# A FUZZY LINGUISTIC DECISION MODEL APPROACH FOR SELECTING THE OPTIMUM PROMOTION MIX FOR DIGITAL PRODUCTS WITH GENETIC ALGORITHMS

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**I hereby declare that all information in this document has been obtained and presented in accordance with academic rules and ethical conduct. I also declare that, as required by these rules and conduct, I have fully cited and referenced all material and results that are not original to this work.**

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## ABSTRACT

A FUZZY LINGUISTIC DECISION MODEL APPROACH
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Promotion is one of the four major marketing elements of the marketing mix (others are product, price and place) in implementing marketing strategy. Promotion is dealing with the ways a company communicates with its customers to persuade them to buy the product. Promotion mix covers all the different ways a company choose to communicate with its customers such as advertising, personnel selling, PR, sales promotion and others. Selecting the optimal blend of the promotion mix is a tough and critical issue for marketers and does not have a fix operative formula. The fast pace of improvements in digitization in this era led companies produce digital products. Due to their inherent characteristic of digital products, such as intangibility, promotion mix selection is a more challenging issue. In my thesis study, I proposed a framework in classifying the digital products and then apply a fuzzy linguistic decision model approach with appropriate genetic algorithms to reach an optimum promotion mix set for digital products. Optimization is targeting to justify the objectives of the company, provide a satisfying marketing performance for the companies of digital product producers and utilize their budget effectively. The proposed model is implemented on an empirical case and produced satisfactory results.



Keywords: Digital products, promotion mix, fuzzy model, genetic algorithms, linguistic decision-making

# ÖZ

DİJİTAL ÜRÜNLERDE OPTİMUM PROMOSYON KARMASINI SEÇMEK İÇİN GENETİK ALGORİTMALARI İLE FUZZY LİNGUİSTİK KARAR VERME MODELİ YAKLAŞIMI

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Promosyon, pazarlama stratejilerini oluştururken kullanılan dört temel pazarlama karmasından biridir (diğerleri ürün, fiyat ve dağıtım). Promosyon, şirketlerin ürünlerini satın almaya ikna etmek amacıyla müşterileriyle kurdukları her türlü iletişim yöntemini içerir. Promosyon karması da bu amaca ulaşmak için reklam, kişisel satış, halkla ilişkiler, satış promosyonları ve diğer farklı yol ve yöntemleri kullanır. Promosyon karmasının optimal karışımını seçmek pazarlama yöneticilerinin oldukça zor ve kritik bir görevleri olup geçerli sabit bir formülü de yoktur. Dijitalleşmenin oldukça hızlandığı günümüzde şirketler daha fazla dijital ürün üretmeye başlamıştır. Dijital ürünlerin yapısından kaynaklanan, elle tutulamama gibi, özelliklerinden dolayı promosyon karmasını oluşturmak çok daha zorlayıcı olmaktadır. Tezimde, önce dijital ürünlerin sınıflandırıldığı bir çerçeve önerisinde bulundum. Ardından bu ürünlerde optimum promosyon karmasını seçmek için uygun genetik algoritmaların kullanıldığı fuzzy linguistik karar verme modeli yaklaşımı kullandım. Optimizasyon ile şirket hedeflerini gerçekleştirmeyi, dijital ürün üreticilerine tatminkar pazarlama performansı sağlamayı ve belirlenen bütçenin en etkin şekilde kullanılmasını hedeflemektedir. Geliştirilen model gerçek bir örnek üzerinde denenmiş ve tatminkar sonuçlar elde edilmiştir.

Anahtar Kelimeler: Dijital ürünler, promosyon karması, bulanık mantık modeli, genetik algoritmalar, linguistik karar verme

*To my loved ones*

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# CHAPTER 1

## INTRODUCTION

Marketing management is basically based on the strategies on major four categories, namely as, product, price, place and promotion. Also known as 4 P's of marketing after grouped by Jerome McCarthy in 1960's, those elements are managed by the marketing managers in order to realize the targets of the company. Better company performance is tied to better coordination of these marketing mix elements. Thus, there is a close interaction between those four basic elements. While determining the impact of any decision for each element solely is very challenging, interactions among these 4P's are extremely tough, if not merely impossible. In this study, only promotion element of 4P's is taken into consideration and other elements are assumed to be a given value. Promotion stands for all efforts to communicate with target customer. Promotion activities deals with defining the objective of the promotion, designing the right communication content –the message-, choosing the right blend of communication channels, budgeting, delivering the message to the right customer at the right time. One of the most critical issues is to decide the distribution of marketing budget among all possible channels since consumer preferences, market variables, product parameters and company strategies are simultaneously in effect. Selecting a promotion mix is not a straightforward process and a tough problem of marketers. In the second chapter, marketing mix and the promotion concept, tools of promotion, dynamics of those promotion tools are briefly summarized.

Internet and information technologies are playing greater role in our everyday life. Products and services are becoming more digitized and with the help of faster internet infrastructure it will become more widespread. This challenge is appealing interest of increasing number of companies which are providing new digital products and services. Digital products, such as software tools, e-books, e-

services, electronic games, search engines, digital service platforms and web sites are gaining ground among their tangible counterparts, if any. Digitization may be regarded as just another format type but it is more than this. Due to its nature, it does not have a physical distribution channel, but via internet. Most of the digital products provide a different customer experience in buying those products. Due to highly intangibility of its nature, digital products need different marketing strategies as well as carefully selected promotion mix. In the third chapter, digital products are defined; a framework for classifying digital products is proposed in order to have a better understanding of them. Moreover, for each category of digital product, relevant promotion strategies and tools are discussed and identified.

Every marketing decision is evaluated according to a marketing strategy which is an interpreted form of the business strategy of the company. The aim is to satisfy the objectives of the company identified by the marketing strategy while utilizing the budget effectively by selecting the optimum promotion mix among a number of potential tools available. Although selecting the promotion mix for tangible products are quiet tough job, promotion mix selection for highly intangible goods and services requires a different decision model. Since more intangibility means more uncertainty. Thus, to overcome the processing of uncertain information, decision making in multi-criteria environment problem, a different approach is needed other than judgment oriented or try-and-fail method which is usually the case. A fuzzy linguistic decision model with genetic algorithms is provided for evaluating the potential promotion tools mix to satisfy the promotion objective under this high uncertainty. It is thought that this type of optimization decisions require linguistic parameters rather than numerical.

In the fourth chapter, a linguistic approach is proposed for the promotion mix concept; a decision model is proposed; based on this decision model, genetic algorithms are applied to reach an optimum solution or at least a satisfactory good solution. The proposed solution will be applied in an empirical study for a digital product.

In the last chapter, the proposed model will be discussed based on implementation outputs. It is supposed that the linguistic decision model is an

effective, appropriate and useful model in defining and formulating the promotion mix problem. It is shown that the model would provide a satisfying marketing performance for the companies of digital product producers, increase the effectiveness of their promotion activities, budgeting and help them to re-evaluate their current strategies.

# CHAPTER 2

# MARKETING MIX AND PROMOTION

## 2.1. Definition of Marketing Mix

Marketing mix is one of the famous concepts in marketing. Maybe the most appropriate definition for marketing mix is as follows: “Marketing mix is the set of marketing tools that the firm uses to pursue its marketing objectives in the target market.”[1] The stated phrase of ‘set of marketing tools’ are defined and fulfilled with concepts and ideas. However, the best known definition is accepted as the one McCarthy stated in 1960. According to him, marketing mix is categorized into 4 groups and abbreviated as 4Ps of marketing, as follows:

- Product
- Place
- Price
- Promotion

It should be noted that 4Ps of marketing is just one of the marketing mix set available today. Especially in recent decade, new definitions, revised suggestions on existing sets are in place. Due to increasing complexity and transformation in customer demand and behavior, fierce competition, product differentiation, new distribution channels, improvements in communication infrastructure, customization and increased interaction between buyer-seller, buyer-buyer leads to different marketing mix definitions. Although new marketing mix sets are introduced, they all followed the style McCarthy did, by means of using acronyms.

Boom and Bitner developed the model by adding 3 new Ps to the existing set as:

- People

- Process
- Physical environment

Robert Lauterborn criticized the 4Ps model as being mainly producer oriented and offered another approach from customer perspective as 4Cs [2] as follows:

- Customer solution for Product
- Customer cost for Price
- Convenience for Place
- Communication for Promotion

Another approach in enhancing the traditional marketing mix is the suggestion that in selling more complex B2B products and services 4 Ps are not sufficient as much as the B2C cases. Thus, additional Ps is needed to capture these limitations. Within this scope 7 additional Ps are added to address the marketing mix also covering the e-marketing concept. [3] Those are defined as:

- People
- Partnership
- Productivity
- Personalization
- Physical image
- Protocols
- Privacy

No matter which set is preferred, the aim is to make the best offer to market in order to satisfy its targeted customers by means of blending these marketing mix tools. Among 4Ps, product and place are more long-term related issues while price and promotion are more short-term issues.

4Ps of marketing is summarized in the following table, including relevant aspects of each Ps which indicates strategic decision parameters:

**Table 2.1.a 4Ps of Marketing**

| PRODUCT | PRICE | PLACE | PROMOTION |
|---|---|---|---|
| Physical good | List price | Channels | Advertising |
| Service | Discounts | Coverage | Sales force |
| Design | Allowance | Locations | Sales Promotion |
| Features | Financing | Inventory | Direct marketing |
| Quality | Geographic terms | Kinds& location of stores | Personal selling |
| Packaging | Flexibility | Middlemen | Online marketing |
| Warranty | Level over PLC | Assortments | Viral marketing |
| Accessories | Payment period | Transportation | Relationship marketing |
| Branding | Credit terms | Service levels | PR |
| Service support | | | Mobile marketing |
| Size | | | Message |
| Installation | | | Media |
| | | | Budget |

The marketing mix decision is the base for determining the marketing strategy of the company. It should be noted that all marketing mix elements are highly tied together. Thus, while developing the mix elements the close interaction between each element should be kept in mind. Due to those interdependencies of marketing mix elements, the 4 Ps can be expressed as a Venn diagram with overlapping circles.[4] Any missing details in any of the marketing mix element would be the weakest link in the marketing strategy and would cause unexpected results. For instance, an x% decrease in price would have a y% increase in sales volume or a new product development may cause z% increase in total sales but t% decrease in sales of existing products, poor promotion performance for existing products.


**Figure 2.1.a Marketing Mix**

It is clear to see the complexity of interaction of each element, so that in our study solely the modeling of promotion is selected. As seen from the table above, promotion element has different tools available for different needs. In the next section, the promotion element and its aspects are briefly defined.

## 2.2. Definition of Promotion

Stated as the final element of 4Ps, promotion stands for all those efforts to communicate with target customer. Promotion activities deals with defining the objective of the promotion, designing the right communication content –the message-, choosing the right blend of communication channels, budgeting, delivering the message to the right customer at the right time. Thus, promotion decision has different steps to handle as follows:

i. Defining the promotion objective : In general, the objective of a promotion program may be increasing the sales / profit / market share, sustainable growth rate, increase awareness, developing brand image and equity, generating desire and interest in company product and finally generate sales. There are a number of other factors affecting those stated objectives. Thus, the promotion objective should be selected as clear, measurable and applicable.

ii. Designing the message : Message is all type of information designed and delivered to customer with a set of attributes as the words, signs, color,

tone, look, etc. Message content is based on USP (unique selling Proposition) of the company which would be subjective, attractive, clear, desirable and outstanding.

iii. Communication channels: There are plenty of communication channels having different characteristics and advantages. Mass marketing, direct marketing, interactive marketing has different communication channel alternatives. Depending on the promotion strategy and the budget, the correct blend of communication channels should be chosen.

iv. Budgeting: Allocating the right budget is a fundamental and tough issue. Promotion budgets are mostly determined by using one of or combination of the following approaches :[5]

   a. Incremental budgeting: budget is calculated as a percentage increase of last year budget
   b. Percent of sales: widely used by companies and the budget is calculated as a percentage of realized sales or expected sales
   c. According to competitors: budget is calculated according to the close competitor's total budget or percentage.
   d. As much as available: Depending on the affordability of the company, the budget is set which is the most inconvenient way.
   e. Value-based budgeting: Promotion budget is calculated as the amount maximizing the discounted future cash flows generated by the product/service to its net present (NPV)

v. Right audience: Audience may be a mass group, a small community, corporate or government. Some communication channels are better than others for a specific audience. Thus, selecting the right combination of communication channel and the message is critical in touching the right audience.

vi. Right time: Sending a message is meaningful only if there is a party receiving, accepting and understanding it. Sending the message at the right time has a crucial influence on the consumer. Otherwise, promotion spending may ruin. Timing should consider the life cycle of the product or service, preferences of target audience, appropriate frequencies, industry and convenience so as to increase the effectiveness of promotion.

Briefly, during a promotion strategy formation, a marketing manager set the objective of the promotion, designs the offer, selects the target audience, select the media, and plan the timing. One of the most critical issues is to decide the distribution of marketing budget among all possible channels. Since each sale is a kind of persuasion of customer, all the promotion process is focus on selecting the best combination of available tools for persuading the customer to buy the offered product or service. However, the difficulty does not end here. Because it is difficult indeed to measure the net effect and contribution of any selected channel since companies communicate with its customers with a number of different ways simultaneously. Moreover, marketing response have different patterns as immediate or subsequent effects which means promotion tool net effect may be seen in short term or long term. In addition, effect of a promotion tool may not be a linear but logarithmic or exponential which makes it hard to measure the net contribution. Another issue is that although a company may choose a good blend of the promotion tools but performance may be beyond expectation since a close competitor may be heavily promoting with a bigger budget. Those issues make the allocation and reallocation of budget among different channels a tough task. Each communication channel has its advantages and disadvantages. Better understanding of the communication channel better selecting the proper ones in promotion planning.

### 2.3. Promotion Methods and Tools

As mentioned in previous section, companies need to communicate with its current and potential customers. Moreover, companies need to communicate with its potential stakeholders and also with the public. Promotion tools are also named as promotion mix or marketing communication mix. Since the last decade, due to increase in forms of communication, customer-centric approach, internet infrastructure, customization and globalization, marketing communication efforts need to be integrated. Named as integrated marketing communication (IMC), all marketing tools and resources are integrated in order to maximize the total effect of promotion mix and minimize the overall cost. Thus, each marketing effort is interrelated with others and should be in harmony rather than isolation. It should be noted that the overall contribution is greater than the sum of contribution of

each tool. Marketing managers face with another mix to choose the best blend to satisfy the marketing objectives effectively.

Promotion mix is composed of six categories, namely, advertising, personal selling, sales promotion, public relations, direct marketing and internet marketing. By means of those tools companies design their communication strategies and apply. It should be noted that not only those tools are used to communicate with the customers but also package shape and color, product style, salesperson dress, call-center performance, post-sales relations, retailer performance, in short every brand contact, is also sending messages to customers. [6] This fact indicates that marketing mix and promotion mix should be integrated and consistent so that no conflicting message is disseminating.

In the following section, promotion mix elements are discussed summarizing the features, advantages and disadvantages of each.

### 2.3.1. Advertising

Advertising is any paid form of non-personal presentation and promotion of ideas, goods or services by an identified sponsor [7] in different media, such as television, newspapers, radio, cinema, magazines, billboards, point of purchase displays, brochures, inserts, web sites etc.

Objective of advertising can be classified as follows:

- Informative advertising
- Persuasive advertising
- Reminder advertising

Advertising can be used to build up a brand image in long term and also short term sales booms. TV advertising relatively requires bigger budgets than other forms of advertisements. The objective of advertisement differs according to the life cycle stage a product or service is in. When the product is in its introduction stage, informative advertising is used. In growth phase persuasive advertising; in maturity and decline stage reminder advertising is used. Each of these objectives tends to code the message in a different manner. Since the advertising has many

forms and uses, it is not easy to find common ground for all but some distinctive points are summarized below:

**Table 2.3.1.a Evaluation of Advertising**

| ADVANTAGES | DISADVANTAGES |
|---|---|
| Effective in building awareness | Impersonal – all audience receive the same message |
| Effective in reaching a wide target audience | Monologue |
| Effective in building customer trust | May not get customer to make a final purchasing decision |
| Effective in building brand image in long term | Some forms are expensive to use |

### 2.3.2. Sales promotion

Sales promotions are basically providing incentives to customers or to the distribution channel to stimulate demand for a product or service. Sales promotion tools are coupons, premiums, cash refunds, price pack, patronage rewards, contests, samples, allowances, sales aids etc. Sales promotion has three main characteristics: [6]

- Communication (gain attention and provide information)
- Incentive (some concession or contribution giving value to customer)
- Invitation (a distinct invitation for purchase)

Sales promotions may target customers, middlemen or company employees. Sales promotion creates quick response and may boom sales. Effects of sales promotion is usually short term and may damage brand image if used so frequently. Another incidence of sales promotion is decrease in profitability. Sales promotions can be used to complement advertising. Packaged products use sales promotion heavily and triggers competitors to act similar. Distinctive points of sales promotions are summarized below:

**Table 2.3.2.a Evaluation of Sales Promotion**

| ADVANTAGES | DISADVANTAGES |
|---|---|
| Effective in stimulating quick increases in sales by targeting on particular products | Lose effect on customers if used over the long-term |
| Effective as an short term tactical tool | Too much sales promotion may damage the brand image |
| Can be used for customer, middlemen and employees | Effective on non-loyal customers |
| Effective in introduction and maturity stages | |

### 2.3.3. Personal selling

Personal is briefly a face-to-face oral communication between seller and potential buyers with the intention of making a sale. Personal selling initially starts for initiating and developing a relation with the potential buyer and finally aims at closing the sale. Personal selling is one of the most effective tools in building buyer preferences, persuasion and action, the sale. Personal selling is the sales team of the company. They search and find potential customers, travel too much, spend time and money to persuade the customer, take regular trainings etc. Personal selling is used in most of promotion mix but it can be very expensive. That is why it should be controlled seriously. Thus companies are looking ways to decrease the cost of personal selling and increasing their efficiency. Telemarketing is a way to decrease the cost of personal selling where sales teams are not spending outside. Using distributors, installing sales automation systems, organizing the sales teams according to vertical markets, using performance monitoring systems are some of those approaches. [8]

Although the personal selling is a relatively expensive promotion tool it is crucial to use in some certain stages and for some critical customers. For most business, it is a known fact that high percentage of sales and profits are earned from small percentage of customers. In other words, Pareto's principle is in power

saying that 80% of your sales come from 20% of your customer. Thus identifying those 20% and focusing on them is crucial which means that talented sales team should have close relationship and spend necessary time with them. For those type of customers, personal selling is the most appropriate promotion tool and can not be supplemented by advertising or PR.

Personal selling has three main characteristics: [1]

- Personal confrontation (it is a immediate and interactive relationship)
- Cultivation (deep relationship opportunity with customer)
- Response (makes the potential buyer feel to attend and respond)

Personal selling requires a great care in recruiting, training, controlling and monitoring the sales team. In addition to good sales skills they are also a sort of display of company continuously giving message about the company. In addition to their verbal expressions, their non-verbal expressions such as appearance, tone of speech, attitudes are very important. One mistake of a salesman may be loose of a critical customer. Thus, a salesman is a showcase of a corporate identity and responsible from corporate reputation.

Another issue of personal selling is the difficulty in establishing a sales team and de-establishing the sales team. Starting, modifying and stopping an advertisement campaign or a sales promotion program is relatively simple when compared the same case in personal selling. Thus, the decision to establish a sales team, deciding on the number of the team, monitoring systems needs careful planning. A well-planned and managed personal selling team would be very profitable for the company while poor performing sales teams would be disaster and very costly for the company. Stopping such costs and damages are not easy and requires extensive effort.

Distinctive points of personal selling are summarized below:

**Table 2.3.3.a Evaluation of Personal Selling 4**

| ADVANTAGES | DISADVANTAGES |
|---|---|
| Highly interactive and responsive – in-dept communication opportunity between the buyer and seller | Costly - employing a sales team has many hidden costs in addition to fixed salaries |
| Excellent for communicating complex, high value and detailed product information and features | May not be suitable if there are huge amount of important buyers |
| Effective if closing a sale is taking a long time | Requires effective sales team management |
| Provides company very valuable detailed customer information | Salesman-buyer relationship may get ahead of company-buyer relationship |
| Required for handling critical customers | Hard to establish, manage and de-establish |

### 2.3.4. Public Relations and publicity

Public relations is any unpaid form of communication of a product, service, brand, ideas or business by means of various channels. Press kits, speeches, annual reports, seminars, sponsorships, publications, lobbying, investor relations, company magazine are some of the platforms of public relations and publicity tools. PR uses all types of media, broadcast media, print media, e-media and outdoor media. Moreover, PR requires effective usage of opinion leaders who receive the information and disseminate to others. This is an indirect information flow to buyer from the company.

Basic tools of PR can be categorized by an acronym of PENCILS: [7]

- Publications (brochures, annual reports, company magazine)
- Events (sponsorships, sport/art events, trade shows, press conference)
- News (Good news about company, products, employees in media)
- Community involvement activities (charitable donations)
- Identity Media (corporate identity, logo, letterhead, business card etc)

- Lobbying (lobby activities for beneficiary legislation for company etc)
- Social Responsibility Activities (active involvement in SR projects)

Public relations activities have some distinctive features over other promotion tools as follows:

- Credibility (news, opinions of others are high credible information sources than paid and biased advertisements)
- Information flow (for financial public relation or crisis management, it is the most convenient way to disseminate information)

Public relations are utilized relatively less than other promotion tools. Effects of public relations are sometimes relatively intangible than other types of promotion and may be regarded as a long-term investment. In some markets and in some certain stages of the product public relations are valuable contribution. For instance, high-tech products highly benefit from effective public relation activities before the launch of product [8]. Opinion leaders, leading IT magazines editor's comments about those products would boost the product sales.

Public relation activities can be used to build up a friendly relationship with potential customers, investors, general public and also employees. While companies plan their public relation activities, some form of those activities may be out of control of company. Public relation activities are mostly used for products/services and also corporate reputation. Moreover, public relations is utilized for disseminate the financial information of the company. In recent years, public relations activities are highly used in crisis management. Other tools of promotion are not so effective in crisis management as public relations. It should be noted that creative public relations is a key differentiator in those types of activities. Briefly, public relations should be carefully designed, planned having the features of 3C, namely, creativity, consistency and continuity. [9]

By means of internet, public relations gained another channel to communicate with targeted audience, the blogs and social media. Blogs and social media such as Facebook, YouTube, MySpace, Twitter are increasing with a fast pace and reaching to others faster than traditional media for active internet users. In that sense, it is becoming an important rival for traditional media. By using search

engines, an internet user can easily reach the comments of others about any of the interested topic in seconds. Search engines are the most popular approach for locating information on the web. [24] In traditional media such kind of a search is not so possible and targeted audience may easily miss the messages of the public relation activities. Companies are using blogging to directly communicate with targeted audience, get aware of the comments, answer questions directly and may reach to a highly distributed target audience easily. However, companied should be ready to face and struggle with bad rumors, false information, intentional inducements, and competitor's attacks as well. In short it is a type of two-side sharp knife to be used. Especially for high-tech products, digital products blogs are so effective in decision making.

Distinctive points of public relations and publicity are summarized below:

**Table 2.3.4.a Evaluation of PR**

| ADVANTAGES | DISADVANTAGES |
|---|---|
| Often regarded as more "credible" - since the message seems to be coming from a third party (e.g. newspaper, blog, customer) | Risk of losing control – can not control what others write or say about you, or your message may be misunderstood |
| Cheaper way of reaching many customers - if the right media and message is selected | Has intangible effects which may be hard to see |

### 2.3.5. Direct Marketing

Markets are splitting into smaller markets owning more homogenous members having similar interests. This creates another opportunity for companies to address their target market more effective and even directly. Direct mail, telemarketing, e-mail marketing, voicemail marketing, mobile marketing, SMS marketing, direct response TV marketing, direct selling are usual ways of direct marketing.

Direct marketing has a history of 40 years and the pioneer of the concept is Wunderman. “The right message to the right person at the right time – that’s the secret of marketing, it’s like Einstein’s formula.”[10]

Direct marketing has two distinctive characteristic:

- Personal, it sends the message directly to customer without using any third-party media,
- Customized, contrary to other tools the message is designed according to the specified individual
- Call-to-action, having an emphasis on a response
- Accelerated, easy to prepare, modify and apply

Since the last decade, direct marketing started to use the power of software and software tools. CRM, SCM, BI are some those software and tools collecting, storing, processing and mining customer data. Also named as database marketing, customer data is utilized as valuable customer information and by means of data mining tools direct marketing programs are easily established. As the market is evolving more and more customer-centric, customer data is becoming extremely valuable asset of a company. Correct data, effective data analysis and mining, right timing is crucial for effective direct marketing activities.

Direct marketing is more effective if used in a mixed manner of different tools consecutively. For instance, a direct mail or e-mail campaign followed by a telemarketing; SMS marketing followed by telemarketing will increase the effectiveness of the campaign.

Direct marketing campaigns should be sensitive in not disturbing the potential customers in using private information of customer, addressing the right audience and reaching them with permission if applicable. Today, many people get aware of sales and discounts, new product launches, new campaigns from SMS services but they also get angry to be disturbed by irrelevant and excess messages. Thus, direct marketing should focus on right timing, right frequency and well-addressed audience.

Distinctive points of public relations and publicity are summarized below:

**Table 2.3.5.a Evaluation Direct Marketing**

| ADVANTAGES | DISADVANTAGES |
|---|---|
| Most of the time effectiveness can be directly measurable | Irrelevant addressing cause negative opinions |
| Lower cost than personal selling | May disturb customers for privacy issues |
| By permission marketing aspects, companies develop good relationship with customers | Wrong timing means lost of sales |

### 2.3.6. Internet Marketing and Promotion

It is the newest type of promotion which is also referred as online marketing or e-marketing. Internet marketing covers all the ways to market product and services over internet. The interesting point is that as a new type of media, internet created its own marketing dynamics based on the opportunities provided by new communication infrastructure, ever-changing customer preferences and attitudes, information richness, interactivity, immediacy, transparency and individualization. It should be noted that some of the tools which will be stated in this topic are already discussed in former promotion tools but due to the new ways of using this tools and variations they are listed under a separate part in this study.

After the first ad is appeared on internet in mid 1990's, it becomes an important media to promote products and services. Conceptually, internet marketing or e-marketing is also a media for traditional promotion tools. For instance, advertising uses internet as a new media but online advertising has different dynamics and methods. That is why internet marketing is regarded as a promotion tool in this study.

**Table 2.3.6.a Evaluation of Internet Marketing**

| ADVANTAGES | DISADVANTAGES |
|---|---|
| Cost effectiveness – promotion on internet cheaper since has almost no distribution cost and cheaper production costs | May be insufficient to satisfy the customers for highly intangible products |
| Market expansion in different geographical markets. Opportunity to have a global presence easily | Person-person interaction is more powerful than machine-person interaction |
| Full access – by means of websites companies become available 24 hours a day | Security and privacy concerns are causing hesitation to complete the sales |
| Highly interactive and responsive – instant communication, interactive relationship speed up the selling process | Requires potential customers to use internet technologies and sufficient communication infrastructure |
| Time saving – it is easy and fast to reach comprehensive information, comments, answers etc | For tangible products touching or trying desire is powerful |
| Measurability of promotion performance | Less effective in low involvement products |

Internet marketing has plenty of promotion tools. The basic step starts with well-designed web site and a domain name. Websites are the first step in generating business. Since it is the evidence of your existence and presence, an attractive, easily accessible, up-to-date website is essential. Briefly, the website itself is the basic promotion tool in internet-age. It is not sufficient by mandatory. Websites are the primary information source of potential customers. Regardless of the product or service and type of business potential customer requires reaching relevant and solid information first then the product itself. Thus, website is the fastest message of the company. Having a 24/7 access, up-to-date information, first impression and profile delivers a good amount of message to potential customer. Moreover, website is also a part of corporate identity and sends some

other messages which are intangible. Website design gives the clues of the business approach, professionalism and corporate values.

Due to the huge amount of digital content, search engines are the only way to reach the relevant one. Unfortunately, the evidence of being of a company is more or less depends on the listing of search engines. Thus search engine optimization is another promotion tool. Search engine optimization requires the carefully selected keywords to pull targeted traffic to company.

Online advertising is also gaining ground in recent years parallel to the increase in internet users and bandwidth capacities. Online advertising has various methods. Banner advertising is the first and the best-known way of paid advertising. There are new forms of banner ads such as interstitials which is a full-page advertisement appeared when exiting a website; pop-up windows loaded with the website; pop-under ads in which ads are placed on another page and visible after the main page is closed; opt-in e-mail advertising which is also known as permission marketing where the ads are sent to only willing customers; online 'advergaming' where young people is targeted to send message by means of games; pay-per-click links mostly used in search engines; sponsorships on website for longer-terms. For opt-in email advertising, websites must have the design to capture the contact information of those willing visitors. Viral marketing is another internet promotion. Also known as "word-of-mouth" in traditional marketing approach this viral marketing is changed as "word of mouse". Blogs, social network sites are the pioneers of viral marketing. Blogs are important tools to build up a trustful relationship with customers and public.

Another tool is structuring a user ratings and reviews about the product and/or company. In fact, there some sites solely established for this purpose. [23] Those sites, such as Bizrate.com, aggregate the user ratings about companies and products and propose the results for potential customers. Also, customer reviews are added about products providing details about the purchase experience in addition to a rating point. Many B2C sites offer such services like amazon.com. Companies may also provide such services to aggregate customers rating and reviews in order to take relevant action in product design, features, pricing and also promotion strategies.

A detailed list of promotion mix tools are given in Appendix A. It should be noted that promotion tools are not limited with this listing and new forms of promotion tools are continuously emerging by means of innovative approaches and development of new channels.

### 2.4. Parameters in Selecting the Promotion Mix

In the former sections, each promotion mix tools are discussed in detail with their unique characteristics. This is a crucial step in order to make appropriate selection among them in establishing the promotion strategy of the company.

In addition to the characteristic of each promotion mix tools companies should also pay attention to factors which are affecting the promotion mix selection process. Unfortunately, companies mostly use casual even instinctual or habitually which results in waste of money and ineffective promotion expenditures.

All communications efforts are aiming to take a desirable response from the customer. It may be putting some idea into their mind, change a habit or an attitude, trigger for an action. Those stages are defined in various customer response hierarchy models. Among many of them AIDA model is seen appropriate to use. AIDA is the acronym formed of first letters of four stages as *awareness, interest, desire and action.* It is a top-down approach where the communication activity should take attention, create an interest about the product or service, arouse a desire to own it and finally trigger for an action, purchasing. AIDA model is important in deciding the promotion mix since it gives a guideline of four steps to follow.

In the following section, major parameters in selecting the appropriate promotion mix are discussed briefly.

#### 2.4.1. Product and Service Parameters

Since the promotion activities are aiming to communicate with the target customer effectively about the products or services of the company, product and

service features, characteristics identifies and conduct this communication manner. Within this scope, several product parameters should be discussed.

a) **Type of Product:** The first factor is the type of the product or service whether it is a consumer good or industrial good. Relative importance of promotion tools in consumer goods and industrial goods are different. The difference is oriented mostly because of the different decision process and the nature of the products. Industrial goods are mostly complex, expensive and risky and require longer decision time, extensive information and large budgets. That is why personal selling is relatively important than advertising. However due to product characteristics, life cycle stage of the product, place of the customer other promotion tools may also well-performing.

b) **Product Life Cycle:** The second factor is the stage of the product in its life cycle. Product life cycle is mainly divided into four stages, namely, introduction, growth, maturity and decline.

   Introduction stage is the most critical stage where the awareness and primary demand should be created. Therefore, promotion effort is highly needed to introduce the new product and service to targeted customer. Advertising, publicity and sales promotions are so effective to create awareness and trial of the product is essential for consumer products. In introduction stage of industrial products and services personal selling is well-performing.

   During the growth stage where the market is expanding a blend of promotion tools may be used for consumer products. Different forms of advertising can be used both in consumer and industrial products. Personal selling is still beneficiary for industrial products. Establishing good market coverage by distribution and play for market share is critical while triggering wider trials should be preferred.

   In maturity stage where competition is fierce and product category is well-known, differentiation becomes critical. Differentiation may be product

feature base or incentive base. Thus, sales promotions as an incentives and advertisements as brand and product differentiation is appropriate for consumer products. Building customer loyalty must be the objective. Personal selling and PR activities are appropriate for industrial goods in this stage.

In decline stage, sales promotion becomes more important because price competition is the driving force. Promotion expenditures are mostly reduced. Personal selling is not much effective. Advertising may be used if the company has a high market share where declining sales still pay the advertising budget and maintain the sales volume at an acceptable level, sustaining the demand.

c) **Tangibility:** The third factor is tangibility of the product or service. Tangibility of a product or service can be defined as the capability of touching, testing, smelling, hearing, running tasting etc. Products are tangible than services in general. Tangibility can be categorized as follows:
    - Pure tangible good (e.g. soft drinks)
    - Tangible good with services (e.g. computer and warranty)
    - Hybrid (e.g. dinner at a restaurant)
    - Majority service with some goods (e.g. airlines)
    - Pure service (e.g. medical and legal services)

    As the product or service become more intangible, it means it is becoming harder for customer to evaluate it before purchase or even after purchase. [12] As the product or service becomes more intangible, the objective of promotion mix must focus building trust and invest on brand image, word-of-mouth, publicity, personal selling, and trials than advertising and sales promotion. Enhancing customer relationship is essential.

### 2.4.2. Market Parameters

The markets are categorized according to different characteristics. Each market has different decision making process of purchase, priorities and complexity:

a) **Market Type:** The markets can be divided as consumer market and industrial or business market. In consumer market, the number of seller and the number of buyer is huge; the number of products and services are enormous. On the other hand the number of seller and the number of buyer is fewer; the number of products and services are limited relative to the consumer market. The complexity, price and riskiness of industrial goods and services are higher than consumer market. High risk and high value purchases requires highly rational decision processing which means promotion mix should address more informative and close-relationship approach. In consumer market although rationality is also high in many cases but emotional approaches are also usual. In emotional approaches promotion mix should target the feelings of the customer in message content and tool selection. Moreover, business markets are differentiated based on the type of industry, location, size and other parameters.

b) **Market Size:** The dimension of the market is another parameter. Market size in terms of target customer may be tremendous or very limited. If the target market is composed of limited number of customers than one-to-one, direct marketing is the preferred method such as producing some spare parts to airplane manufacturer. If there are huge numbers of target customer than mass marketing tools are more applicable such as soft drink market.

c) **Market Actors:** Market parameters are identifying the commercial activity actors. Trade of goods, services and information can be among and between business, consumer and government. In the internet-age, capability of doing business over internet in addition to traditional way added richness in terms of volume, different types and geographical coverage. Although business-to-business and business-to-consumer are the areas where most progress has taken place but the other types are also gaining ground, especially business-to-government.

   Commercial activities among leading actors are listed below. [14]

**Table 2.4.2.a Commercial Activities of Leading Actors**

| | Government | Business | Consumer |
|---|---|---|---|
| **Government** | G2G (co-ordination) | G2B (information) | G2C (information) |
| **Business** | B2G (procurement) | B2B (e-commerce) | B2C (e-commerce) |
| **Consumer** | C2G (tax compliance) | C2B (price comparison) | C2C (auction) |

Due to their specific characteristics, each type of buyer-seller relationship requires different promotion strategy and tools which are summarized below:

**Table 2.4.2.b Buyer-Seller Relationship**

| | G2G | G2B | G2C |
|---|---|---|---|
| **Strategy and Tools** | • Establishing common standards<br>• Delivering effective service<br>• Information sharing<br>• Coordination and integration<br>• Internal PR | • Informing<br>• Advising<br>• Regulating<br>• Funding<br>• Web sites<br>• E-government portals | • Informing<br>• Increasing the awareness<br>• Building trust<br>• Advertising<br>• Direct mailing<br>• Price promotion in using some services |
| | **B2G** | **B2B** | **B2C** |
| **Strategy and Tools** | • Public sector marketing<br>• Strategic PR<br>• Personal selling<br>• Brand image<br>• Advertising | • Complex, rational<br>• High involvement<br>• Personal selling<br>• PR<br>• Corporate image<br>• Advertising | • High or low involvement<br>• Advertising<br>• Sales promotion<br>• Websites<br>• PR |
| | **C2G** | **C2B** | **C2C** |
| **Strategy and Tools** | • Cost saving<br>• Convenience<br>• Blogs about government service | • Buying than selling<br>• Setting the buying standards<br>• Awareness | • Oldest form of trade<br>• Personal credibility<br>• Word of Web |

In the above figure, another detail is that beside the active parties who are in direct transaction, in some cases there are intermediaries who are providing the media for transaction to occur. Especially in C2C transaction those companies provides a media for customers meet each other for auction, social media, friendship sites, such as eBay.com, gittigidiyor.com, oley.com, facebook.com, twitter.com and secondlife.com. Those companies are selling their services and should be treated as B2C companies. Moreover, C2B applications also have similar service providers where customers set the rules for their purchase demands like priceline.com. In addition, B2C transactions may also use intermediaries such as amazon.com, hepsiburada.com and lastminute.com. Those companies are also B2C companies not selling goods but their service, idea, technology infrastructure.

d) **Market Structure:** One of the critical parameter describing a market is number of sellers and type of the products whether they are homogenous or heterogeneous. The answer to these questions is the answer of the structure of the market: Monopoly and oligopoly scale. The two extremes are the pure monopoly where one seller, a unique product, price is controlled by the sole producer. This situation can be result of regulation, a strategic government owned enterprise, a patent or license, technology or some other factors. Company do no or little marketing activities for increasing the sales but may use its power to set up higher entry barriers for potential competitors if possible. That is the dream of marketers to work for.

In the other extreme, there are many, small companies, homogenous products, very elastic price, no brand loyalty, no price control. Markets of highly commodity products are where differentiation is almost hard to attain. Those markets can be named as pure competitive. [1] Those markets may be attractive if the producer can get a production and distribution efficiency and some level of image differentiation by means of promotion. For marketers that is the tough market to make profit and market share.

Other markets are in between this scale. In oligopolistic markets there are fewer number of relatively large company but still homogeneous products. In the second case, product is more or less heterogeneous based on some features there are few to many companies large and small, namely, monopolistic competition. In that market each company is aiming to get control of their small market due to differentiation parameter. [26]

Avoiding pure competition is an important issue but not the task of marketing only. If it is inevitable, marketing and promotion strategies are important tools for realizing company objectives. Competitiveness of a market is also subject to change even in fast pace. A company may be in a monopoly at the introductory stage of a newly innovated product. After a while, other companies notice the opportunity and enter the market. Now the market structure is monopolistic competition. As the products become similar, growth of demand stable and many companies in the market, it becomes a pure competition market. Thus, companies should carefully determine the stage and structure of market for entering and exiting. Briefly, as the competition becomes fierce differentiation strategy is crucial in marketing and promotion. In case where competition is low, creating high entry barriers by a strong brand image, creating customer value is crucial.

### 2.4.3. Consumer Parameters

Basically there are two types of buyer: Consumers and organizational or business buyers. Those two types of buyers both utilize a decision making process to decide on a purchase, but differently.

a) **Decision Making Approach:** Consumers use either rational decision making or emotional decision making. Briefly, a consumer decision making has the following steps. [13]

- Need or problem recognition
- Search for information
- Alternative evaluation

- Purchase decision
- Outcomes and post-purchase evaluation

In each step, different promotion strategies and tools can be applied, such as matching the needs with product and services attributes, information providing, interactive feedback analysis etc.

Consumer decision making process is highly affected from the perceived risk and degree of involvement. High involvement is spending considerable amount of time and effort in searching the needed product or service, personal and high level of perceived risk. Low involvement is spending minimum time and effort, having little risk, not vital for customer.

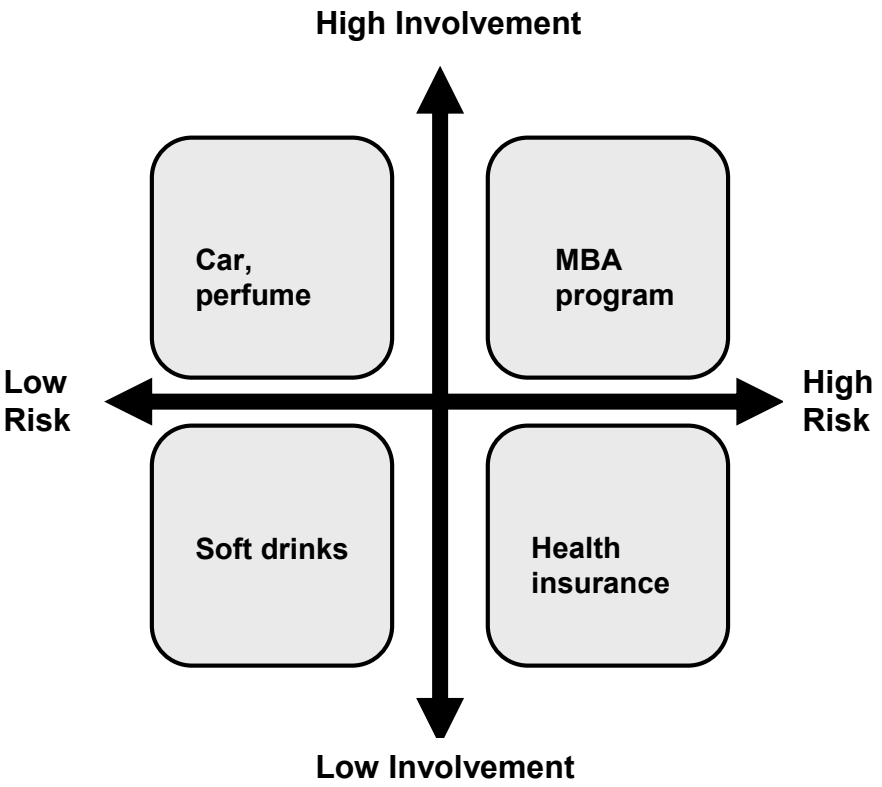


**Figure 2.4..2.a Involvement Level in Decision Making**

If customer is in a high involvement purchase, information search is very important. Evaluating all the alternatives is done and an attitude is developed before a commitment. The most appropriate tools for this type

of purchase are credible source of information by means of personal selling and opinion leaders, word-of-mouth, strong brand image, messages pointing features and attributes, guarantees, money-back offers and trial sample if possible are critical.

If customer is in a low involvement purchase, information search is not very important. Generally an attitude about the product or service is developed after experiencing the product or service. The most appropriate tools for this type of purchase are broadcast media, strong brand association, shorter and emotional messages, message repetition, pop displays, sales promotions are critical.

In a high involvement purchase, if the customer is satisfied then brand loyalty start to establish. Customer acquisition is critical in the first sales. In a low involvement purchase, if the customer is satisfied then it is not an expression of brand loyalty. Message frequency, reminding is essential.

In the following table, promotion strategies and tools for decision making in different types of involvement are summarized:

**Table 2.4.3.a Promotion Strategies in Different Involvement Levels**

| | HIGH INVOLVEMENT | LOW INVOLVEMENT |
|---|---|---|
| **Creating Awareness** | • Advertising<br>  ○ Highly informative<br>  ○ Low frequency<br>  ○ Rational<br>  ○ Function oriented<br>• PR | • Advertising<br>  ○ Less informative<br>  ○ High frequency<br>  ○ Emotional oriented<br>• PR<br>• Word of mouth |
| **Short-term strategy** | • Personal selling<br>  ○ Demo and trials<br>• Sales promotions<br>  ○ Informative materials | • Sales promotions<br>  ○ Trigger trial<br>• Pop |
| **Long-term strategy** | • Corporate PR<br>• Guarantees and service | • Advertising<br>• Pricing promotions |

b) **Involvement Level:** Business or organizational buyers also follow the similar steps that consumers do but there are different factors and parameters affecting the process. Briefly the decision making stages are as follows:

   **a.** Need or problem recognition (similar to consumer)
   **b.** Product or service specification
   **c.** Search for information not only for product but also for supplier
   **d.** Proposal evaluation
   **e.** Supplier decision
   **f.** Post-purchase evaluation

   Decision making process ranges between 'extended problem solving' and 'limited problem solving'. [13] As the involvement is getting higher than the decision making process is more likely an extended problem solving whereas the involvement is getting lower it is more limited problem solving. Organizational decisions are regarded as more extended problem solving but consumer buying process can also be similar depending on the type of buying.

   Business buying decision also differs whether it is a new buy or straight buy. If it is a first time buy, then in-dept information is needed, decision is regarded as more risky, making decision takes longer time. However, if straight, repetitive buys it is almost a routine buying process from a list of approved suppliers.

   Organizational buying decisions are affected from various sources which make the process more complicated. The final decision is a balanced combination of those factors. For instance, economic conditions, competitor strategies, applicable law, corporate business strategy, purchasing procedures, costs, technology, values are all affecting the final decision.

   In organizational buying decision process, the aim of marketing is to provide the necessary information when and where possible, decrease the perceived risk of buyer, satisfy the buyer by means of quality,

corporate image, strategic PR and close relationship by personal selling. In the following figure the approaches of the buyer to reduce the risk in buying process is defined. [15]

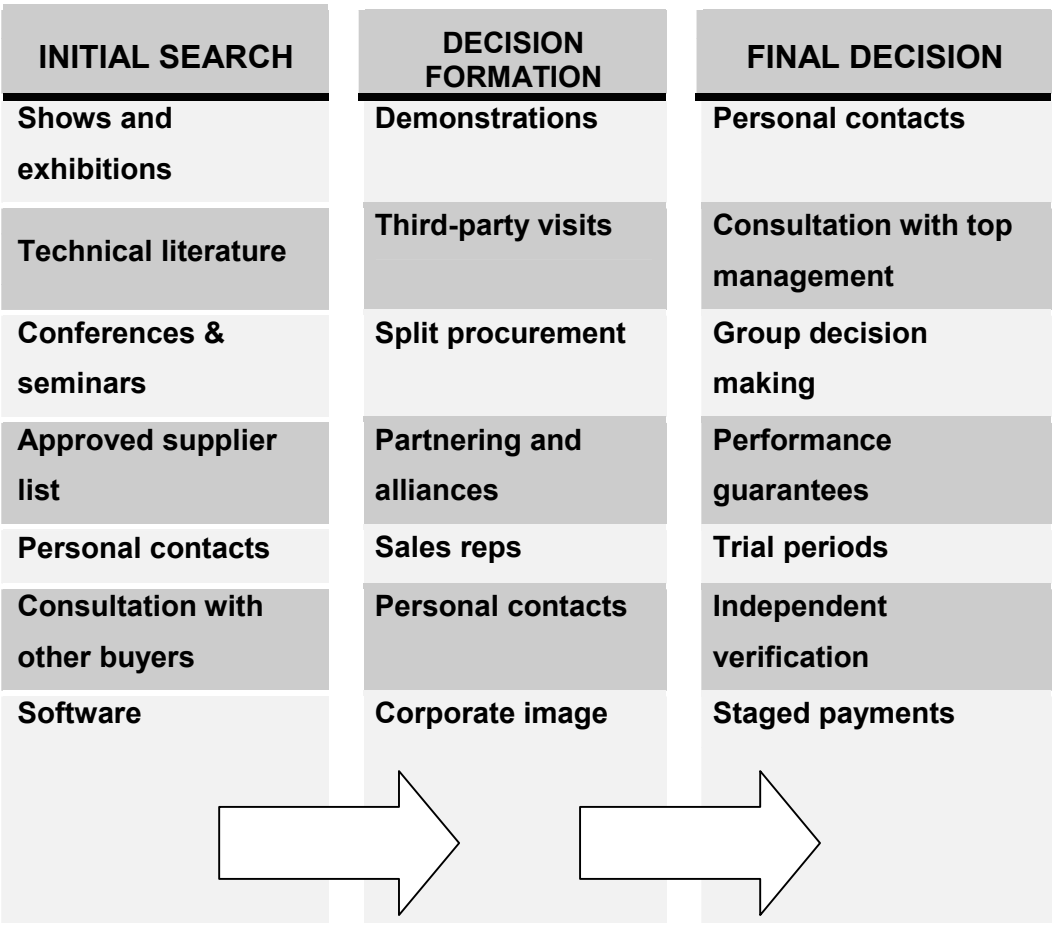


**Figure 2.4.3.b Decision Making Process**

c) **Readiness Stage:** Buyer readiness stage is another parameter in which decision making stages of customer is considered. It is a matter of good timing such that serving the dessert after the main course not before. Anticipating or if possible knowing the readiness stage would help marketers to determine the right message and right tools of promotion.
These stages are as follows:

- Awareness – the customer is just aware of the product or product class where any efforts to build customer awareness is appropriate such as advertising and publicity

- Knowledge – awareness is a good start but potential customers need to know more about the features and benefits.
- Interest – knowing more may trigger liking, advertising, brand image, PR is suitable
- Conviction – the potential customer is convicted about the superiority or suitability of the product but may still need some triggers to act. Personal selling is critical.
- Purchase – final stage is affected by personal selling and also sales promotion
- Re-purchasing – for a satisfied customer re-purchase may be a routine process but should be supported by reminder advertising and sales promotions

Determining the readiness stage of a customer is mostly possible when there is an interactive communication with potential customer and taking feedbacks like personal selling or internet marketing. In mass marketing cases, where there is enormous number of customers, it is not so possible to track the buyer readiness stage exactly but by means of sales figures, testimonials, pop activities some judgments can be made based on the clues where messages are understood, media coverage is sufficient etc.

d) **Suspects, Prospects, First-time and Repeat Buyers:** Consumers of a product or service may either be suspects or prospects or first-time buyers or repeat customers. Understanding the buyer behavior of each stage is critical for a firm's promotion strategy since the first three stages' customers are potential repeat customers having brand loyalty. [44] Some potential customers are just hearing about the product or company for the first time, others know about product or company but need additional information, some are willing to buy.

Suspects are those whom company thinks as be interested in one or more of company product or service. Suspects are the addressed group in defining the target market but who are unaware of that. The aim of the company is to convert those suspects into prospects. The basic approach is to create awareness by means of free, clear, attractive relevant

information to communicate the provided solution (product or service) for the problem of potential customers.

A prospect is aware of the product or company by some type of communication means but not makes a purchase yet. A prospect starts to develop a perception about the company and the product at this stage. The aim of the company is to convert those prospects into first-time buyers. In most cases, first purchase should be viewed as a trial purchase. Convincing the prospects are highly depends on proposing a challenging offer to try the product or service. These may be a special price, bonuses, sales promotions or others.

When a prospect makes a purchase, they are named as first-time customer. The aim of the company is to make them a repeat customer. First-time buyers may be the ones who are buying this type of product first time or brand switchers where they are familiar with the product type but not the brand. In the past, consumer satisfaction or dissatisfaction was regarded as an output of a post-purchase evaluation but today the process begins before the purchase. Thus, the companies should take relevant actions to convince and persuade the potential customer for a trial purchase. If the experience is successful for the customer, then it will be turned into repeat purchaser. First-time buyer maybe offered some special membership advantages, premium services, in-advance notification for sales, new products, special discounts which are not offered to prospects.

A repeat customer is the one who has purchased more than once. Repeat customers are the source of regular income for the company, the most valuable group and also the volunteer marketer of the product. Repeat customer means retained and loyal customer and it is much easier and profitable to market to existing customers than to prospects or suspects. Retaining the repeat customers is essential for the companies so that they have to offer additional values to them continuously.

Repeat purchase process is either extended or limited problem solving or habitual decision making. Many of repeat purchases are a sort of limited problem solving process where customers like to spend less time and energy in shopping and no unexpected surprised. However, if there is dissatisfaction at the previous purchase or the product is unavailable or if there is a challenging offer to try a new one, brand switching is likely. Habitual buying is more simplified version where consumers heavily rely on their habits where brand loyalty (especially in high involvement products) is basic motivation.

Moreover, the involvement level is another measure in repeat customer as higher the involvement level lower the probability of brand switching. [13] In case where low loyalty products are considered, consumers do not feel any critical difference between products and may have a habit of purchasing same product for years but may also switch brand easily if any incentive exists for another product. In these cases, advertising is an effective tool where the core message is the word “new”. Moreover, advertising recall is essential for market share. [45] Thus companies should use heavy advertising to keep brand image fresh for repeat customers and utilize point-of-sale, sales promotions, sampling effectively for prospecting customers to make them first-time buyers.

Consequently, continues costumer satisfaction, creating brand loyalty (if possible), continuous message recall and heavy sales promotion (for low loyalty products) are essential for convincing the prospects to become a firs-time buyer and to retain the repeat customers for longer times.

e) **Consumer Characteristics:** Consumer markets are segmented based on some factors in order to address specific needs for targeted segment. Customer segmentation is basically done based on four variables as demographic, geographic, psychographic and behavioral. In a good defined segmentation, consumers are homogenous within the segment.

**Demographic** segmentation is done using the variables such as age, gender, income, family size, family life cycle, nationality, social class,

occupation, education, race, religion and etc. Each parameter affects the buying behavior such as older consumers are more loyal, higher income consumers spend less time in searching, higher education consumers are more search-centric, younger people are more open to new ideas but less loyal etc.

**Geographic** segmentation divides the market into different units as continents, nations, regions, countries, cities, population density, climate or others. Companies may be active in more that one geographic unit but should pay attention to local differences. [6] Moreover, a new segmentation variable is in use, named as geodemography. [13] Mixing geography with demographic variables, new clusters can be formed. Spending are different in rural or urban areas as well as the breakdown. Climate is also determinative in buying preferences.

**Psychographic** segmentation is based on life style and personality factors. Life styles are realized by activities, interests, opinions, attitudes and core values. Consumer surveys focus on these to measure lifestyles. For instance, “creatives” are those who are young, active, interested in knowledge and technology; strivers are those who work as hard as a slave and focus on professional goals.

**Behavioral** segmentation uses the variables as benefit, loyalty, usage rate, user status, and occasions. A purchase decision may be triggered by an occasion such as an anniversary, holidays, etc. Same product can be purchased for different benefits. A consumer may be a heavy, medium or light user and a company may select to focus on light users. Consumers may be brand-loyal or a switcher.

In conclusion, consumer characteristics are used to define, segment, address and focus the market. Increasingly, multi-attribute segmentation is preferred to better define target market, more homogenous clusters. Utilizing IT tools and software, internet, it become possible, applicable and affordable to define and reach micro segments.

### 2.4.4. Corporate Parameters

Companies' promotion strategy is categorized as two main approaches: Pull or push strategy. It defines the manner how the company creates customer demand for its product and services.

Push strategy is promoting the product and service to wholesalers, the wholesalers promote it to retailers and the retailers promote it to final customer. Briefly activating the distribution channel is the key. Promotional strategies are applied heavily on distribution channel. Wholesale discounts, bonuses, premiums, sales force, trade promotions are applied which customers are not aware of.

Word-of-mouth is another type of push strategy. Satisfied and happy customers spread their pleasure about the product to their families, friends and push them to purchase the product.

In the pull strategy, all promotion activities are aimed to directly customer to build up a strong demand for the product. A successful pull strategy let the consumers ask the product from the retailer and retailer ask the wholesaler and finally wholesaler ask the producer of the product. In pull strategy, advertising in all media and consumer sales promotions are mostly used.

Companies need not to choose solely one strategy. In fact a good balance of pull and push strategy would increase the performance of promotion activity and help to convince the potential customer more easily. Push marketing may an effective tool for short-term strategies while pull strategies are longer-term trust and brand development strategies.

# CHAPTER 3

# PRODUCTS and DIGITAL PRODUCTS

## 3.1. Definition of Product

Internet-age not only changed the attitudes of the customers, way of communication but also provided new opportunities to companies to develop and position new types of products and services. This new challenge created new markets for digital forms of existing products of established companies and also let new entrepreneurs to emerge in providing new products and e-services.

Before discussing the digital products, it would be helpful to define the word 'product'. In marketing literature definition of product by Kotler is as follows [6]:"anything that can be offered to a market to satisfy a want or need. Products include physical goods, services, experiences, events, persons, places, properties, organizations, information and ideas". As seen from the definition 'product' is far beyond just physical entities. Products have three basic elements to offer: features, benefits and quality. Benefit is the reason why the customer is buying, the problem-solving capability of the product. Quality is the degree at which the product is able to perform its offered functions. Lastly, features are all measures that differentiate the product from others, such as design, brand, packaging, style etc. Although product definition covers the 'service' as well, a more specific wording for it is as follows [1]: "any act or performance that one party can offer to another that is essentially intangible and does not result in the ownership of anything; its production may or may not be tied to a physical product." Services have some special characteristics as follows [6]:

- Intangibility (can not be seen, tasted, felt, heard, smelled before purchase),

- Inseparability (produced and consumed simultaneously, can not be separated from the producer),
- Variability (their quality depends on the provider, the place and time; heterogeneous)
- Perishability (can not be stored for later use, produced and consumed simultaneously)

Companies make offer to market for their production as either pure tangible good, pure service or different blends of tangible and intangible products. Depending on the composition of the proposal, companies select appropriate marketing strategies as well as promotion strategies to realize their marketing objectives.

### 3.2. Definition of Digital Product

Digital products are gaining popularity in many markets and forcing companies to develop such products. Since digital products have no distribution and logistic costs, they have a great potential to serve to global market easily. In addition, relevant information of the digital product and payment transaction is also carried through internet. [25] Digital products are also changing the habits about the perception of a product. Digital products are not only products satisfying a need but also a different experience. Similar to services, value of digital products can mostly be determined after using it. Today, some physical products are transformed and delivered as digital form and some products exist only in digital form.

In general, digital products can be defined as all products and services that can be digitized. [11] Thus, those products and services which are applicable to be converted into binary format are regarded as digital products. It can also be defined as anything that can be delivered “electronically”. Software packages and tools, e-games, e-books, music and videos, search engines, digital libraries, betting sites are well-known examples of digital products today and new types will emerge in near future. Another definition with a reversely approach is like that:[17] “Non-digital products must be physically delivered to consumers.” A more comprehensive definition is specifies the digital product as “a bundle of properties or features which are constituted by artifacts that are digitized or

produced electronically. They are distributed in purely digital form, tradable or exchangeable good and can satisfy a want or need."[16]

As stated above, digital products may be either digitized version of an existing physical product or produced and exist only in digital form. For instance a digital newspaper or digital journal is simply a digital version of a physical good. However, digital form of the product offers new and attractive features which are impossible for the counterpart to deliver, such as extensive search capability, personalized information, clickable relevant links, up-to-date content, easily accessible achieve and accessing other online sources. It is interesting to see that although the core product is a newspaper which provides news, columns and ads, it becomes a different offer to customer. Briefly, digital products are adding new values to products so as to customers.

Digital products all have the common feature of having a binary format but have very different attributes as well. Understanding those different features and characteristics is crucial for identifying the marketing strategies of those products. Due to their short history and relatively small market size, there are only a few studies in attempting to classify digital products. In order to decide on appropriate marketing strategies and also selecting the optimum promotion mix for digital products, it is mandatory to identify special characteristics and features for major types of digital products. In this chapter, main characteristics and attributes of digital products are identified and a framework is developed to categorize those products accordingly. This framework will be used as a base in selecting the proper set of promotion tools for each category.

## 3.3. Characteristics of Digital Products

The former introductory brief will provide a base for defining the characteristic of digital products. Major characteristics are listed as follows:

### 3.3.1. Everlastingness

Once the digital products are produced, they will exist forever with the same quality having no wear like tangible goods. While having no incurring production

costs, this feature is a treat for producer as has to compete with already sold products. Another issue is that since usage does not wear out the product, it is new at the time of purchase and still new two years later. The content may get old but the not bits it is made up of. Everlastingness is valid only if not an intentional damage is not made.

### 3.3.2. Changeability

Due to their format, digital products can be changed or customized easily. [18] This feature has an advantage of easy and fast customization feature of products. However, it has a disadvantage of unauthorized modification and copyright problems.

### 3.3.3. Replication

Digital products can be reproduced, shared, stored and transferred easily. After the first original copy is produced, digital products are replicated with a negligible cost without any loss. Digital products can be composed of text, graphics, video, voice and know-how. Another issue is that the original product and the duplicated one is almost similar.

### 3.3.4. Cost Structure and Pricing

Digital products have huge fixed costs and low or negligible margin costs. [19] Since the reproduction costs are negligible, pricing of digital products can not be based on be based on cost structure. Price discrimination strategies are applied by proposing different versions of the same product. In terms of economies of scale, digital products are extremely successful. After recovering the fixed cost, each new sale means net profit.

## 3.4. Classification of Digital Products

Different marketing strategies may be applied to different types of digital products due to their unique characteristic. [22] Due to their short history and even not having a generally accepted definition, there are only a few and limited studies in

attempting to classify digital products. In order to decide on appropriate marketing strategies and also selecting the optimum promotion mix for digital products, it is needed to make a classification of digital products based on their special characteristics and features of major categories.

In this study, a framework for classifying the digital products is proposed. The framework has two dimensions, namely major product categories and product features.

### 3.5. Digital Product Categories

Identifying categories for digital products are challenging. Categories based on broad definitions are missing specific features and categories based on more specific features need to update more frequently as the new products emerge.

In a broader approach, digital products are categorized in three major groups as '*tools and utilities', 'content-based digital products*' and '*online services'*. [11] In that classification, commercial software, shareware or freeware that are downloadable via internet is grouped under '*tools and utilities*' category. Products having Information content including e-newspapers, e-journals, research reports, music, videos are categorized in '*content-based digital products*'. Finally, online search services, support services, online therapy services are grouped under '*online services'* category.

In a more in-dept study, digital products are grouped under 13 different categories, namely: [20]

- Paper-based information products (newspaper, magazines)
- Product information (user manuals, software)
- Graphics (photographs, maps)
- Audio (music, speeches)
- Video (movies, television)
- Tickets and reservation (airplane, hotel, train)
- Financial instruments (securities, internet banking)
- Government services (tax payments)
- Electronic messaging (email, faxes)

- Business value creation processes (ordering)
- Auctions (online bidding)
- Remote education (asynchronous e-learning)
- Interactive entertainment (online games)

Categorizing the digital products is not that easy because digital product may have some characteristic of the other category also. For instance, the categorization of Hui and Chau [11] mentioned above states that software is a member of 'tools and utilities' category. On the other hand an interactive help and a training kit in that software is more likely to be a 'content based digital product'. According to Choi [20], audio and video are separate categories but they are also content-based products.

Thus it is really tough to make a generally accepted categorization every categorization is open to criticize due to the mixed features of the digital products. In that respect the selected categorization criteria should be taken into account. In this study, the proposed categorization is made based on marketing approach and functional coherence as much as possible.

### 3.5.1. Information Products

Digital information products are those whose core value is the information delivered with it. Thus, products including any form of content are in that category. Content creation covers both digitization of existing information goods and also creation of digital content from scratch. Contents may consist of text in any format, graphics, sound, video, animations or even embedded programs. Currently, over 90% of the information created is in digital format and it is expected that this ratio will increase. [21] Digital products in this category are electronic newspapers, magazines, journals, books, e-learning contents, digital audio, speeches, digital video, movies, television programs, training manuals, digital weather reports, stock info, business research reports, electronic maps, electronic libraries and websites.

### 3.5.2. Software and Utilities

Software programs and utilities are products used to execute a task and perform some specific functions. All types of software, shareware, freeware, productivity tools, networking tools, drivers, multimedia and design tools, security tools, web authoring tools, backup & restore utilities, compression tools, file and disk management tools, optimizers, editors, shell tools, programming tools, instant messaging utilities are regarded in that category.

### 3.5.3. Online Services

Online services are somehow different from formers since customers are not buying a digital product but using it to satisfy a need. Thus, online services are providing an access right to reach resources to accomplish a task. Online services providers are proposing an infrastructure letting the subscribers communicate, participate, taking consultancy, search, perform a task etc. Online services also provide some form of information, but our categorization criterion is using a service not owing a product. Search engines, online banking, online ticketing, online consultancy, online translation, online financial instruments are regarded as online services.

### 3.5.4. Online Entertainment

Online entertainment is one of the most popular usages of internet. Especially for teenagers and young adults online entertainment is a life style. Many forms of online entertainment exist today as music, movies, sports, games and others. Some digital information products listed above are also listed in this category since the purpose of using is different. Online games, electronic games, music, video and photographs are examples of this category.

### 3.5.5. Government Services

Government services are a mixture of information products and online services. However due to the nature of relationship between government & business and

government & citizens, government services are separately categorized. A variety of e-government services are active today. All types of tax payments, knowledge acquisition, information dissemination, citizenship applications, integrated government services, e-procurement are listed under this category.

### 3.5.6. Service Platforms

This category is the final one providing an infrastructure for subscribers to share, trade, communicate with others. Those service platforms are mostly used in C2C type relations. In this particular category do not provide or sell information or transaction but only rent the platform and make people to contact for different aims. Online bidding, auction sites, blog sites, social networks, dating services, safe payments, chat-rooms, digital broadcasting platforms are samples of this category. The difference of this category from the online services are that online services owns and provide some kind of information and know-how, as in case of online banking. They have the account records, transaction infrastructure, investment options and tools, financial consultancy services, online stock info etc. However, in an auction site, service platform provider only set the rules and acts as an arbitrator. For instance, eBay is one of the leading service companies providing a global trade platform where anyone can trade anything. The aim of eBay is to provide safe and fair environment. Buyers' trust is the critical success factor for eBay. Setting rules and policies to effectively manage millions of trade, preventing trade of offensive items while keeping company reputation and public standing strong is essential. [27]

Consequently, digital products are grouped under six category based on their functional features. Some digital products are not exclusively member of a single category but positioned where most appropriate.

In the following section, the next dimension of the framework is discussed, the features of digital products. The selected features will be briefly defined and evaluation of those features for each category in general will be specified. This evaluation will be used to define the proper promotion strategy and applicable tools set for the next chapter where optimization of promotion tools will be studied.

## 3.6. Digital Product Features

Digital product features or criteria to categorize them as a second parameter is again a tough job. A compiled list from Choi [20] determined those criteria in five topics, namely, transfer mode, timeliness, intensity in use, operational usage and externalities. In another study, Hui [11] stated three criteria as trialability, granularity and delivery mode. In both of the study, there are some similar criteria as well as some different criteria. In this study, a more comprehensive approach is selected to define and also find distinctive points between digital products due to their embedded features and characteristics.

### 3.6.1. Trial Run

Digital products are mostly intangible to potential customers. In some cases only limited information provided by the producer is available. That makes it difficult to evaluate or judge the quality of the digital product. Some digital product has a change for a trial run but others not. Thus, the possibility of a test drive will help potential customers to convince more easily. In other cases, producers have to use other promotion tools in order to make the customer feel and judge about the product.

### 3.6.2. Transfer Mode

Digital products are generally transferred by two ways: Internet downloads or interactive. Downloaded product becomes totally available for customer after the download while interactive transfer is a continual base throughout the transaction. Software and information products are downloadable while online services are mostly interactive.

### 3.6.3. Tangibility

Digital products are mostly not as tangible as physical goods. As the degree of intangibility increase, meaning that the provided value of the product can be realized after the purchase and even after a period of usage. Thus, as the product intangibility increases, marketers should find ways to convince the quality

and benefits of the product. In other words, marketers try to make those intangible products somehow more tangible for potential customer.

### 3.6.4. Existence of physical counterpart

As stated in previous part, digital products may be either digitized version of an existing physical product or produced and exist only in digital form. If there exist a physical counterpart such as an electronic version of a book, than potential customer can judge about the product more easily. This type of buying can be made for convenience and preference. In case where only digital form of the product is exist like auction sites then convincing customers are more difficult.

### 3.6.5. Involvement Level

Discussed in previous chapter, products are classified as high involvement products and low involvement products. For high involvement products, decision making process is long, information need is high, credibility of producer is critical. In low involvement products, short decision process, less informative high emotional messages are needed and customers as expected to be less loyal.

### 3.6.6. Timeliness and Perishability

Timeliness is the measure for freshness of digital product. Some digital products are time independent meaning that time has a minor effect on the value. Some other products are time dependent that time has major effect on the value of it. A classical digital music album can be time independent while a newspaper of last year has lost its value mostly. Lastly, some digital products are perishable, can not be stored for future sale. An unsold ticket of an airplane or a movie is perished. Thus timing of sale in some digital products is critical and promotion strategies for increasing short-term sales. Moreover, time independent digital products are meant to be multiple-use products. Those products are used more than once and utilization may increase by using. Time dependent products are mostly single use products and their value are utilized after the first use of the product.

### 3.6.7. Heterogeneity

Quality is a key and unfailing performance criterion for products and services. As the products are becoming more intangible, quality assurance becomes a question. Depending on who is the producer, what type of product potential customers makes judgments about the homogeneity of the product. Thus, producer of digital products should assure customers that they have high quality standards, talented personal, responsive service, intensive customer care so that their products are of same quality.

## 3.7. Digital Product Classification Framework

In previous section, a framework to classify the digital products is discussed and proposed. A two dimensional matrix is formed below. Digital products are first distributed among 6 different major categories based on their functional coherence and marketing perspective, namely, information products, software and utilities, online services, online entertainment, government services and service platforms.

As a second step, seven distinctive features of digital products are selected as a second dimension of the framework, namely, trial run option, transfer mode, tangibility, existence of physical counterpart, involvement level, timeliness and perishability and heterogeneity.

In the following figure, each cell in the matrix is assigned an appropriate value demonstrating the corresponding feature of each digital product category which will be explained. It should be noted that those evaluations are representing an average for the category and may not be a best fit for all members of the category. However, it is not applicable to make such a valuation solely for each single digital product. The proposed framework will help determining the promotion strategies more precisely.

**Table 3.7.a Digital Products Classification Framework**

| CATEGORY / FEATURE | Trial Run | Transfer Mode | Tangibility | Physical Counterpart | Involvement Level | Timeliness Perishability | Heterogeneity |
|---|---|---|---|---|---|---|---|
| **Information Products** | Fairly Low-Low-Moderate | Download and interactive | Moderate – High | Highly exist | Low – high | Low - moderate | Low |
| **Software and Utilities** | Moderate-High | Download | Fairly Low-Low | Exist | Moderate - high | Moderate | Low – moderate |
| **Online Services** | Low - Moderate | Interactive | Fairly Low-Low | Highly exist | Moderate - High | Low to high | Moderate |
| **Online Entertainment** | Moderate-High | Download and interactive | Low-Moderate | Moderate to no exist | Low | Moderate | Low – moderate |
| **Government Services** | High | Interactive | High | Exist | High | Low | Low |
| **Service Platforms** | Moderate-High | Interactive | Fairly Low | Exist in different forms | Moderate – High | Moderate | Low |



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The Figure 3.7.a above summarizes the proposed framework of classification of digital products. The logic behind the valuation is of each cell is expressed below.

**Information products** generally do not have trial run options. Books, reports, journals, training materials have very limited clues about the total of the product. Only an abstract or table of content, old copies may be available. Some e-learning products may provide short demo versions. Information products are mostly downloaded and rarely interactive as in e-learning. Since most of the information products have their physical counterpart they are highly tangible. But recently some copies are started to be realized in digital form first or only. Information products are low to high involvement products. An e-book may be low involvement but a business report or an e-MBA program is a high involvement product. Information products are low to moderate time dependent products. A stock report of last year may lost some value but still be useful for long investment decisions. However, a digital weather report of last month is not informative for most.

**Software and utilities** are relatively more trialable by means of trial version, limited editions or evaluation copy for limited time. They are fully downloadable. Although they have physical counterpart on CD or DVD software and utilities are highly intangible and their offered value can be realized after using it or even heavy usage. Systems software or performance optimization tools may need long evaluation time. Involvement level for software and tools are moderate to high such as buying an antivirus software or CRM software. Software and utilities are moderate time dependent. They have to cope with fierce competition in terms of performance, customizability, compatibility, availability, functionality and service. They are highly homogenous products since versioning is the path for development. But sometimes some new versions of software and utilities may be a disappointment when compared with former versions.

**Online services** may offer low to moderate trial run options as in demo accounts for online banking and financial services but limited in online consultancy services. Value-add of the products are transferred interactively. They are fairly low tangible products and many of them have physical counterpart. Their involvement level is moderate to high. A financial transaction or legal advice is a

high involvement case while a ticket reservation is moderate or even low. Time dependence is maybe low or very high. Online translation or physiological therapy service is not time dependent and do not perish but an airline ticket is perished after the flight. Since online services are relatively more human dependent heterogeneity of the product is moderate.

**Online entertainment** products have moderate to high test drive option. Online games, music, movies provide some means of trail options. Online entertainment is downloadable and sometimes interactive as in multi-user interactive games. Online entertainment is low-to-moderate tangibility. New products are more intangible for customers such as a new game or movie. Music albums have physical counterparts but some interactive games are only available in online mode. Entertainment is generally low involvement aspect and time dependence is moderate. After a period, games may become boring. Like software and utilities, online entertainment market has relatively shorter product life cycle and in order to keep the interest of customers' fresh, new versions, new features and new product development should be continue. They are homogenous products but some new versions of software and utilities may be a disappointment when compared with former versions.

**Government services** are e-government applications available for both enterprises and citizens. Since they are provided on portals it is easy to try and web services are interactive. Since government services are available in traditional way it is highly tangible and straightforward. Government services are high involvement in nature since tax payment or other applications are critical for business or personal issues and may have penalties if not completed on-time. Government services are not time dependent and homogenous but may be altered based on legislative arrangements and new online services.

**Service platforms** provide moderate-to-high degree of trial run options as demo accounts. They are totally interactive and intangible. They have other means of physical counterparts but may not that much organized. Auction sites are generally high involvement and personal products while social networks may be moderate involvement for majority. Service platforms are like software and utilities in terms of timeliness and perishability. They are mostly homogenous

products but require high quality management, security and personalization strategies.

### 3.8. Promotion Strategy Approach for Digital Products based on Framework

The proposed framework provides a basis for better determination of promotion strategies for digital product categories. A brief promotion strategy approach is listed below:

- If a product does not have trial run option then more promotional activities is needed
- As the product becomes more intangible, third party reviews, references, independent comments, strong public standing and company reputation is needed
- Websites are critical for all categories. Both the technological infrastructure, security, performance, management, service, personalization, ease-of-use and the physical appearance, atmosphere, accessibility of the website is essential for both the producer and intermediaries.
- While online promotion tools are cheaper than traditional ones, companies try to get free off others and reach to customer. Offline promotion tools are effective complementary tools.
- Viral marketing in internet is so effective, fast but hard to control. Companies should be also fast, responsive and trustful
- People are curios about the ideas of others. Blogs, user ratings, comparison sites are information source of potential customers. It gives the chance for companies to know what others think about their products. Companies may utilize them to work as voluntaries
- Digital products are mostly experience products. Companies should find ways to provide some ways of experience to customers before selling.
- It is relatively easy to monitor the performance of online promotion tools, so it should be quickly adopted and modified when needed
- Digital products are intangible in nature and the delivery of them is also machine based mostly. However, personal contact is always valuable. Service infrastructure, contact center facilities are critical.

- Promotion is more powerful if it is creative, consistent and continuous
- Due to shorter product life cycle, fast pace of information diffusion, instant feedback mechanisms, fierce competition, each P's of 4P should be closely integrated more than ever.
- Company reputation is the key whatever a company is selling in long term. Beside short-term objectives every company should spend necessary effort to build up a strong, robust company reputation with long term strategies

# CHAPTER 4

## A FUZZY LINGUISTIC DECISION MODEL WITH GENETIC ALGORITHMS

In previous chapters, marketing and promotion concept, digital products and classification of digital products are discussed. In this chapter, for selecting the optimum promotion mix for highly intangible digital products by means of a fuzzy linguistic decision model with genetic algorithms will be proposed. Optimization can be defined as adjusting the variables to achieve a best possible result. In a systematic approach, many variables even conflicting ones are optimized simultaneously. Otherwise, optimization is done by 'trial and error' approach. In promotion mix optimization for digital products where there is a high level of uncertainty, a decision model will help to make better decisions than trial-and-error approach. The overall process includes identifying the promotion methods and promotion tool mix, based on the product features and customer preferences while fulfilling the communication objective of the company on time and on budget.

Fuzzy linguistic model replaces the numerical values in traditional model with linguistic ones. Linguistic variables are capable of manipulating the uncertainty. [28] Moreover, linguistic operators will be used to get a final result based on the importance level of each selected objective to reach the satisfaction degree of each promotion objective within budget. [29]

Genetic algorithms are general purpose search algorithms based on the principles of natural genetic populations' reproduction to solve problems. [30] Genetic algorithms are useful in complex domains, in global optimization problems to reach an exact or approximate solution. In this thesis, genetic algorithms are utilized in linguistic fitness function evaluation, briefly, the fitness of promotion objective of the company and the fitness of the promotion mix.

In the following sections, a linguistic approach will be proposed and a linguistic promotion mix decision model will be introduced. Finally, genetic algorithms will be applied to reach a satisfactory result for a selected digital product.

### 4.1. Fuzzy Linguistic Model Approach

Fuzzy logic enables and helps to handle uncertainty, formalize imprecise data and enables arithmetic and also Boolean functions. [32] Expressing issues in qualitative way rather than quantitative, linguistic approach is better to use. Those variables are named as linguistic terms. They may be used for quantification such as “some”, “most of it”; or qualitative numeric one, such as “high” or “low”; or non-numeric qualitative one such as, while evaluating comfort of a hotel, “good”, “extraordinary”, “average”, “poor” or “terrible”. Those are for sure subjective wordings but better understanding of people.

In order to clarify some misconceptions about fuzzy logic it should be stated that fuzzy logic is not fuzzy but is a precise logic of imprecision and approximate reasoning. By means of fuzzy logic, two remarkable human capabilities are formalized. First is the capability to reason and make rational decisions in an environment of imprecision, uncertainty, incompleteness of information or simply imperfect information; second is the capability to perform a wide range of physical and mental tasks without any computations. [47]

Fuzzy linguistic approach presents qualitative aspects by using linguistic variables. A linguistic variable can be defined by a quintuple (H, T(H), U, G, M) as, H representing the name of the variable; T(H) representing the term set of H; U represents the discourse universe; G is a syntactic rule; M represents the semantic rule. [28]

Fuzzy rules and reasoning processes are the most important modeling tools of fuzzy set theory. In classical set theory, a subset, $A$, of a universe, $X$, is identified by a function that assigns to every $x \in X$ the value 1 in case that $x$ is a member of $A$ and the value 0 in other cases. [33] For instance, a classical set A of real numbers greater than 8 is a set can be expressed as follows:

$$A = \{x \mid x > 10\} \quad (1)$$

It is clear cut that if a number is greater than 10 then this number belongs to set $A$; otherwise it does not. These classical sets are important and suitable for mathematics but not reflect the human concepts correctly. For instance, a mathematical expression of children as a collection of junior people whose age is less than 10 can be shown as, $A$ = "children" and $x$ = "age". Based on that set definition a person of 10 years and 1 day old is not a children but a person who will celebrate his birthday tomorrow is a children. Mathematically it is true but in normal life some strict distinction is not reasonable.

In fuzzy set theory, the boundaries are not that strict and belonging to a set is more gradual nature. This is characterized by a membership function and modeled by daily expressions as "the weather is hot". While a classical set get a value 1 or 0 depending on the membership function, a fuzzy set can get values between 0 and 1. The value of the element shows the degree of membership. As a practical example, let $X$ be a set of objects depicted by $x$, a fuzzy set $A$ in $X$ is defined as a set of ordered pairs as follows:

$$A = \{(x, \mu_A(x)) \mid x \in X\} \quad (2)$$

Where $\mu_A(x)$ is called membership function for the fuzzy set $A$. The stated membership function assigns each element of X a grade between value 0 and 1. For instance let $X = \{Mercedes, BMW, Audi, Porshe, Ferrari\}$ be a set of car brands and the fuzzy set B="preferred brand to own" and given as:

$$B = \{(Mercedes, 0.8), (BMW, 0.6), (Audi, 0.7), (Porshe, 0.9), (Ferrari, 1.0)\} \quad (3)$$

As seen above the membership grades are subjective and different grades are possible for different persons.

Linguistic variables are expressed as words or sentences and for sure they are not precise as numbers. Linguistic term sets are selected according to the type of

domain. Thus, terms sets are slicing the problem domain as meaning and applicable parts.

As stated above, membership function is the basic definition of the fuzzy set. Most of the time it is not applicable and practical to list all pairs of membership function but better to express it as a mathematical function. Among the most well known ones, triangular will be used in this study and its membership function is formulated as follows by three parameters:

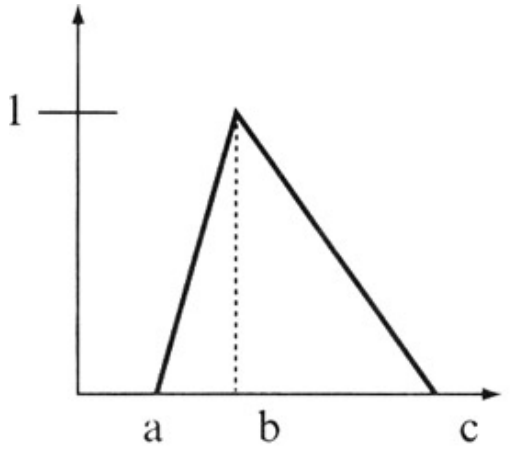


**Figure 4.1.a. Triangular membership function**

$$\mu(x) = triangle(x,a,b,c) = \begin{cases} 0 & x \le a \\ (x-a)/(b-a) & for\ a \le x \le b \\ (c-x)/(c-b) & b \le x \le c \\ 0 & c \le x \end{cases} \qquad (4)$$

The parameters $\{a,b,c\}$ with values $a < b < c$ determine the x coordinates of the triangle. For instance, a membership function for the above triangle can be stated as $\mu(x) = triangle(x,20,30,50)$.

Briefly to say, a fuzzy set consists of two parts: an identified suitable universe and an appropriate membership function.

The basic fuzzy set operations are union, intersection, complement. The union of two fuzzy sets A and B is a fuzzy set of C which can be demonstrated as $C = A \cup B$ and its membership function can be depicted as follows:

$$\mu_C(x) = \max\left(\mu_A(x), \mu_B(x)\right) = \mu_A(x) \vee \mu_B(x), \forall x \in X \quad (5)$$

The intersection of two fuzzy sets A and B is a fuzzy set of C which can be demonstrated as $C = A \cap B$ and its membership function can be depicted as follows:

$$\mu_C(x) = \min\left(\mu_A(x), \mu_B(x)\right) = \mu_A(x) \wedge \mu_B(x), \forall x \in X \quad (6)$$

The complement of a fuzzy set A is depicted as $A'$ and the membership function is as follows:

$$\mu_{A'}(x) = 1 - \mu_A(x), \forall x \in X \quad (7)$$

A numerical example of fuzzy set operations is demonstrated below. Let $X = \{Barcelona, RealMadrid, M.United, Liverpool\}$ and the chance of championship as fuzzy sets A and B as follows:

$$A = \{(Barcelona, 0.8), (RealMadrid, 0.9), (M.United, 0.6), (Liverpool, 0.7)\} \quad (8)$$

$$B = \{(Barcelona, 0.6), (RealMadrid, 0.8), (M.United, 0.5), (Liverpool, 0.8)\} \quad (9)$$

Then the results of the operations are as follows:

$$A \cup B = \{(Barcelona, 0.8), (RealMadrid, 0.9), (M.United, 0.6), (Liverpool, 0.8)\} \quad (10)$$

$$A \cap B = \{(Barcelona, 0.6), (RealMadrid, 0.8), (M.United, 0.5), (Liverpool, 0.7)\} \quad (11)$$

$$A' = \{(Barcelona, 0.2), (RealMadrid, 0.1), (M.United, 0.4), (Liverpool, 0.3)\} \quad (12)$$

Linguistic approach needs a term set as an appropriate linguistic description. In our study, a term set, $S$, is defined as $S = \{s_i\}$ where $i \in H = \{0, ..., T\}$ a finite

and ordered terms set on interval $[0,1]$. Thus any of the element, $s_i$, represents a value of a linguistic variable within interval $[0,1]$. As mentioned before, a triangular membership function is selected. Term set have the following characteristics: [35]

- A negation operator $Neg(s_i) = s_j$ such that $j = T - i$; (13)
- A max operator as $\max(s_i, s_j) = s_i$ if $s_i \geq s_j$ (14)
- A min operator as $\min(s_i, s_j) = s_i$ if $s_i \leq s_j$ (15)
- Set order as $s_i \geq s_j$ if $i \geq j$ (16)

In selecting the term set the issue of "granularity of uncertainty" should be determined. [34] Thus, the level of discrimination among different number of uncertainty. Also named as the cardinality of the term set, it should be small enough in order not to let unnecessary precision and rich enough in order to let discrimination is sufficient. The term set is in the interval of $[0,1]$. Generating a term set may be done by all terms distributed on scale with order. Term sets may have different number of terms mostly distributed symmetrically around the mean, odd numbers, usually 5, 7 or 9, but generally no more than 13. [34] Moreover, according to Miller's Law, capacity limit of human cognition in terms of one-dimensional judgment and short-term memory is about seven. [43]

In this thesis, a uniformly distributed ordered set of nine terms with its semantic is selected. Term set and its semantic is shown and listed below:

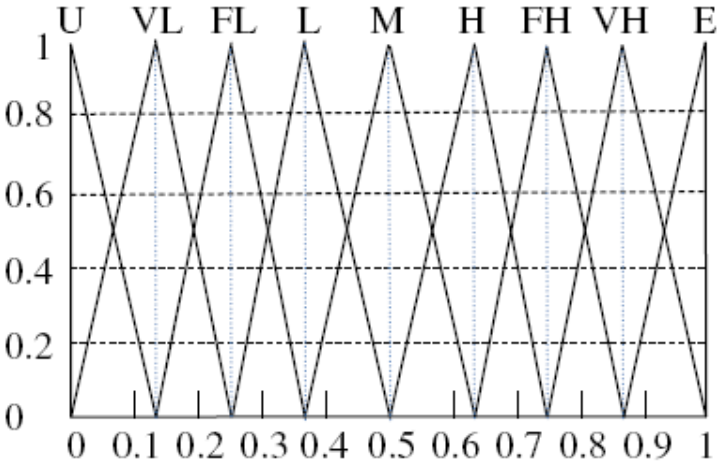


**Figure 4.1.b Linguistic term set**

As mentioned above, a triangular membership function is selected. In a triangular membership function each fuzzy number is depicted as 3-tuples (a,b,c) to represent the membership degree. As shown in Fig. 4.1.a, parameters are indicating the smallest possible value (a), the most promising value (b) and the largest possible value (c). The linguistic labels and the corresponding fuzzy numbers are listed below in Table 4.1.a.

**Table 4.11 Linguistic labels and fuzzy numbers**

| Linguistic labels | Linguistic Terms | Fuzzy Number |
|---|---|---|
| **E** | Essential $(s_8)$ | (0.875, 1, 1) |
| **VH** | Very High $(s_7)$ | (0.75, 0.875, 1) |
| **FH** | Fairly High $(s_6)$ | (0.625, 0.75, 0.875) |
| **H** | High $(s_5)$ | (0.5, 0.625, 0.75) |
| **M** | Moderate $(s_4)$ | (0.375, 0.5, 0.625) |
| **L** | Low $(s_3)$ | (0.25, 0.375, 0.5) |
| **FL** | Fairly Low $(s_2)$ | (0.125, 0.25, 0.375) |
| **VL** | Very Low $(s_1)$ | (0, 0.125, 0.25) |
| **U** | Unnecessary $(s_0)$ | (0, 0, 0.125) |

It should be emphasized that selected membership function could not be a totally agreed one. In overcoming this weakness and to obtain a better quality data aggregation operators are used. Thus with different aggregation operators used to combine data into a new and more reliable datum. [36] Linguistic information may be present as two types: [30]

- Weighted linguistic information where there is a set of values to aggregate having different degree of importance
- Non-weighted linguistic information where there is a single set of values to aggregate having same importance value

Both types of information are aggregated to reach better final value but in weighted information type, linguistic information is combined with the relevant weights. This is crucial for this study since companies have a set of business objectives but not all objectives have the same importance. Thus, weighed linguistic information type will be used according for the objectives of the company. Within this scope, operator LOWA (linguistic ordered weighted averaging) will be utilized. [37, 38]

## 4.2. Linguistic Promotion Mix Model

In the first chapter, marketing and promotion concept is discussed. Briefly, each promotion activity is based on a promotion strategy which is a subset of marketing strategy; utilize a set of tools based on parameters of product, market and customer within budget. In the second chapter, digital products are discussed and classified within a framework. Mapping of promotion strategies for digital products are proposed. The next step is proposing a model for linguistic promotion mix for digital products based on the strategies and budget.

### 4.2.1. Definition of Promotion Objectives

The initial step is determining the promotion objectives of the company. Promotion objectives may be any of increasing the sales volume, increasing market share, acquiring new customers, entering new markets, building up brand image, maintaining sales volume, increasing profit, creating awareness, creating entry barrier etc. The promotion objectives are highly depends on the product

features, product life cycle, market conditions, economic conditions and customer parameters. For a case product, relevant promotion strategy will be selected based on the given criteria later.

In this study, promotion objectives of the company for the product/product line/brand are defined as a set as follows:

$$o = \left(o_1, o_2, o_3, ..., o_k\right) \tag{17}$$

It is clear that each objective does not have the same importance. Thus, promotion objectives are weighted linguistic information and each of them are assigned the relevant weights. Based on the selected term set of nine linguistic labels listed in Table 4.1.a, importance of each objective will be one of the following set members:

$$W = \begin{Bmatrix} Essential, Very\ High, Fairly\ High, High, Moderate, \\ Low, Fairly\ Low, Very\ Low, Unnecessary \end{Bmatrix} \tag{18}$$

The linguistic weights of $k$ objectives are defined as the following set:

$$\alpha = \left(\alpha_1, \alpha_2, \alpha_3, ..., \alpha_k\right), \quad \alpha_i \in W \tag{19}$$

### 4.2.2. Definition of Promotion Mix

The next step is selecting the appropriate promotion tools. The promotion mix is consisting of a blend of carefully selected promotion tools. It should be noted that the affect of each promotion tool is not precise but linguistic labels will assist in dealing with this problem. A promotion mix consisting of different promotion tools are defined as follows, where $n$ denotes the number of tools:

$$n = \left(n_1, n_2, n_3, ..., n_k\right) \tag{20}$$

The following step is the satisfaction degree of each promotion objective. Satisfaction degree is a function of insertions of the relevant tools, meaning that

the number of times the relevant promotion tool is used. Since continuity is an important issue in the performance of promotion tool, number of insertion is determines the increasing effect of that tool, up to a limit. Thus, the satisfaction degree of each objective is evaluated as follows:

$$n^1 = \begin{pmatrix} n_{11}^1 & n_{12}^1 & n_{13}^1 & \dots & n_{1k}^1 \\ . & . & . & & . \\ . & . & . & & . \\ n_{m_1 1}^1 & n_{m_1 2}^1 & n_{m_1 3}^1 & \dots & n_{m_n k}^n \end{pmatrix}$$

$$\vdots \qquad n_{ij}^1 \in w\,, n_{ij}^h \in w \qquad (21)$$

$$n^h = \begin{pmatrix} n_{11}^h & n_{12}^h & n_{13}^h & \dots & n_{1k}^h \\ . & . & . & & . \\ . & . & . & & . \\ n_{m_n 1}^h & n_{m_n 2}^h & n_{m_n 3}^h & \dots & n_{m_n k}^h \end{pmatrix}$$

where the value $n_{ij}^h$ is represents the linguistic valuation of the tool $h$ on the selected promotion objective $j$ with $i$ insertions; $m_i,...,m_n$ represents the maximum number of tool insertions.

### 4.2.3. Definition of Promotion Budget

The next step is determination of promotion budget. Each promotion tool has a cost and the number of insertions is the other parameter of the total cost. Thus, as the number of promotion tools and the times of insertion increase the total cost of promotion activity will increase. Therefore, total amount of promotion investment should not exceed total budget. The cost function is identified as follows:

$$c^1 = \left(c_1^1, c_2^1, c_3^1, ..., c_{m_1}^1\right),$$

$$\vdots \qquad c_i^h \in R, \qquad (22)$$

$$c^h = \left(c_1^h, c_2^h, c_3^h, ..., c_{m_n}^h\right),$$

where value $c_i^h$ represents the cost of $i$ insertion of promotion tool $h$.

As a result, total investment amount for a promotion mix which can be denoted as $T$, is the maximum amount set by budget. After completing the previous two parts an appropriate promotion mix can be as follows:

$$S = \left(S_1, S_2, S_3, ..., S_n\right) \tag{23}$$

Since the total budget is an upper limit and only promotion mixes having a total investment amount equal or less than the total budget is acceptable than the following equation should be satisfied:

$$\sum_{h=1}^{n} S_h \leq T \quad and \quad C_{H_h}^h = S_h \tag{24}$$

where $S_h$ is the total investment level for the $h^{th}$ promotion tool; $H_h$ is the number of insertions for the relevant tool; $C_{H_h}^h$ is the cost of promotion tool $h$ for $h$ times of insertion.

### 4.3. Linguistic Promotion Mix Decision Model

In this part, a linguistic promotion mix decision model will be proposed. Linguistic operators will be utilized to evaluate the possible solutions of a promotion mix selection problem.

#### 4.3.1. Linguistic Objective Satisfaction Degree of the Promotion Mix

Companies are using various promotion tools to achieve defined company objectives. Not only the utilized promotion tool but the frequency of the usage is a affecting the satisfaction degree. Thus the first step is to evaluate satisfaction degree of promotion mix according to the defined objectives, as denoted before, $o = \left(o_1, o_2, o_3, ..., o_k\right)$

For each promotion tool, $h$, an investment amount is defined as, $S_h$. $H_h$, denoting the number of insertions for the relevant tool, $n^h_{H_h j}, j = 1,...,k$ represents the degree of satisfaction achieved for the $j^{th}$ promotion objective by means of using promotion tool, $h$, with insertion number $H_h$. Maximum level of promotion objective satisfaction is evaluated by means of linguistic ordered weighed averaging (LOWA) operator with the linguistic quantifier "as many as possible" (0.5,1) to consider the collective effect of most important tools. [39] Thus, promotion tools should not be regarded as independent from each other, even there may be a multiplier effect by utilizing multiple tools. Thus linguistic satisfaction degree of promotion objective, $t_j$, is evaluated as follows:

$$t_j = S_M(x,\alpha) = LOWA\left(n^1_{H_1 j}, n^2_{H_2 j}, ..., n^n_{H_n j}\right), \quad j = 1,...,k \tag{25}$$

In Appendix B, LOWA operator is briefly defined.

### 4.3.2. Objective Fitness Evaluation

After evaluating the maximum level of satisfaction degree for each promotion objective, $t_j$, the fitness of the objective is evaluated by comparing it with the importance rate of each promotion objective $(\alpha_j)$. For each objective, relative importance weight is calculated. The evaluation of objective fitness is depicted as follows:

$$g_j = \frac{\alpha_j}{\sum_{n=1}^{k} \alpha_n} \qquad j = 1,...,k \tag{26}$$

### 4.3.3. Overall Solution Fitness Evaluation

The last evaluation is the established final promotion mix solution fitness by means of aggregation of relative objective importance and aggregated satisfaction rate for each objective. The evaluation function is denoted as follows:

$$Z_s = \sum (g_j . t_j) \quad j = 1,...,k \tag{27}$$

### 4.3.4. Cost Function Evaluation

The last criterion is the satisfaction of budget constraint. Thus the total cost of selected promotion tool mix should not exceed the total budget. Moreover, having the same satisfaction degree, the lower budget promotion tool mix is preferred others. The final solution set must satisfy the following equation:

$$\sum_{h=1}^{k} S_h = T_S \text{ and } T_S \leq T \tag{28}$$

where $T$ is denoting the total budget, $T_S$ is cost of solution.

The linguistic label $Z_S$, depicted in previous part, is the final evaluation of the promotion mix where $S$ is the denoting satisfactory solution. As stated above, a lower budget solution having at least the same overall satisfactory rate is preferred over other. Let $S_1 \text{ and } S_2$ be two satisfactory solutions and $T_{S_1} \text{ and } T_{S_2}$ are denoting the corresponding costs then the preference can be demonstrated as follows:

$$\begin{aligned} &S_1 \text{ is better than } S_2 \text{ if } Z_{S_1} > Z_{S_2} \text{ and } T_{S_1} = T_{S_2} \\ &\text{or } S_1 \text{ is better than } S_2 \text{ if } Z_{S_1} = Z_{S_2} \text{ and } T_{S_1} < T_{S_2} \end{aligned} \tag{29}$$

Thus, the aim of the model is to reach the most satisfactory promotion mix with the minimum cost.

## 4.4. 2-Tuple Representation Model

The fuzzy linguistic approach has a limitation in its information representation model and also the computation methods when any fusion processes are performed on linguistic values. This limitation is basically the loss of information due to the need to express the results discretely in the initially defined expression domain by means of approximation. [51] For instance, after applying an arithmetic operation on linguistic values, the result should be rounded to the

nearest linguistic label which causes loss of information and lack of precision in final results. In this thesis study, to overcome this limitation 2-tuples representation of linguistic variables is preferred.

2-tuples fuzzy linguistic representation is composed of two parts as a linguistic term and a numeric value. The first part, linguistic term, is the usual representation of relevant term based on term set. The second part, numeric value, is defined as a value in [-0.5, 0.5). Thus, after any computation process, the result is expressed as is in the domain without any loss of information and no need to rounding to the closest term set value.

In 2-tuple representation, a pair is used as $(s,\alpha)$ where $s$ is the linguistic term and $\alpha$ is the numerical value. ($s_i \in S$ *and* $\alpha_i \in [-0.5, 0.5)$) In this representation, $s_i$ shows the linguistic label as the center information of triangular term set and $\alpha_i$ is the numerical value showing the value from the original result $\beta$ to the closest index value in the linguistic term set. For instance, a representation of $(s_4, 0.3)$ means that the result is linguistic term $s_4$ and plus 0.3 which is a value between $s_4$ and $s_5$ but closer to $s_4$. By this representation model, it is possible to compare results which have same linguistic labels but different numeric values. As a result, applying a rounding operation in aggregating the linguistic variables are no longer needed. Instead of expressing the results in discrete values, it is possible to demonstrate the results in a continuous way without loss of information. For this reason, the linguistic label is used as i.e., (VH, 0) instead of simply VH.

In this study, using 2-tuple model let us to modify the LOWA function. Since representing the results in discrete values are no longer a necessity, the “round” operation in LOWA operator is discarded. Thus, instead of approximation, actual results are utilized throughout the study.

## 4.5. Genetic Algorithms

In many different disciplines such as physics, economy, social sciences, medicine, *optimization* is a classical problem. The general approach to optimization problems are basically an analytical approach where a formulated function is iteratively processed. This approach has a proven efficiency in small data sets and linear interactions.
Genetic algorithms (GA) are an evolutionary optimization approach which is developed based on the principles of natural evolution, mimicking the evolution of a species, according to the Darwinian theory of the "survival of the fittest." Genetic algorithms are one of the alternative solutions to classical optimization methods and are highly appropriate for large, complex, non-linear, real-world problem sets. [40]

Principle of natural evolution is a population-based type optimization process. Since the algorithm is simply biological based, the way how the biological living beings solve problems are the basic inspire of it. Most of the time those methods are explained as chaos, chance, temporality, nonlinearity and multidimensionality. Such problems are proven to be intractable to classical optimization techniques. [32] In such cases, where heuristic solutions are not available or unsuccessful, evolutionary processes such as genetic algorithms can be applied which are flexible and easy to use. [42]

Since natural evolution is a population-based optimization approach, GA methodology is based on stochastically developing generations of solution populations. This stochastic-optimization process use a given fitness statistic and often produce satisfactory results to large, non-linear and difficult real-life problems. It should be noted that, GA do not guarantee optimality but approximate an optimum solution.

In 1950s, evolutionary systems studies started with the idea to evolve a candidate solution population by using natural selection inspired operators to solve a problem. Evolution strategies, evolutionary programming concepts accomplished in the following years and proposed by John Holland proposed GA

in 1970s. [42] Interestingly, the aim of Holland was to understand the adaptation in nature and use these techniques in computers.

GA is in use in extensive number of engineering, scientific and business problems. These areas include the following topics:

- Optimization - GA is often used in global optimization problems such as timetabling, job scheduling, travelling salesman problem etc
- Economics – utilized in market simulations, game theory, portfolio selection, bidding strategies, asset pricing, cobweb model
- Programming – used in computational science to develop specific computer programs, machine learning applications, neural network design, database query optimization
- Bioinformatics – used in gene studies, population genetics, multiple sequence alignment, immune system studies
- Engineering – in many disciplines of engineering GA is utilized to solve problems of constrained, combinational, multi-objective problems such as advanced transportation problems, network design, routing, mechanical component design, process design
- Chemistry – GA is used to fin patterns in large data and applied in protein folding, regression curves, parameterization, molecular modeling
- Manufacturing – solving problems in sequencing, scheduling, routing, facility layout design, system design, product assignments, cellular manufacturing

### 4.5.1. Components of Genetic Algorithms

Components of a genetic algorithm are basically population of chromosomes, fitness function and operators.

Chromosomes are binary bit strings. Genetic algorithms match each point in a solution space to a chromosome. Decision variables of an optimization problem are depicted as one or more strings. Those strings are composed of relevant features. The position of a feature in a string is called “locus” and the assigned value is “allele” which is either 0 or 1. The string structures in the chromosomes are processed by some operations like the natural-evolution process to produce

better alternative solutions by means of successively replacing the population with another. In each process phase, the newly created chromosomes' quality should be estimated based on a fitness score. This fitness function is the objective of the optimization problem. GA usually keeps a population and evolves it repeatedly to attain a better fitness value. New populations are generated by using genetic operators.

The basic operators are selection, crossover, mutation and inversion.

Selection operator is selecting the chromosomes from the population set to generate new generations. Higher fitness value means higher possibility of selection. Selection processes use different methods according to problem domain, namely, roulette-wheel selection, elitist selection, tournament selection, rank selection etc. Crossover operator selects a random locus and exchanges the string before and after locus between two chromosomes to reproduce new generation. Crossover operator can be used from one to n-point where n-point is selected randomly and each portion in between is swapped accordingly. Uniform crossover, cut-splice crossover, shuffle crossover are the other usually utilized types. For instance, one and two point crossover operator operates as follows:

- One point crossover: (at locus 4)

$$\begin{matrix} 10001100 \\ 10101010 \end{matrix} \Big\rangle \; crossover\ point\ 4 \; \Big\langle \begin{matrix} 10001010 \\ 10101100 \end{matrix}$$

- Two point crossover: (at locus 3 and 6)

$$\begin{matrix} 10001100 \\ 10101010 \end{matrix} \Big\rangle \; crossover\ point\ 3\,\&\,6 \; \Big\langle \begin{matrix} 10101000 \\ 10001110 \end{matrix}$$

Mutation operator is just flipping a bit according to a given very low mutation rate. Mutation operator is needed when the population does not include information needed to propose a solution thus crossover operator is unable to produce the needed string. Mutation rate is generally set to a low rate such as less than 0.1 in order not to loose good chromosomes. For instance, a string of 10010011 applied mutation operator with a randomly selected mutation bit at fifth position generates

a string as 100110011. Inversion operator is the final operator mentioned by Holland but it is rarely used today. Its function is accomplished somehow by crossover operator.

### 4.5.2. A Generic Genetic Algorithm

A generic genetic algorithm work as follows:

1. A genetic representation of the solution domain
2. Start with an initial candidate solution which is a randomly generated population of n bit chromosomes (GA usually use binary-coding schema)
3. Evaluate the fitness of each chromosome in the selected population
4. Repeat the following steps until n offspring is created (termination occurs at a time limit or satisfactory fitness is reached)
   4.1. Select a pair of parent chromosomes from the current population based on the specified method
   4.2. Cross over the pair at a randomly selected point based on the crossover rate
   4.3. Mutate the two offspring at randomly selected locus with the probability defined in mutation rate
5. Replace the current population with the new one
6. Go to step 3

Genetic algorithm work in an iterative way and each iteration produce a new generation similar to reproduction in nature. Number of iterations may be 30 or 300 or even more based on the type of problem. The performance of the algorithm highly depends on the population size, selection method, carefully selected crossover and mutation rates. The iterations in genetic algorithms are finalized when:

- A solution is reached where the criterion is met
- Any defined constraint is reached
- Successive iterations do not generate better solutions than a former point
- Iterations may converge to a local optima in which a means of intervention is required like changing fitness function, initial population, mutation rate, selection method and increasing diversity

It should be noted that GA does not assure to reach a global optimum solution but mostly produces satisfactory, near to optimum solution, if not optimum at all.

### 4.6. Proposed GA Methodology

In section 4.3 a linguistic decision model is proposed to achieve a satisfaction degree by means of the identified objectives. After this point, a GA will be used to find the optimum promotion mix with the minimum budget while satisfying the objectives at least same level.

GA is utilized in two steps as follows:

1. Budgeting – each promotion plan has a defined budget. Thus any proposed promotion mix solution can not exceed the total budget of the plan.

$$\sum_{h=1}^{k} S_h = T_S \quad and \quad T_S \leq T \tag{28}$$

where $T$ is denoting the total budget, $T_S$ is cost of solution

2. Promotion mix evaluation – promotion mix optimization will be based on objective satisfaction bounded with cost parameter. Thus, optimization aims to reach the maximum promotion objective satisfaction with minimum cost. A lower budget solution having at least the same overall satisfactory rate is preferred over other. Let $S_1$ *and* $S_2$ be two satisfactory solutions and $T_{S_1}$ *and* $T_{S_2}$ are denoting the corresponding costs then the preference can be demonstrated as follows:

$$\begin{aligned} &S_1 \, is \, better \, than \, S_2 \; if \; Z_{S_1} > Z_{S_2} \; and \; T_{S_1} = T_{S_2} \\ &or \; S_1 \, is \, better \, than \, S_2 \; if \; Z_{S_1} = Z_{S_2} \; and \; T_{S_1} < T_{S_2} \end{aligned} \tag{29}$$

The fitness function stated above clearly defines the fitness rule as the highest overall satisfaction rate within the budget limit is the optimal solution. Although it is mathematically correct but may be no sense in real business world. Because dealing with sole performance but not price/performance would be misleading.

For instance, a solution set having a satisfaction rate of 7.5 over 8 with a budget of 100 units wins another solution set having a satisfaction rate of 7.4 over 8 with a budget of 80 units. Thus, considering the “price/performance” rate of each solution set would also be interesting. However, in this case, a very unsatisfactory solution set with a very low budget would have a very good price/performance rate but not a preferable solution. For instance, a solution set having a satisfaction rate of 2 over 8 with a budget of 5 would have the highest price/performance rate. For this reason, a parametric approach is selected. Giving the user the chance to change the importance weight between the promotion mix solution set satisfaction rate and the budget would propose a better optimization for real business world than the sole satisfaction rate and price/performance rate. Thus, selecting the weights which sum up to 1 is used as a parameter in this study. For instance, an importance weight of 0.9 for satisfaction rate and 0.10 for budget may end up a better realistic optimization. In any case, the budget constraint and the Equation (29) are ruling.

Application of the methodology is as follows:

i. Solution domain will be based on the values of promotion tool insertions. For each candidate tool strings will be generated in which relevant investment level are assigned. A binary coding method is used to encode the promotion tools. Each chromosome represents the number of insertions for the relevant tool and also whether the tool is used or not. The binary representation is shown below. The first bit of the chromosome points whether the specified promotion tool is selected for the solution set or not. The following bits (either 2 bits or more depending on the number of total insertion) indicate the number of insertion for this promotion tool.

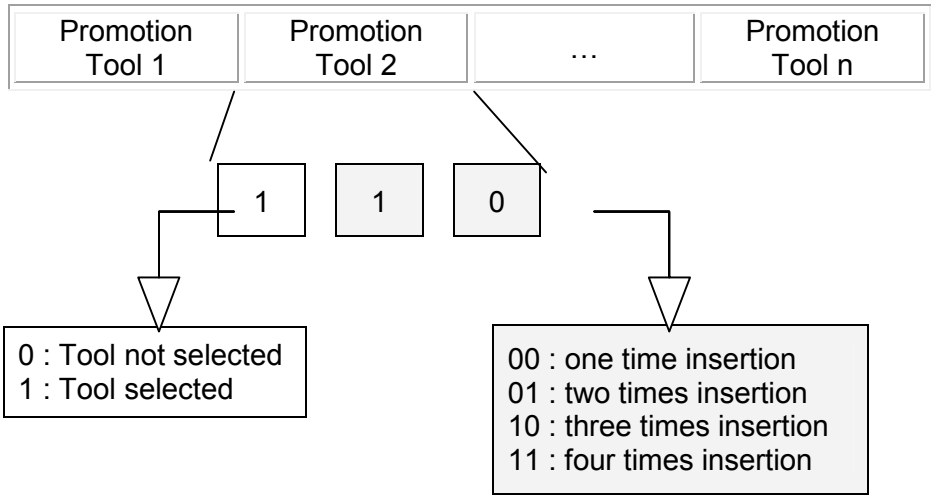


**Figure 4.6.a Proposed chromosome structure**

ii. Fitness function will be based on the linguistic decision model proposed in Section 4.3. As summarized above, fitness function is depending on two factors. One is the total promotion investment amount and the next is the final overall satisfaction rate of the model. Thus, a linguistic label for each promotion tool and a numeric value showing the cost of each solution is obtained.

iii. For selection method, roulette wheel selection method is preferred due to its efficiency in cost estimation and multiple criteria decision problems. The selection process can be denoted by selection probability $p$ as follows:

$$p_i = \frac{f_i}{\sum_{k=1}^{n} f_k}, \quad i = 1,2,...,n \tag{30}$$

where $f_i$ is denoting the fitness value of the promotion mix for the $i^{th}$ chromosome, $n$ is the population size and $\sum_{k=1}^{n} f_k$ is the sum of the fitness value of overall promotion mixes. The effect of this selection method is to let members having over-average value to reproduce and replace members having below-average values. In the roulette wheel, slot sizes are determined according to the fitness for each chromosome. After

calculating the probability of selection in Eq.(30), a cumulative probability after each chromosome is added will be calculated as follows:

$$q_i = \sum_{j=1}^{i} p_j \tag{31}$$

where $q \in [0,1]$. The selection is done on spinning the wheel population size time. Each time a single chromosome is selected for a new generation.

Moreover, in order not to loose the best chromosomes, elitism method is also utilized beside roulette wheel selection. It is believed that elitism increase the performance of genetic algorithm by keeping the best found solution. The following steps are repeated until population size times:

- A random number r is generated from the range [0,1]
- If $r < q_1$ then the first chromosome is selected; if not $i^{th}$ chromosomes is selected where $q_i - 1 < r \leq q_i$

iv. For crossover operator one-point crossover is preferred due to the solution dimension. Crossover rate would be about 0.75-0.85.

v. Mutation operator is used in order not to reach a local optima. Mutation rate would be around 0.01-0.05.

### 4.7. Knapsack Problem Approach and Solution Algorithms

The knapsack problem or also named as rucksack problem is one of the most studied problems in combinatorial optimization. This type of problem often arises in resource allocation with financial constraints. The knapsack problem can be defined as: Given a set of items *N*, consisting of *n* items, each with a weight and a value, determine the number of each item to include in a collection so that the total weight is less than a given limit the capacity *c* and the total value is as large as possible.[48] Its name comes from the problem faced by someone who is

constrained by a fixed-size knapsack and must fill it with the most useful or valuable items.

The knapsack problem is applied in many real-life applications. The concept of this thesis study can be regarded as a knapsack problem. Thus, the basic optimization approaches of to knapsack problem are examined according to genetic algorithm.

The knapsack problem can be represented as follows:

$$maximize \sum_{j=1}^{n} p_j x_j \tag{32}$$

$$subject\ to \sum_{j=1}^{n} w_j x_j \leq W,\ x_j \in \{0,1\}\ \forall j \in \{1,2,...,n\} \tag{33}$$

There are many variants of knapsack problem as 0/1 knapsack problem, bounded knapsack problem, unbounded knapsack problem, subset sum problem, multidimensional knapsack problem, multiple-choice knapsack problem and etc.

Many algorithms are available in order to solve knapsack problems. Among this long list, some of them may be listed as the Greedy Algorithm, Dynamic Programming, Branch and Bound, Brute Force Algorithm, Word RAM Algorithms, Lagrangian Decompositions, Linear Programming Relaxation and others.

Greedy Algorithm is focused on a basic but effective approach where filling up the knapsack starting from the highest efficient item. Efficiency of an item can be represented as:

$$e_j = \frac{p_j}{w_j} \tag{34}$$

It is clear that, as the efficiency of an item increase, higher value with lower weight is attained. Thus, without regarding future consequences, the most efficient item is selected and the process continuous same with the rest. Greedy algorithm can be summarized as locally optimal choice would lead to global optimal solution. Greedy algorithm works well and fast in some type of problems but may fail in some others. For instance, Greedy Algorithm performing well in fractional knapsack problem but not so efficient in 0/1 knapsack problems. Since

the optimization of this thesis study is a type of 0/1knapsack problem, Greedy Algorithm would not be applicable.

As listed above, another optimization algorithm is Brute Force. Also named as exhaustive search, it is a trivial problem solving technique where all possible candidates of the solution are iterated systematically. Brute force is simple to implement and will always end with the correct solution if exists. However, as the size of the problem increases, the complexity of the algorithm increases exponentially. Thus, it is practical to use Brute Force with a limited problem size and where the implementation simplicity is more important than speed.

In the implementation phase, Brute Force Algorithm will be used both for to compare the performance of Genetic Algorithm (a heuristic search) vs Brute Force (exhaustive search) and to check the validity and quality of Genetic Algorithm output.

### 4.8. Marketing Optimization Tools and Approaches

Optimization can be defined as "the action of finding the best solution." Optimization modeling is a branch of mathematical modeling concerned to find the optimal solution to a problem basically the optimal allocation of scarce resources. Optimization has been used in various areas like manufacturing, engineering, supply chain, financial investment, risk evaluation and marketing.

Marketing optimization focuses on the optimal subset of combinations that will maximize the profit. Due to the complexity caused by ample number of customers, product and services, fierce competition, market fragmentation, communication channels, it is indeed difficult to find the right set of customer-product-communication channel blend which will maximize profit while ensuring customer satisfaction.

By means of using data and analytics, marketing optimization processes and models are developed to help to determine the optimal solution stated above.

Deploying an optimization method allows companies to explore all the possible solutions and select the optimal one satisfying all of the constraints.

Marketing optimization is based on three fundamental components. The first is precise and accurate data. Internal and external sources should be used to collect relevant data. The second is an adequate model describing the problem. The modeling would help to convert the marketing management problem into a marketing programming problem. [49] Thus, this is a mathematical model describing the relationships between the relevant variables in a quantitative manner. [50] And the third is the selected optimization algorithm.

Decision models can be classified in different groups. In optimization-type grouping, there are four basic decision models: [1]

- Differential calculus
- Mathematical programming
- Bayesian decision theory
- Game theory

Moreover, graphical models are other major group for market analysis as a visual guide. Mathematical models are a long list of optimization methods. A brief list of optimization methods can be summarized as follows:

- Linear programming
- Integer programming
- Quadratic programming
- Geometric programming
- Non-linear programming
- Stochastic programming
- Dynamic programming
- Combinatorial programming
- Heuristic Algorithms
- Infinite dimensional optimization
- Hill Climbing
- Simulated annealing
- Genetic Algorithm

- Ant Colony Optimization
- Bees algorithm
- Constraint Satisfaction
- Dynamic relaxation
- Greedy algorithm

Each optimization algorithm has different advantages and also limitations. Marketing optimization processes and models are important tools to assist marketing decision makers to solve marketing problems efficiently. Marketing optimization tools become available and applicable by means of information technology which enhanced analytical capabilities as well as accumulating marketing data.

In this thesis study, genetic algorithm is selected as an optimization algorithm which is heuristic, evolutionary approach. The input of the genetic algorithm is provided by linguistic fuzzy logic model which help us to reason and make rational decisions in an environment of imprecision, uncertainty, incompleteness of information.

There are some key points to consider in using optimization methods:

- The quality of final solution is based on the quality of data. Since, there are vast amount of parameters and factors affecting the marketing data, it is regarded as incomplete or imprecise data. That is why linguistic fuzzy logic approach is selected
- Decision making process is rarely a complete rational process. The environment can be better defined as bounded rationality which directs them to be satisficers rather than optimizers. [50] The linguistic fuzzy model approach applied in this study is also focused on this in gathering and manipulating the data.
- Marketing optimization is more convenient where the problem is highly structured and enough time to collect and process data. In cases where the problem is weakly structured and limited time then more heuristic instead of analytical styles is used like deductive reasoning.

# CHAPTER 5

# IMPLEMENTATION

In this part of the study, the proposed model will be applied on a sample application of promotion mix decision for a digital product.

For an empirical application, a digital product company which provided relevant data, with the promise of keeping it confidential, is selected. Promotion objectives for this product each assigned an importance level and relative budgeting is received. The linguistic satisfaction degree assessments of reaching promotion objective for each selected promotion tool and the cost of each promotion tool as a function of times the relevant promotion tool utilized is also received. The proposed linguistic decision model is applied. The output of the model, as the fitness of the promotion mix solution, is calculated as a linguistic variable in the next section. This output demonstrates the evaluation of the current promotion mix of the company.

This linguistic decision model output is the input for GA. Based on the solution domain, GA search process is applied. Fitness function evaluated the fitness of promotion objective and the fitness of promotion mix based on the satisfaction rates and budget constraints. Roulette wheel selection method with elitism is applied to select the chromosomes with selected crossover and mutation rates.

The output of the model is compared and discussed with the current solution set of the company in the following section.

## 5.1. Model Implementation

The proposed model is applied on an empirical application of a Turkish company. The details of the company, business and the product are as follows:

- A Turkish company
- Legal online betting business
- Active about 5 years
- More than one million subscribers
- Subscribers are mostly male and aged 18+
- Online betting business is around %15 of the total betting market
- Online betting is preferred by more educated people
- Online betting games in Turkey are as follows:
    - “Iddaa”, betting on score of various aspects of various sports games both in Turkey and abroad
    - Horse racing betting
    - “Spor Toto”, betting on final results of football matches in Turkey
    - “Milli Piyango” the national lottery
- Market growth rate is around %10-12
- There is a fierce competition in the market especially due the reason that the competitors’ main business is media
- Promotion budget is identified as a percentage of sales volume
- Budget of each promotion tool is given as a percentage of total promotion budget
- Total promotion budget is not specified due to confidentiality
- Online betting companies are aimed to provide a secure, trustable service platform
- Online betting sites uses some ways for trial run for prospective customers
- Online betting sites interactive platforms
- Since there are physical counterpart of online betting sites for long years tangibility is fairly low
- Involvement level of online betting sites highly depends on the characteristics of the subscriber. It may be regarded as a way of entertainment for a group but a passion for another group. Thus, information search is generally intense.
- The nature of the product is perishable since each betting is a time-stamped action.
- The types of betting are clearly defined so that it is highly homogenous.

- Competing companies are providing similar services so the main competition areas are in easy-to-use web design, speed of award payment, accuracy of recommendations and channel variety of payment channels.

The business objectives and their importance levels, assessment of promotion tool mix satisfaction rates for different number of insertions for each tool and relevant budgeting is listed below. All linguistic variables are expressed as 2-tuple form:

**Table 5.1.a Business Objectives and Importance**

| 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|
| Increase sales volume | Raising market share | Increasing brand loyalty | Increasing mid-term profitability | Strengthening brand image |
| (VH,0) | (E,0) | (H,0) | (FH,0) | (VH,0) |

**Table 5.1.b Promotion Mix Tools and Budget**

| Tool Name | Investment amount |
|---|---|
| Rebates | 20 |
| Sponsorship | 18 |
| TV Ads | 13 |
| Web Ads | 12 |
| Bonuses | 8 |
| Contest | 6 |
| Print Ads | 6 |
| Radio Ads | 4 |
| Gifts | 4 |
| PR | 3 |
| Loyalty Program | 2 |
| Others | 2 |
| Donations | 1 |
| Outdoor | 1 |

Before proceeding further, the promotion tool mix of the company will be evaluated according to the proposed digital product classification framework demonstrated at Figure 3.7.a. as follows:

- Online betting service platforms provide moderate-to-high degree of trial run options. Company provides bonuses and gifts to enforce trial
- Since betting business has physical counterpart, it is a familiar business for concerned for years. But, online betting business is a new one and need to take attention. For this reason company is using both the traditional (TV, radio, print) and digital channels
- Involvement level is moderate to high, thus require extensive information search. Company provides recommendations of opinion leaders from its web site extensively
- Online betting is a perishable product. Each betting has a due time. Thus, companies are providing campaigns to attract more subscriber, such as rebates, contests
- Product is highly homogenous but requires high quality management, security, award payment and personalization strategies for differentiation. Promotion tools are used to make those differentiations known
- Brand image building, creating trust and brand loyalty is one of the most critical issues for digital companies. Here, the company uses PR, loyalty program, donations

Consequently, the promotion tool mix of the company can be considered highly appropriate with its type of business. The insertion number of each promotion tool is also critical since using the right tool with wrong frequency may also be ineffective. It should be also noted that further market data is essential to make comments in detail.

In the following consecutive tables, assessment of marketing department of the company for the promotion tools satisfaction rates for different numbers of insertions are listed:

**Table 5.14**

| # Insertion | Invest-ment amount | Buss. Obj-1 | Buss. Obj-2 | Buss. Obj-3 | Buss. Obj-4 | Buss. Obj-5 |
|---|---|---|---|---|---|---|
| 1 | 15 | (FH,0) | (FH,0) | (FH,0) | (FH,0) | (FH,0) |
| 2 | 20 | (VH,0) | (VH,) | (FH,0) | (FH,0) | (FH,0) |
| 3 | 25 | (VH,0) | (VH,0) | (VH,0) | (FH,0) | (FH,0) |
| 4 | 30 | (E,0) | (E,0) | (VH,0) | (H,0) | (H,0) |

**Table 5.15 Sponsorship**

| # Insertion | Invest-ment amount | Buss. Obj-1 | Buss. Obj-2 | Buss. Obj-3 | Buss. Obj-4 | Buss. Obj-5 |
|---|---|---|---|---|---|---|
| 1 | 14 | (FH,0) | (VH,0) | (FH,0) | (H,0) | (H,0) |
| 2 | 18 | (VH,0) | (VH,0) | (VH,0) | (H,0) | (FH,0) |
| 3 | 22 | (VH,0) | (E,0) | (VH,0) | (FH,0) | (FH,0) |
| 4 | 26 | (E,0) | (E,0) | (VH,0) | (FH,0) | (VH,0) |

**Table 5.16**

| Insertion | Invest-ment amount | Buss. Obj-1 | Buss. Obj-2 | Buss. Obj-3 | Buss. Obj-4 | Buss. Obj-5 |
|---|---|---|---|---|---|---|
| 1 | 9 | (FH,0) | (FH,0) | (FH,0) | (FH,0) | (FH,0) |
| 2 | 13 | (VH,0) | (FH,0) | (FH,0) | (FH,0) | (VH,0) |
| 3 | 17 | (VH,0) | (VH,0) | (VH,0) | (FH,0) | (VH,0) |
| 4 | 21 | (FH,0) | (FH,0) | (VH,0) | (FH,0) | (VH,0) |

**Table 5.1.f – Web Ads**

| # Insertion | Invest-ment amount | Buss. Obj-1 | Buss. Obj-2 | Buss. Obj-3 | Buss. Obj-4 | Buss. Obj-5 |
|---|---|---|---|---|---|---|
| 1 | 9 | (FH,0) | (FH,0) | (FH,0) | (FH,0) | (FH,0) |
| 2 | 12 | (VH,0) | (VH,0) | (FH,0) | (FH,0) | (FH,0) |
| 3 | 15 | (VH,0) | (VH,0) | (FH,0) | (VH,0) | (VH,0) |
| 4 | 18 | (VH,0) | (VH,0) | (VH,0) | (VH,0) | (E,0) |

**Table 5.1.g – Bonuses**

| # Insertion | Invest-ment amount | Buss. Obj-1 | Buss. Obj-2 | Buss. Obj-3 | Buss. Obj-4 | Buss. Obj-5 |
|---|---|---|---|---|---|---|
| 1 | 7 | (FH,0) | (FH,0) | (FH,0) | (H,0) | (H,0) |
| 2 | 8 | (VH,0) | (FH,0) | (VH,0) | (H,0) | (FH,0) |
| 3 | 9 | (VH,0) | (VH,0) | (VH,0) | (H,0) | (FH,0) |

**Table 5.1.h – Contests**

| # Insertion | Invest-ment amount | Buss. Obj-1 | Buss. Obj-2 | Buss. Obj-3 | Buss. Obj-4 | Buss. Obj-5 |
|---|---|---|---|---|---|---|
| 1 | 4 | (FH,0) | (FH,0) | (H,0) | (H,0) | (H,0) |
| 2 | 5 | (FH,0) | (FH,0) | (H,0) | (H,0) | (FH,0) |
| 3 | 6 | (VH,0) | (FH,0) | (H,0) | (FH,0) | (FH,0) |
| 4 | 7 | (VH,0) | (VH,0) | (H,0) | (FH,0) | (FH,0) |

**Table 5.1.i – Print Ads**

| # Insertion | Invest-ment amount | Buss. Obj-1 | Buss. Obj-2 | Buss. Obj-3 | Buss. Obj-4 | Buss. Obj-5 |
|---|---|---|---|---|---|---|
| 1 | 4 | (FH,0) | (H,0) | (FH,0) | (H,0) | (FH,0) |
| 2 | 6 | (FH,0) | (FH,0) | (FH,0) | (FH,0) | (FH,0) |
| 3 | 8 | (VH,0) | (FH,0) | (FH,0) | (FH,0) | (VH,0) |
| 4 | 10 | (VH,0) | (VH,0) | (FH,0) | (VH,0) | (VH,0) |

**Table 5.1.j – Radio Ads**

| # Insertion | Invest-ment amount | Buss. Obj-1 | Buss. Obj-2 | Buss. Obj-3 | Buss. Obj-4 | Buss. Obj-5 |
|---|---|---|---|---|---|---|
| 1 | 3 | (FH,0) | (H,0) | (FH,0) | (H,0) | (H,0) |
| 2 | 4 | (FH,0) | (H,0) | (FH,0) | (H,0) | (H,0) |
| 3 | 5 | (FH,0) | (FH,0) | (FH,0) | (H,0) | (FH,0) |
| 4 | 6 | (VH,0) | (FH,0) | (FH,0) | (FH,0) | (FH,0) |

**Table 5.1.k – Gifts**

| # Insertion | Invest-ment amount | Buss. Obj-1 | Buss. Obj-2 | Buss. Obj-3 | Buss. Obj-4 | Buss. Obj-5 |
|---|---|---|---|---|---|---|
| 1 | 3 | (FH,0) | (H,0) | (H,0) | (M,0) | (M,0) |
| 2 | 4 | (FH,0) | (H,0) | (H,0) | (M,0) | (M,0) |
| 3 | 5 | (FH,0) | (FH,0) | (FH,0) | (M,0) | (M,0) |
| 4 | 6 | (VH,0) | (FH,0) | (VH,0) | (L,0) | (M,0) |

**Table 5.1.l – PR**

| # Insertion | Invest-ment amount | Buss. Obj-1 | Buss. Obj-2 | Buss. Obj-3 | Buss. Obj-4 | Buss. Obj-5 |
|---|---|---|---|---|---|---|
| 1 | 2 | (M,0) | (M,0) | (H,0) | (M,0) | (FH,0) |
| 2 | 3 | (M,0) | (M,0) | (FH,0) | (M,0) | (FH,0) |
| 3 | 4 | (H,0) | (H,0) | (FH,0) | (H,0) | (VH,0) |

**Table 5.1.m – Loyalty Program**

| # Insertion | Invest-ment amount | Buss. Obj-1 | Buss. Obj-2 | Buss. Obj-3 | Buss. Obj-4 | Buss. Obj-5 |
|---|---|---|---|---|---|---|
| 1 | 1 | (M,0) | (M,0) | (H,0) | (H,0) | (M,0) |
| 2 | 2 | (H,0) | (M,0) | (FH,0) | (FH,0) | (H,0) |
| 3 | 3 | (H,0) | (H,0) | (VH,0) | (FH,0) | (H,0) |

**Table 5.1.n – Others**

| # Insertion | Invest-ment amount | Buss. Obj-1 | Buss. Obj-2 | Buss. Obj-3 | Buss. Obj-4 | Buss. Obj-5 |
|---|---|---|---|---|---|---|
| 1 | 1 | (M,0) | (M,0) | (L,0) | (M,0) | (M,0) |
| 2 | 2 | (M,0) | (M,0) | (M,0) | (M,0) | (H,0) |

**Table 5.1.o – Donations**

| # Insertion | Invest-ment amount | Buss. Obj-1 | Buss. Obj-2 | Buss. Obj-3 | Buss. Obj-4 | Buss. Obj-5 |
|---|---|---|---|---|---|---|
| 1 | 1 | (L,0) | (L,0) | (M,0) | (M,0) | (H,0) |
| 2 | 2 | (L,0) | (L,0) | (H,0) | (M,0) | (FH,0) |

**Table 5.1.p – Outdoor**

| # Insertion | Invest-ment amount | Buss. Obj-1 | Buss. Obj-2 | Buss. Obj-3 | Buss. Obj-4 | Buss. Obj-5 |
|---|---|---|---|---|---|---|
| 1 | 1 | (H,0) | (H,0) | (FH,0) | (H,0) | (FH,0) |
| 2 | 2 | (FH,0) | (FH,0) | (FH,0) | (H,0) | (FH,0) |
| 3 | 3 | (VH,0) | (FH,0) | (VH,0) | (FH,0) | (VH,0) |

## 5.2. Linguistic Promotion Mix Decision Model Implementation

As stated in section 4.3., the business objectives of the company and their relevant importance rates are listed in Table 5.1.a. The current budgeting of existing promotion tool mix is listed in Table 5.1.b. Moreover, the assessment of marketing department of the company for the promotion tools satisfaction rates for different numbers of insertions are demonstrated in Table 5.1.c to 5.1.p. Based on those data, the maximum level of promotion objective satisfaction rate, objective fitness and overall solution fitness is evaluated as follows:

**a)** The maximum level of promotion objective satisfaction for current promotion tool mix is calculated by applying the Eq.(25) The resulting table is as follows with the last row demonstrating the final value in 2-tuple form. LOWA aggregation operator is used with “as many as possible” quantifier. This operator and the quantifier provide an aggregation of values of highest-half among all promotion tools are done with weighted averaging. By this approach, the promotion tools are not independent from others but creating a combinational effect, some sort of synergy together.

**Table 5.2.a Satisfaction Degree of Current Tool Set**

| Tool Name | Buss. Obj-1 | Buss. Obj-2 | Buss. Obj-3 | Buss. Obj-4 | Buss. Obj-5 |
|---|---|---|---|---|---|
| Rebates | (VH,0) | (VH,0) | (FH,0) | (FH,0) | (FH,0) |
| Sponsorship | (VH,0) | (VH,0) | (VH,0) | (H,0) | (FH,0) |
| TV Ads | (VH,0) | (FH,0) | (FH,0) | (FH,0) | (VH,0) |
| Web Ads | (VH,0) | (VH,0) | (FH,0) | (FH,0) | (FH,0) |
| Bonuses | (VH,0) | (FH,0) | (VH,0) | (H,0) | (FH,0) |
| Contest | (VH,0) | (FH,0) | (H,0) | (FH,0) | (FH,0) |
| Print Ads | (FH,0) | (FH,0) | (FH,0) | (FH,0) | (FH,0) |
| Radio Ads | (FH,0) | (H,0) | (FH,0) | (H,0) | (H,0) |
| Gifts | (FH,0) | (H,0) | (H,0) | (M,0) | (M,0) |
| PR | (M,0) | (M,0) | (FH,0) | (M,0) | (FH,0) |
| Loyalty Program | (H,0) | (M,0) | (FH,0) | (FH,0) | (H,0) |
| Others | (M,0) | (M,0) | (M,0) | (M,0) | (H,0) |
| Donations | (L,0) | (L,0) | (M,0) | (M,0) | (H,0) |
| Outdoor | (H,0) | (H,0) | (FH,0) | (H,0) | (FH,0) |
| **Maximum Rate** | (VH,-0.04) | (VH,-0.36) | (FH,0.46) | (FH,-0.04) | (FH,0.25) |

**b)** Objective fitness and overall solution fitness for current promotion tool mix is calculated by applying the Eq.(26) and Eq.(27) The resulting table is as follows with the last row demonstrating the final value in 2-tuple form.

**Table 5.2.b Satisfaction Degree of Current**

| Business Objectives | Increase Sales volume | Raising market share | Increasing brand loyalty | Increasing mid-term profitability | Strengthen brand image |
|---|---|---|---|---|---|
| Importance level | (VH,0) | (E,0) | (H,0) | (FH,0) | (VH,0) |
| Aggregated Satisfaction | (VH,-0.04) | (VH,-0.36) | (FH,0.46) | (FH,-0.04) | (FH,0.25) |
| **Final Score** | **(FH,0.48)** | | | | |

Final score of the existing promotion tool mix is calculates and demonstrated. According to the linguistic label terms the overall

satisfaction rate of solution is (FH,0.48) which means a value approximately between “fairly high” and “very high”.

$$Z_s = \sum (g_j . t_j) = \left(FH, 0.48\right) \tag{27}$$

As a summary, the evaluation result of fuzzy linguistic model approach for the promotion tool mix is (FH,+0.48; 100), where the linguistic term represents the overall satisfaction rate of the solution set as a 2-tuple representation and the second item is the total fictive budget.

### 5.3. Proposed GA Implementation

Based on the proposed model detailed in section 4.6, a GA code is generated to find out the optimum promotion mix. The details of GA code are as follows:

- GA code is generated via C++
- GAlib, a C++ library of genetic algorithm components is used in development
- Due to the number of maximum insertion, 3 bit binary coding is used as depicted at Figure 4.6.a to represent each promotion tool
- Fitness functions of GA are the total promotion investment amount and the final overall satisfaction rate of the model.
- For selection process, roulette wheel selection and elitism is used.
- Initial population is generated randomly
- GA parameters used are as follows:
    - Number of generation : 500
    - Population size : 50
    - Crossover rate : 0.85
    - Mutation rate : 0.01
- Total budget limit is 100

The output of developed GA code with the parameters above is listed in the following table:

**Table 5.3.a GA Selection Process Output**

| Tool Name | # insertion | Investment amount |
|---|---|---|
| Rebates | 0 | 0 |
| Sponsorship | 4 | 26 |
| TV Ads | 3 | 17 |
| Web Ads | 4 | 18 |
| Bonuses | 3 | 9 |
| Contest | 4 | 7 |
| Print Ads | 4 | 10 |
| Radio Ads | 0 | 0 |
| Gifts | 0 | 0 |
| PR | 3 | 4 |
| Loyalty Program | 3 | 3 |
| Others | 0 | 0 |
| Donations | 0 | 0 |
| Outdoor | 3 | 3 |
| Total | | 97 |
| Total Satisfaction Level : (VH, 0.04) | | |

The proposed GA model provided a better satisfaction rate and also lower budget. According to the linguistic label terms the overall satisfaction rate of solution is (VH,0.04) which means a value slightly above “very high”. In order to clearly compare the both solution set, the existing and the optimized solution is demonstrated in the following table.

As seen from the comparison table below, instead of 14 different promotion tools in current situation, GA model proposed 9 different promotion tools with higher insertion numbers. The total budget is %3 lower than the original one. The numerical interpretation of overall satisfaction rates as demonstrated at Figure 4.1.a is 6.48/8.0 for current promotion mix and the rate increased to 7.04/8 after the GA model.

In marketing point of view, the output of GA model also makes sense. The proposed promotion strategies for digital products were detailed in Section 3.8. Based on those recommendations the following assessments may be proposed. Due to the nature of online betting sites, web is an essential channel to use.

Moreover, traditional channels are also critical complementary channels which are also used in the optimized solution set. Promotion tools to attract and retain prospects and first time users are utilized such as bonuses and contests. Increased insertion rate in PR and loyalty programs can be considered as the aim to build trust, brand name and brand loyalty. A suggestion may be to qualify the importance level of business objective-5, “strengthening brand image”, as the linguistic label “essential” since the digital product companies should pay high attention to this issue.

**Table 5.3.b Final Solution before and after Optimization**

| | Before GA | | After GA | |
|---|---|---|---|---|
| **Tool Name** | **Investment amount** | **# insertion** | **Investment amount** | **# insertion** |
| Rebates | 20 | 2 | 0 | 0 |
| Sponsorship | 18 | 2 | 26 | 4 |
| TV Ads | 13 | 2 | 17 | 3 |
| Web Ads | 12 | 2 | 18 | 4 |
| Bonuses | 8 | 2 | 9 | 3 |
| Contest | 6 | 3 | 7 | 4 |
| Print Ads | 6 | 2 | 10 | 4 |
| Radio Ads | 4 | 2 | 0 | 0 |
| Gifts | 4 | 2 | 0 | 0 |
| PR | 3 | 2 | 4 | 3 |
| Loyalty Program | 2 | 2 | 3 | 3 |
| Others | 2 | 2 | 0 | 0 |
| Donations | 1 | 1 | 0 | 0 |
| Outdoor | 1 | 1 | 3 | 3 |
| Total Budget | 100 | | 97 | |
| Satisfaction Rate | **(FH,0.48)** | | **(VH,0.04)** | |

The next step is to make the same calculation for not solely optimizing the solution set for the best satisfaction rate but giving some weights to overall satisfaction rate and also the budget as mentioned in Section 4.6. This controlled price/performance approach also resulted interesting outputs which may make more sense in business. In this approach, the total budget constraint is still valid and a lower satisfaction rate for the sake of higher budgeting advantage may be a challenging proposal as well.

In order to test this approach, satisfaction rate is assigned a weight of 0.9 and the budget assigned a weight of 0.1 for a total of 1. Discarding some high budget promotion tool is an expected output. A sample output is demonstrated in the table below:

**Table 5.3.c GA Selection Process for Weighted Variables**

| Tool Name | # insertion | Investment amount |
|---|---|---|
| Rebates | 0 | 0 |
| Sponsorship | 0 | 0 |
| TV Ads | 0 | 0 |
| Web Ads | 4 | 18 |
| Bonuses | 3 | 9 |
| Contest | 4 | 7 |
| Print Ads | 4 | 10 |
| Radio Ads | 4 | 6 |
| Gifts | 0 | 0 |
| PR | 3 | 4 |
| Loyalty Program | 3 | 3 |
| Others | 0 | 0 |
| Donations | 0 | 0 |
| Outdoor | 3 | 3 |
| Total | | 60 |
| Total Satisfaction Level : (VH,-0.20) | | |

The attained satisfaction rate is higher than the current running promotion tool set with approximately half of the budget. Eight different promotion tools are used and some expensive tools are discarded for the sake of challenging budget gain. By this weight parameter, it is supposed that the proposed model is more applicable and realistic for business life.

It should be noted that assessments of the satisfaction performance for promotion tools for different insertions are subjective evaluations of the experts based on their experiences and know-how. Those assessments may change by even short period of time due to high transformation in the market, economy, competition and products. Each time when assessments change, the optimization process should be repeated.

## 5.4. Performance of GA Model

Proposed GA model is tested in the following configuration:

- Asus P5Q-SE P45
- Intel E7400 c2d 2.8
- Ram 4GB
- Windows XP

The running time of the code is about 1 second. The optimization complexity is almost linear.

The same problem is coded in Brute Force algorithm as stated in Section 4.7. Since the optimization complexity is exponential$\left(2^{42}\right)$, first a subset of the problem is run on the above configuration. Based on this running time, the actual problem set running duration is calculated to be about 7 years.

Thus, performance of GA is highly satisfactory in this type of optimization problem.

# CHAPTER 6

# CONCLUSION

Marketing concept is basically rely on the strategies on major four categories, namely as, product, price, place and promotion. It is certain that better company performance is highly tied to better coordination of marketing mix elements. Promotion stands for all efforts to communicate with target customer. Promotion activities deals with defining the objective of the promotion, designing the right communication content –the message-, choosing the right blend of communication channels, budgeting, delivering the message to the right customer at the right time. Each channel has different features, each product deserves different approaches, market conditions and customer preferences are always challenging. One of the most critical issues is to decide the distribution of marketing budget among all possible channels. It is almost a multi criteria decision in which there is high uncertainty and vagueness. Selecting a promotion mix is not a straightforward process and a tough problem of marketers.

Products and services are becoming more digitized and becoming more widespread. Digital products, such as software tools, e-books, e-services, electronic games, search engines, digital service platforms and web sites are gaining ground among their tangible counterparts, if any. Most of the digital products provide a different customer experience in buying those products. Due to highly intangibility of its nature, digital products need different marketing strategies as well as carefully selected promotion mix. Thus, a tough problem of selecting an optimum promotion mix for physical products becomes tougher. Since more intangibility means more uncertainty. Reasoning in an environment of uncertainty, imprecision and incompleteness of information is a challenging issue today. [46] Decision making in case of multiple criteria, multiple agents and also heterogeneous information sources let human to use perception-based soft metrics rather than number crunching. Thus, a fuzzy linguistic decision model

with genetic algorithms is a prospective solution alternative for evaluating the potential promotion tools mix to satisfy the promotion objective under this high uncertainty.

In this study, a linguistic approach is proposed for the promotion mix concept; a decision model is proposed; based on this decision model and genetic algorithm is applied to reach an optimum solution or at least a satisfactory good solution. The details of the model are summarized below. The proposed solution is applied in an empirical study for a digital product. According to the outputs, the proposed model is compared and discussed.

Selecting the optimum promotion mix for highly intangible digital products by means of a fuzzy linguistic decision model with genetic algorithm is a challenging approach. In promotion mix optimization for digital products where there is a high level of uncertainty, a decision model will help to make better decisions than trial-and-error approach. The overall process includes identifying the promotion methods and promotion tool mix, based on the product features and customer preferences while fulfilling the communication objective of the company on time and on budget.

Fuzzy linguistic model replaces the numerical values in traditional model with linguistic ones to be capable of manipulating the uncertainty, formalize imprecise data and enables arithmetic and also Boolean functions. In order to clarify some misconceptions about fuzzy logic, it should be stated that fuzzy logic is not fuzzy but is a precise logic of imprecision and approximate reasoning. By means of fuzzy logic, two remarkable human capabilities are formalized. First is the capability to reason and make rational decisions in an environment of imprecision, uncertainty, incompleteness of information or simply imperfect information; second is the capability to perform a wide range of physical and mental tasks without any computations. [47]

Genetic algorithms that are mimicking the principles of natural genetic populations' reproduction to solve problems are useful in complex domains, in global optimization problems to reach an exact or approximate solution. In this thesis, genetic algorithms are utilized in linguistic fitness function evaluation,

briefly, the fitness of promotion objective of the company and the fitness of the promotion mix.

In this study, a uniformly distributed ordered set of nine terms with its semantic is selected. The model is formed as follows:

The initial step was determining the promotion objectives of the company. Since each objective does not have the same importance, each of them is assigned the relevant weights.

The next step was selecting the appropriate promotion tools. The promotion mix is consisting of a blend of carefully selected promotion tools. It should be noted that the affect of each promotion tool is not precise but linguistic labels will assist in dealing with this problem.

The following step was the satisfaction degree of each promotion objective. Satisfaction degree is a function of insertions of the relevant tools, meaning that the number of times the relevant promotion tool is used. Since continuity is an important issue in the performance of promotion tool, number of insertion is determines the increasing effect of that tool, up to a limit.

The next step was determination of promotion budget. Each promotion tool has a cost and the number of insertions is the other parameter of the total cost. Thus, as the number of promotion tools and the times of insertion increase the total cost of promotion activity will increase. Since the total budget is an upper limit and only promotion mixes having a total investment amount equal or less than the total budget is acceptable.

Maximum level of promotion objective satisfaction is evaluated by means of linguistic ordered weighed averaging (LOWA) operator with the linguistic quantifier “as many as possible” (0.5,1) to consider the collective effect of most important tools. [39] Thus, promotion tools should not be regarded as independent from each other, even there may be a multiplier effect by utilizing multiple tools.

After evaluating the maximum level of satisfaction degree for each promotion objective, the fitness of the objective is evaluated by comparing it with the importance rate of each promotion objective. For each objective, relative importance weight is calculated.

The last evaluation is the final promotion mix solution fitness by means of aggregation of relative objective importance and aggregated satisfaction rate for each objective.

The final criterion is the satisfaction of budget constraint. Thus the total cost of selected promotion tool mix should not exceed the total budget. Moreover, having the same satisfaction degree, the lower budget promotion tool mix is preferred others.

While applying the stated steps above, a different linguistic label representation is used because the fuzzy linguistic approach has a limitation in its information representation model and also the computation methods when any fusion processes are performed on linguistic values. This limitation is basically the loss of information due to the need to express the results discretely in the initially defined expression domain by means of approximation. [51] For instance, after applying an arithmetic operation on linguistic values, the result should be rounded to the nearest linguistic label which causes loss of information and lack of precision in final results. In this thesis study, to overcome this limitation 2-tuples representation of linguistic variables is preferred.

The output of the linguistic decision model output is used as the input of the developed GA code. The stated code is developed by using C++ and GAlib, a C++ library of genetic algorithm components. Each promotion tool is represented as a 3 bit coding. Total promotion investment amount and the final overall satisfaction rate of the mode being the fitness functions of GA, roulette wheel selection and elitism is used for selection process. Initial population is generated randomly and number of generation is set to 500, population size to 50, crossover rate to 0.85 and mutation rate to 0.01.

The proposed model is applied on an empirical application of a Turkish company active in legal online betting business.

The business objectives and their importance levels, assessment of promotion tool mix satisfaction rates for different number of insertions for each tool and relevant budgeting for the company is gathered and the linguistic decision model is implemented.

The evaluation result of fuzzy linguistic model approach for the promotion tool mix of the company is calculated as (FH,+0.48; 100), where the linguistic term represents the overall satisfaction rate of the solution set as a 2-tuple representation and the second item is the total fictive budget.

As a second step, GA code is run on the company data to make the optimization. The proposed GA model provided a better satisfaction rate and also lower budget. According to the linguistic label terms the overall satisfaction rate of solution is (VH, +0.04; 97) which means a value slightly above “very high” and a budget of 97.

In marketing point of view, the output of GA model also makes sense. The proposed promotion strategies for digital products were detailed in Section 3.8. Based on those recommendations the following assessments may be proposed. Due to the nature of online betting sites, web is an essential channel to use. Moreover, traditional channels are also critical complementary channels which are also used in the optimized solution set. Promotion tools to attract and retain prospects and first time users are utilized such as bonuses and contests. Increased insertion rate in PR and loyalty programs can be considered as the aim to build trust, brand name and brand loyalty. A suggestion may be to qualify the importance level of business objective-5, “strengthening brand image”, as the linguistic label “essential” since the digital product companies should pay high attention to this issue.

The final step was to make the same calculation for not solely optimizing the solution set for the best satisfaction rate but giving some weights to overall satisfaction rate and also the budget. Giving the user the chance to change the

importance weight between the promotion mix solution set satisfaction rate and the budget would propose a better optimization for real business world than the sole satisfaction rate and price/performance rate. This controlled price/performance approach also resulted interesting outputs which may make more sense in business. In this approach, the total budget constraint is still valid and a lower satisfaction rate for the sake of higher budgeting advantage may be a challenging proposal as well. The attained satisfaction rate is higher than the current running promotion tool set with approximately half of the budget.

The GA output is evaluated by the company and found as worth to consider. Rebates are regarded as an important promotion tool for acquiring and retaining customers. Thus, allocating some budget for rebates are thought to be important but the insertion number would be re-evaluated. Since the evaluation and optimization in this study are done based on the assessments of the company staff, it is also thought to review those assessments as relative to each other. Increased insertion in TV ads, web ads and print ads are found to be very reasonable. Increased insertion in loyalty program, PR as a mid-to-long term investment in brand is regarded as remarkable. Consequently, the optimized solution is found to be interesting and worth to consider not only for revising the promotion mix set but also re-evaluating the assessment of relative promotion tool satisfaction rates as well.

The optimization performance of GA is also tested. The running time of the GA code was about 1 second where the same problem coded in Brute Force algorithm running duration is calculated to be about 7 years. Thus, performance of GA is highly satisfactory in this type of optimization problem.

In conclusion, it is shown that the proposed model is effective, appropriate and useful in defining and formulating the promotion mix problem where uncertainty, imprecision and incompleteness of information is the reality. It is thought that it would provide a satisfying marketing performance for the companies of digital product producers, increase the effectiveness of their promotion activities, budgeting and help them to re-evaluate their current strategies.

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## APPENDIX A

### Promotion Tools

A list of promotion mix tools are given below:

**Table A.1 Promotion Mix Tools**

**ADVERTISING**

| | | |
|---|---|---|
| TV ads | Newspaper ads | Radio ads |
| Internet ads | Magazine ads | Trade journal ads |
| Fliers | Cinema ads | Brochures |
| Kiosks | Inserts | Billboards |
| Booklets | Packaging | Motion pictures |
| DVD/CD ads | Outdoor ads | In-flight ads |
| Skywriting | Directories | Mobile ads |
| Business cards | POP displays | Logo |
| Celebrity ads | Stickers | Covert ads |
| In-store ads | Catalogs | Posters |
| Advertainment | Public service ads | |

**Sales Promotion**

| | | |
|---|---|---|
| Rebates | Sampling | Coupons |
| Trial periods | Premiums | Gifts |
| Lotteries | Contests | Sweepstakes |
| Exhibits | Fairs | Trade shows |
| Tie-ins | Demonstrations | Games |
| Free-standing insert | POP materials | Trading stamps |

**Table A.1 Promotion Mix Tools (continued)**

| | | |
|---|---|---|
| Happy hour | Banners | Bonuses |
| Checkout dispenser | Loyalty programs | Price-pack deal |
| Trade allowance | Mobile couponing | Online game |
| Sales training | Push money | Vouchers |
| **Personal Selling** | | |
| Incentive programs | Trade shows | Fairs |
| Samples | Sales meetings | Telemarketing |
| Sales presentations | Teleconferencing | |
| **PR** | | |
| Press kits | Annual reports | Sponsorship |
| Speeches | Seminars | Donations |
| Publications | Identity media | Corporate magazine |
| Lobbying | Workshops | Case studies |
| Special events | Community relations | Employee relations |
| Interviews | Newsletters | Blogs |
| Investor relations | Issue ads | WOM |
| E-letters | | |
| **Direct marketing** | | |
| E-mail marketing | Direct mail | Telemarketing |
| SMS marketing | Voicemail marketing | Mobile marketing |
| Catalogs | TV shopping | Direct selling |
| Couponing | E-shopping | Door-to-door leaflet |
| Database marketing | Broadcast faxing | Opt-in e-mailing |
| **Internet Marketing** | | |
| Websites | E-mail publishing | Affiliate marketing |
| Search engines | E-books | Content |
| Blogging | Skyscrapers | Interstitials |

**Table A.1 Promotion Mix Tools (continued)**

| | | |
|---|---|---|
| Banner ads | Pop-under ads | Pay-per-sale ads |
| Pop-up windows | Opt-in e-mail ads | Reciprocal links |
| Pay-per-click ads | Paid listing in portals | Sponsorships |
| Online advergaming | Viral marketing | Podcasting |
| WOM | | |

## APPENDIX B

### LOWA Operator

LOWA operator is defined as follows: [30]

Let $A = \{a_1, a_2, ..., a_m\}$ be a set of labels to be aggregated, $\otimes$ is the product of a linguistic label by a positive real number, $\oplus$ is the sum of labels, $C^m$ is the convex combination operator of *m* labels is defined as follows:

$$\begin{aligned} C^m &= \{w_k, b_k, k = 1, ..., m\} \\ &= W / B^T = w_1 \otimes b_1 \oplus (1 - w_1) \otimes C^{m-1}\{\beta_n, b_n, n = 2, ..., m\} \end{aligned} \tag{35}$$

where $W = [w_1, ..., w_m]$ is the weighting set and $w_i \in [0,1]$ and $\sum w_i = 1$.

The revaluated weighting set is

$$\beta_h = w_h / \sum_2^m w_k, h = 2, ..., m \tag{36}$$

Based on this definition, the LOWA operator, $\phi$, is defined as:

$$\phi(a_1, a_2, ..., a_m) = C^m\{w_k, b_k, k = 1, ..., m\} \tag{37}$$

If the number of labels *m=2* then $C^2$ can be defined as:

$$\begin{aligned} C^2 = \{w_i, b_i, i = 1,2\} &= w_1 \otimes s_j \oplus (1 - w_1) \otimes s_i \\ &= s_k, s_j, s_i \in S, (j \geq i) \end{aligned} \tag{38}$$

The *k* value is calculated as $k = \min\{T, i + round(w_1(j - i))\}$ where T is the cardinality of the term set and "round" is the general round operation.

One of the main issues in LOWA operator is the decision of the appropriate weighting set. Among many choices, fuzzy linguistic quantifiers are one of the possible solutions. An interesting approach is defined as follows: [38]

$$w_i = Q\left(i / n\right) - Q\left(\left(i - n\right) / n\right), i = 1,...,n \tag{39}$$

The membership function of Q is defined as follows:

$$Q\left(r\right) = \begin{cases} 0 & if\ r < a, \\ r - a / b - a & if\ a \le r \le b, \\ 1 & if\ r > b \end{cases} \tag{40}$$

where a, b, r$\in$[0,1].

Some of the most used quantifiers are “at least half” (0, 0.5), “as many as possible” (0.5, 1) and “most” (0.3, 0.8).