DECISSION MODELS.

1. **Purpose** – A decision model has a well defined purpose which represents the reason for its construction and circumscribes its domain of applicability.

   E.g the *ADBUDG model* designed primarily to help managers arrive at good advertising budgets, *Clustering model*, is useful for identifying successful market segments…

2. *Assumptions* – Provide the context or framework for a model.

E.g. a model to evaluate the advertising budget for a product could include the following assumptions:

1. Product sales are related to its advertising.
2. Sales will go up if advertising is increased.
3. Increased advertising will decrease customers' sensitivity to product price…

3. ***Variables*** – Are those marketing aspects of a marketing phenomenon that are not fixed. E.g. firms sales…

- ***Independent/input variables: - Controllable variables, non controllable variables*** and ***environmental variables.***
- ***Dependent/output variables*** - are those whose values are determined by a set of independent variables.

4. ***Relationships*** – Between the variables based on marketing theories and managerial insights, specify how changes in one variable affect another variable. E.g. a change in package design can be hypothesized to increase customer attention at point of purchase.

Structural Characteristics

We distinguish between models on the basis of their structural characteristics: verbal, graphical and mathematical.

- ***Verbal models*** – described in words. E.g advertising moves consumers' mental states along the following chain:

- Awareness to knowledge to liking to preference to conviction to purchase.
- Easy to explain
- Intuitively understandable
- Sufficient for the purpose at hand
- Lack of quantification is a fundamental limitation of verbal models, especially when it comes to decission making.

Graphical models – ie road maps, organizational charts, & flow diagrams.

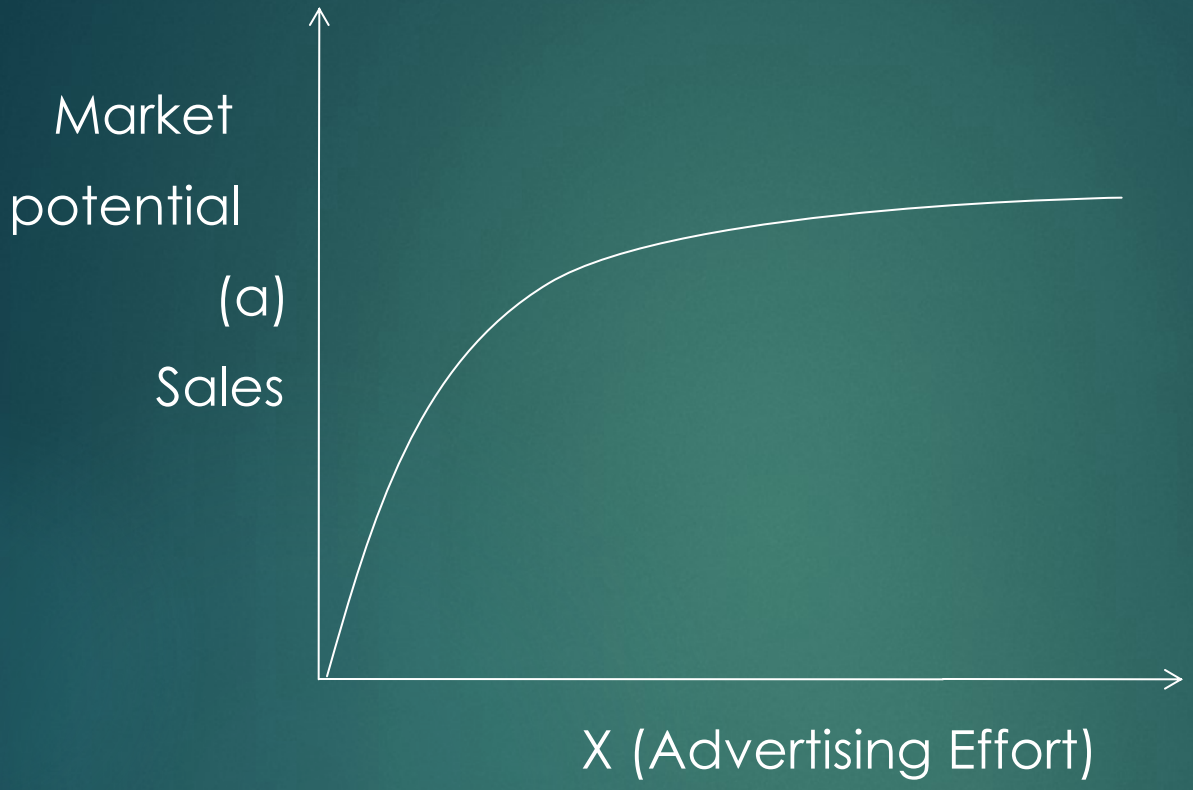
Graphical models – illuminate and identify key issues relevant to a phenomenon.

- Aid communication about the phenomenon
- Guide analysis
- Provide bridge between verbal models and the more formal mathematical models.

Mathematical models – Specify the relationships embodied in a model in the form of equations. E.g the Rel. btn between advertising expenditure and sales often incorporates two important properties: ***saturation*** and ***diminishing returns***

- Saturation suggests that after some point, no amount of additional advertising will increase sales.
- Diminishing returns suggest that each incremental unit of advertising will lead to progressively decreasing increases in sales.

- Represented graphically below



Types of Models

1. Descriptive/ Predictive decision models.

These address the question, ***'What will happen if we do X?'***

- E.g., a manager's decision about whether or not to introduce a new product might depend on the likely total sales for the product line if the new product is introduced; a decision to go ahead with a two-for-one promotional offer might depend on the incremental profit that might be generated by the promo.

Using descriptive models the manager conducts *"simulations"* to evaluate consequences of marketing actions.

- **Descriptive models are useful for;**

- Exploring the impact of a set of alternative assumptions
- Finding explanations
- Predicting possible outcomes.

2. Normative/Prescriptive decision models

Address the question; ***"What is our best course of action in a given situation?"***

E.g., A manager might want to determine the best location for a new store or the best level of advertising for a particular product.

Normative models are designed to help mangers to answer such questions by enabling them to explore the value of a decision option under diff scenarios.

BENEFITS OF USING DECISION MODELS

1. Improve consistency of decisions.

One benefit of using models is that they help managers make more consistent decisions.

2. Explore more decision options.

In some situations the number of options available to the decision makers is so large that it would be physically impossible for them to apply mental models to evaluate each option. E.g in deciding which media vehicles to use for an Ad.

3. Asses the relative impact of variables.

In some situations the decision options may be few , but the variables that may affect the decision may be numerous. E.g competitor and dealer reactions, consumer trial rates, competitive promotions, brand equity associated with brand name.

4. Facilitate group decision making.

Modeling provides focus and objectivity to group decision making by externalizing ideas and relationships that reside inside the minds of decision makers. e,g. discussions on allocating resources tend to degenerate into turf battles, but if the members of a group agree on a modeling approach, then they may view the model results as unbiased.

5. Update mental models.

Marketing managers have mental models of how their markets operate. They develop these models through trial and error over years of experience, and these mental models serve as valuable guides in decision making. When managers are exposed to decision models, they update their own internal mental models in subtle but significant ways.

Reasons why some managers choose NOT to use models.

- **Mental models are often good enough**
- **Models don't solve managerial problems, people do.** By design models are incomplete, its unrealistic to expect them directly solve managerial problems.
- **Managers do not observe the opportunity costs of their decisions**. Managers observe only the consequences of decisions they have actually made and not of those they didn't.
- **Models require precision.** i.e. assumptions be made explicit, data sources clearly specified… threat to power base & devaluation of their positions, particularly middle level managers.
- **Models emphasize analysis:** Managers prefer action. They prefer to call on corporate support staff whenever they need them to help with analysis.

TOOLS FOR MARKETING ENGINEERING:

MARKET RESPONSE MODELS

Why Response Models?

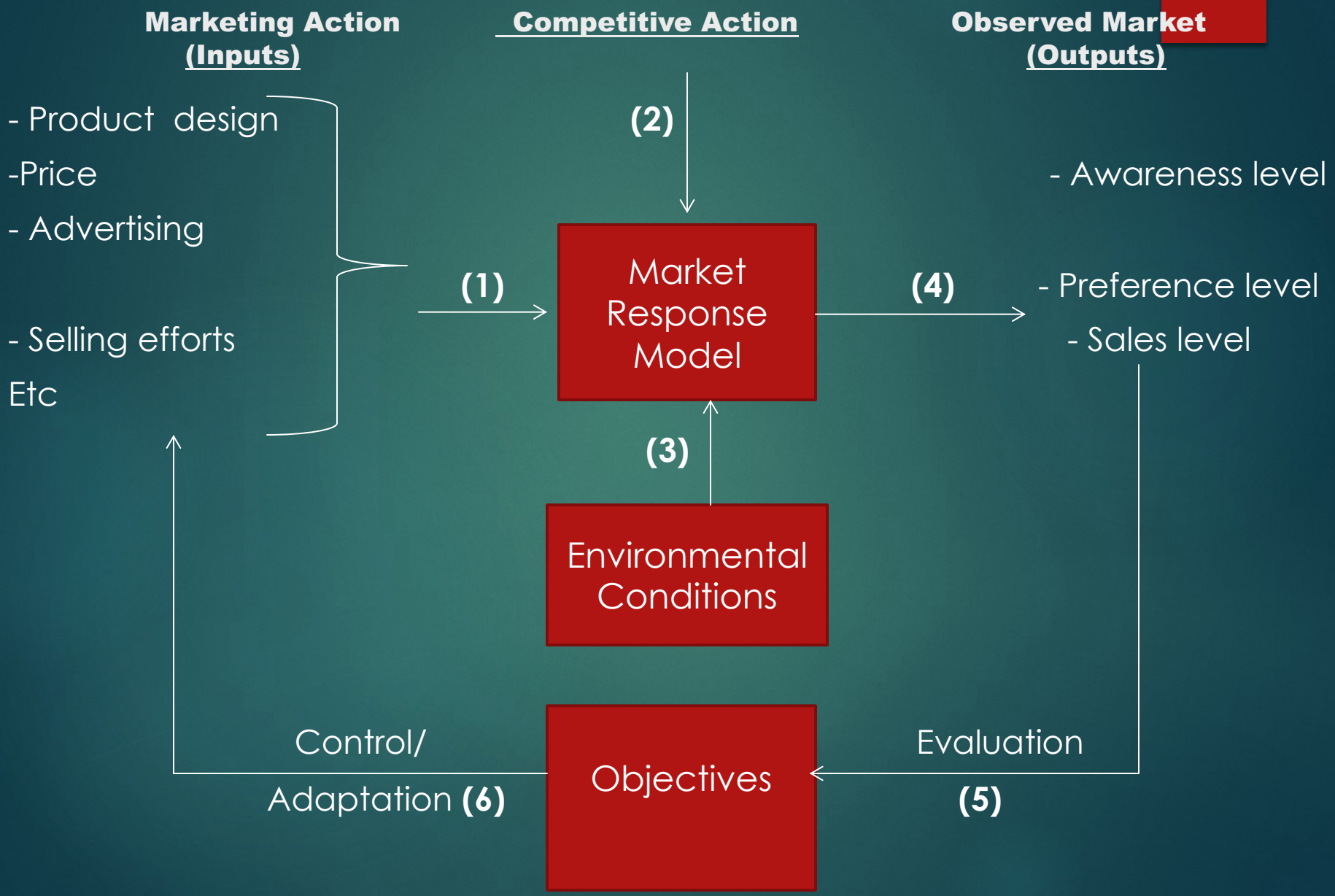
Because of the complexity of marketing problems and the limitations of mental models for decision making, the marketing engineering (ME) approach is of increasing interest to managers. This approach requires that the following be made explicit;

Inputs:- marketing actions that a marketer can control ie price, advertising, selling effort…(marketing mix) as well as non controllable variables i.e market size, competitive environment…

Response models:- the linkage from those inputs to the measurable outputs of concern to the firm.(customer awareness levels, product perceptions, sales levels, and profits)

Objectives:- measures that the firm uses for monitoring and evaluating those actions (e.g level of sales in response to a promo, the % of a target audience that recalls an ad)

HOW RESPONSE MODELS WORK.



- Response models function within the frame work of marketing decisions. E.g a firms marketing actions (arrow 1), along with actions of competitors (arrow 2) environmental conditions(arrow 3) combine to drive market response, leading to outputs (arrow 4). Outputs are then evaluated relative to the objectives of the firm (arrow 5).

- Market response models translate marketing inputs, competitive actions and environmental variables into observed market outputs within the frame work of a marketing decision model (arrow 6), the decision model link.

We use several terms to denote the equation or sets of equations that relate dependent variables to independent variables in a model. Such as relationship, specification and mathematical form.

- Parameters = constants usually (***a*** and ***b***)
- Calibration = process of determining appropriate values for the parameters.

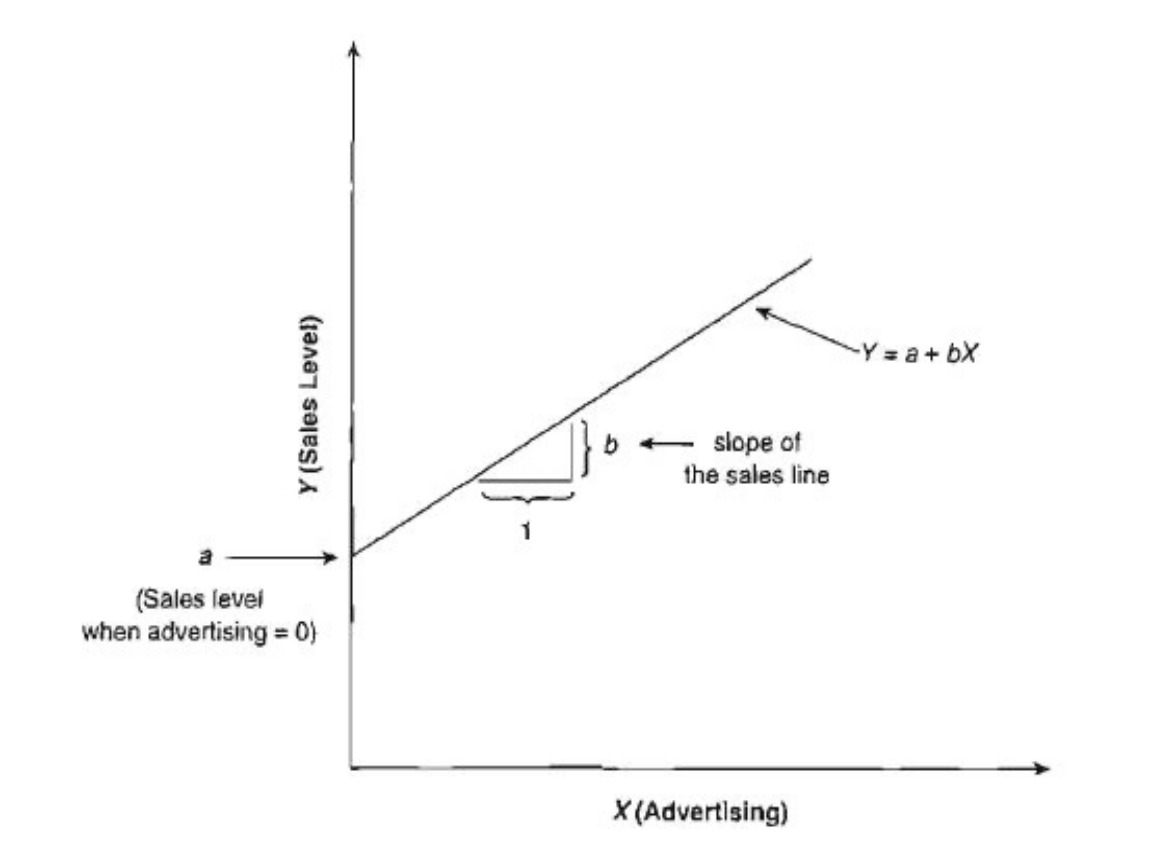
For example a simple model is :

$$Y = a + bX$$

X *is* an independent variable (say advertising), ***Y*** is a dependent variable (sales), the model form is linear , and ***a*** and ***b*** are parameters.

a = Y when X = 0 i.e., a is the level of sales when X = 0 (zero advertising) For every dollar increase in advertising, we expect to see a change in sales of ***b*** units.

Here b is the slope of the sales/advertising model. E.g. if a = 23000 and b = 4, then Y = 2300 + 4X. Then we say we have calibrated the model (given value to the parameters). See graph below.



- ***THERE ARE 8 PHENOMENA*** that have been reported in marketing studies that we can handle with our tool kit of models. We use the term ***input*** to refer to the level of marketing effort, (the X or independent variable), and ***output*** to refer to the result (the Y or dependent variable)

Ref : Fig 1.3 ***THE 8 PHENOMENON.***

P1: Out put = 0 when input = 0

P2: The relationship between input &output is linear

P3: Returns decrease as the scale of input increases (every additional unit of input gives less output than the previous unit gave)

P4: Output cannot exceed some level (saturation)

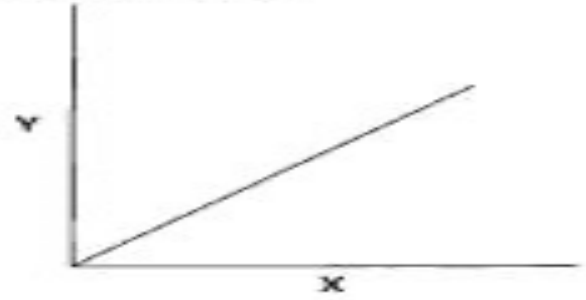
P5: Returns increase as scale of input increases (every additional unit of input gives more output than the previous unit)

P6: Returns first increase and then decrease as input increases (S-shaped return)

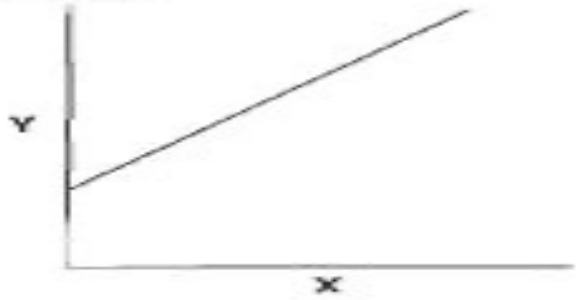
P7: Input must exceed some level before it produces any output (threshold)

P8: Beyond some level of input, output declines(super saturation point)

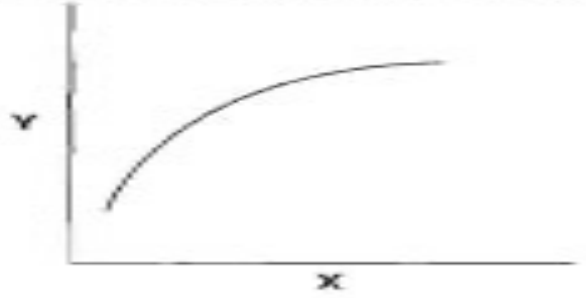
P1: Through origin



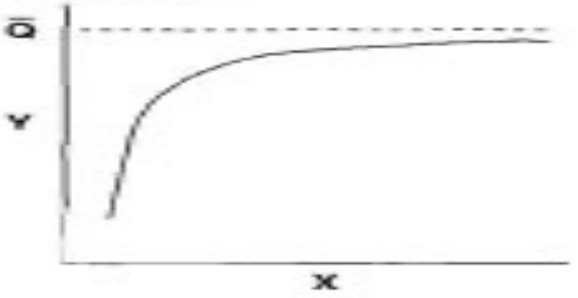
P2: Linear



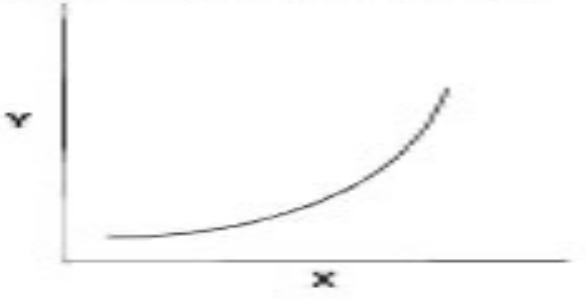
P3: Decreasing returns (concave)



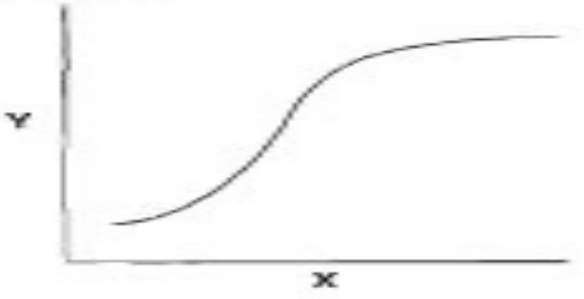
P4: Saturation



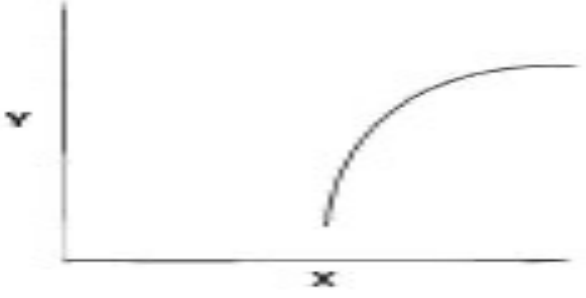
P5: Increasing returns (convex)



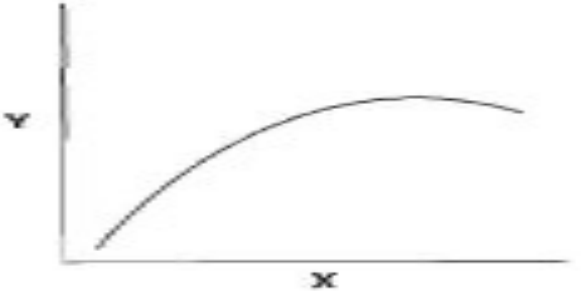
P6: S-shape



P7: Threshold



P8: Super-saturation



Most common model forms that incorporate these phenomena.

The linear model :

$$Y = a + bx$$

Characteristics of the linear model

1. *Given market data, one can use standard regression methods to estimate the parameters*
2. *The model is easy to visualize and understand*
3. *Within specific ranges of inputs, the model can approximate many more complicated functions quite well-a straight line can come fairly close to approximating most curves in a limited region.*

Problems

1. *It assumes constant returns to scale everywhere ie cant accommodate P3, P5 or P6.*
2. *Has no upper bound on Y*
3. *Often gives managers unreasonable guidance on decisions.*

The power series model: if we are uncertain what the relationship is between X and Y, we can use a power series model.

$$Y = a + bx + cx^2 + dx^3 + \ldots$$

The power series model may fit well within the range of the data but will normally behave badly (becoming unbounded) outside the data range.

By selecting parameter values appropriately the model may be designed to handle phenomena P1,P2,P3,P5,P6 and P8.

The fractional root model:

$Y = a + bx^c$ **(with c prespecified),** *the fractional root model has a simple but flexible form. There are combinations of parameters that give increasing, decreasing and (with c = 1) constant returns to scale. When c = ½ the model is called the square root model.*

When c = 1, its called the reciprocal model; here Y approaches the value a when X gets large. If a = 0, the parameter c, has the economic interpretation of elasciticity (the percentage change in sales, Y, when there is a 1 percent change in marketing effort X). When X is price, c, is normally negative whereas its positive for other marketing variables. Handles P1,P2,P3,P4 & P5.

The semilog model:

$$Y = a + b \ln x$$

The semilog model handles situations in which constant percentage increases in marketing effort result in constant absolute increases in sales. Handles P3 &P7 and can be used to represent a response to advertising spending where after some threshold of awareness, additional spending may have diminishing returns.

The exponential model:

$Y = ae^{bx}$ where $X > 0$ *the exponential model characterizes situations where there are increasing returns to scale (for $b > 0$); however its most widely used as a price response function for $b < 0$ (ie, increasing returns to decreases in price) when Y approaches 0 as X becomes large. Handles P5 and if b, is negative, P4 (approaches 0, a lower bound here)*

The modified exponential model:

$y = a(1 - e^{-bx}) + c$ *the modified exponential model has the following form. It has an upper bound or saturation level a + c and a lower bound of c, and it shows decreasing returns to scale. The model handles phenomenaP3 &P4 and is used as a response function to selling effort. It can accommodate P1, when c = 0.*

The logistic model:

$$Y = \frac{a}{1 + e^{-(b+cx)} + d}$$

This model has a saturation level at a + d and has a region of increasing returns followed by decreasing return to scale; its symmetrical around d + a/2. it handles phenomena and P6, is easy to estimate and is widely used.

The Gompertz model: A less widely used S-shaped function is the following Gompertz model:

$$Y = ab^{cx} + d,\ a > 0,\ 1 > b > 0,\ c < 1.$$

Both the Gompertz and logistic curves lie between a lower bound and an upper bound; the Gompertz curve involves a constant ratio of successive first differences of log Y, whereas the logistic curve involves a constant ratio of successive first differences of 1/y. handles P1,P4 &P6.

The ADBUDG Model:

$$Y = b + (a - b)\frac{x^c}{d + x^c}$$

the model is S-shaped for $c > 1$ and concave for $0 < c < 1$. *it is bounded between b (lower bound) and a (upper bound). The model handles phenomena P1,P3,P4 &P6 and its used widely to model response to advertising and selling effort.*

MULTIPLE MARKETING-MIX ELEMENTS: INTERACTIONS.

- When dealing with marketing mix variables, we consider their interactions, and interactions are usually in one of three ways:
- **1)** By assuming they do exist
- **2)** assuming they are multiplicative
- **3)** assuming they are multiplicative and additive.

E.g if we have two marketing-mix variables **X1** and **X2** with individual response functions **f(X1)** and **g(X2)**, then;

assumption **(1)** gives us **Y = af(X1) + bg(X2);**

assumption **(2)** gives us **Y = af(X1)g(X2)**

And assumption **(3)** gives us **Y = af(X1) + bg(X2) + cf(X1)g(X2)** In practice when multiple mix elements are involved, we can resort to one or two forms: the full linear interactive form or the multi active form respectively

Y = a + bX1 + cX2 + dX1X2 note that ***ΔY/ΔX1 = b + dX2****, so that sales response to changes in marketing-mix element **X1** is affected by the level of the second variable, **X2**.*

Multiplicative form is as follows:

$$Y = aX1^{b}X2^{C}$$

- Here $\Delta Y/\Delta X1 = abX1^{b-1}X2^{c}$ so that the change in the response at any point is a function of the levels of both independent variables. Ie b and c are the constant elasticities of the first and second marketing-mix variables, respectively, at all levels X1 an X2.

DYNAMIC EFFECTS

Response to marketing actions does not often take place instantly. The effect of an AD campaign does not end when the AD is over; the effect or part of it, will continue in a diminished way for some time.

Carryover effects is the term used to describe the influence of a current marketing expenditure on sales in future periods.

e.g. ***delayed-response effect***, arises from delays between when marketing dollars are spent and their impact.

Customer –holdover effect, arises when new customers created by the marketing expenditures remain customers for many subsequent periods.

- ***Hysteresis***, here sales arise quickly when an advertising campaign begins and then remain the same or decline slowly after the program ends.
- ***New trier effects***, here sales reach a peak before settling down to steady state, common for frequently purchased products, for which many customers try a new brand but only a few become regular users.
- ***Stocking effects***, occur when a sales promotion not only attracts new customers but encourages existing customers to stock up or buy ahead.

Market share models and competitive effects.

- Brand sales models (y)
- Product class sales models (v)
- Market-share models (M)

Y = M x V ie we obtain our sales (y) by extracting our share (M) from the market in which we are operating (V).

A class of models that satisfy both the range and the sum restrictions are attraction models

General attraction $Mi = \frac{Ai}{A1 + A2 + \ldots An}$

Where Ai = attractiveness of brand i, and $Ai \geq 0$,

Mi = firm i's market share.

Suppose A1= 10, A2 = 5, and A3 = 5

In a market with A1 and A2 only,

Mi = $\frac{10}{10+5}$ = $66_{2/3\%}$ and M2 = $\frac{5}{10+5}$ = $33_{1/3\%}$

Suppose A3 enters. Then after entry,

M1 = $\frac{10}{10+5+5}$ = 50%, m2 = 25%, and m3 = 25%.

Note that brand 3 draws its 25% market share from the other two brands, 50% from brand 1 and 25% from brand 2. ie proportional to those brands' market shares. But suppose that brand 3 is a product aimed at attacking brand 1, one would expect it to compete more than proportionally with brand 1 and less than proportionally with brand 2.

CHOOSING EVALUATING AND BENEFITING FROM A MARKETING RESPONSE MODEL

Model specification

Does the model include the right variables to represent the decision situation?

Are the variables, as represented, managerially actionable?

Does the model incorporate the expected behavior of individual variables e.g diminishing returns, carryover effects…

Model calibration

Can the model be calibrated by using data from managerial judgment or historical data or through experimentation?

Model validity and value

Does the level of detail in the model match that in the available data?

Does the model reproduce the current market environment reasonably accurately?

Does the model provide value in use for the user?

Does the model represent the phenomenon of interest accurately and completely?

Model usability.

Is the model easy to use? (Simple, understandable)

Does it give managers guidance that makes sense?

LINEAR PROGRAMMING

IN MARKETING

Definition

- Mathematical model/technique for efficient and effective utilization of limited resources to achieve organisational objectives (maximize profits or minimise cost).

Components of an LP

1. Objective Function – summarizes objective of the problem (MAX, MIN)

- Max (Profits, Revenue, Returns) **<**
- Min (Costs, scrap, time) **>**

2. Constraints of problem: – limitations placed on the problem; control allowable solutions

– Problem statement: 'given….', 'must ensure…', 'subject to'

– Equations or inequalities

3. Decision Variables – quantities, decisions to be determined

– multiple types (real numbers, non-negative, integer, binary)

– In an LP, the decision variables are real numbers

– Choice of decision variables will determine difficulty in formulating and solving the problem

4. Parameters – Each decision variable must have coefficients of X1, X2

Assumptions of LP

- **Linearity –** both objective & constraint function must be linear in nature y = ax+by
- **Certanity –** parameters of decision variables must be given/known
- **Divisibility –** given variables must be divisible. No infinity
- **Non-negativity –** it assumes non negativity

$X1, X2, X3 \geq 0$

Main applications of LP in Marketing

- Product mix problems
- Product scheduling problem
- Assembly line balancing
- Make or buy problems
- Media selection problems
- Portfolio selection
- Profit planning problems
- Transportation problems

Advantages of LP

- It helps in attaining optimum use of productive factors
- It improves the quality of decisions
- It provides better tools for meeting the changing conditions
- It highlights the bottle neck in the production process

Limitations of LP

- For large problems the computational difficulties are enormous
- It may yield fractional value answers to decision variables
- Its applicable to only static situation
- LP deals with the problems with single objective.

Ex'ple

- Assume that you have two products as part of your product mix problem A & B. Product A spends 4 hours and 2 hours whereas product B spends 3 hours and 1 hour in electronic & assembly departments respectively. The available hours per week are 240 hours and 1oo hours for electronic and assembly and the profit per unit is 7 and 5 respectively.
- Required: Determine the product mix that would maximize profit.

Segmentation Marketing

Definition

Differentiating your product and marketing efforts to meet the needs of different segments, that is, applying the marketing concept to market segmentation.

STP as Business Strategy

Segmentation

- Identify segmentation bases and segment the market.
- Develop profiles of resulting segments.

Targeting

- Evaluate attractiveness of each segment.
- Select target segments.

Positioning

- Identify possible positioning concepts for each target segment.
- Select, develop, and communicate the chosen concept.

… to create and claim value

Overview of Marketing Engineering Methods for STP

- Clustering and discriminant analysis (PDA2001 exercise)
- Choice-based segmentation (ABB Electric)
- Perceptual mapping (G20 exercise)

Steps in a Segmentation Study

- **Establish need for segmentation.** Articulate a strategic rationale for segmentation (i.e., why are we segmenting this market?).
- **Determine variables to use.** Select a set of needs-based segmentation variables most useful for achieving the strategic goals.
- **Select clusters.** Select a cluster analysis procedure for aggregating (or disaggregating customers) into segments.
- **Determine No. segments.** Group customers into a defined number of different segments.
- **Choose segments.** Choose the segments that will best serve the firm's strategy, given its capabilities and the likely reactions of competitors.

Segmentation: Methods Overview

- Factor analysis (to reduce data before cluster analysis).
- Cluster analysis to form segments.
- Discriminant analysis to describe segments.

Cluster Analysis Process

- **Define a measure to assess the similarity** of customers on the basis of their needs.
- **Group customers with similar needs.** The software uses the "Ward's minimum variance criterion" and, as an option, the K-Means algorithm for doing this.
- **Select the number of segments** using numeric and strategic criteria, and your judgment.
- **Profile the needs** of the selected segments (e.g., using cluster means).
- **Map & interpret clusters**. – draw conclusions – illustrative techniques like perceptual maps are useful.

Cluster Analysis Issues

- Defining a measure of similarity (or distance) between segments.
- Identifying "outliers."
- Selecting a clustering procedure
  - Hierarchical clustering (e.g., Single linkage, average linkage, and minimum variance methods)
  - Partitioning methods (e.g., K-Means)
- Cluster profiling
  - Univariate analysis
  - Multiple discriminant analysis

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