Optimisation of the New Product Price

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Abstract. **Search results of the expectation gap of price and quality ratio between approaches of consumers and manufacturers applying methods of product structure optimisation are presented in the publication. After summarizing the results of recent scientific works it was observed that expectation gap is very wide when placing new product on the market and it significantly reduces after certain time. Processes of structure optimisation of traditionally understood products (volume control devices) using methods of mathematical programming were chosen for the research of optimal design of sister products.**

As expectations of a manufacturer and consumer might differ from the viewpoint of price and quality, the possibility to analyse widely the introduction of product to consumer and development of consumer conception from the psychological standpoint is discussed in the article.

Keywords: **expectation gap; optimal product structure; mathematical programming.**

I. INTRODUCTION

Topicality of the research – dealing with practical tasks of product price establishment it is necessary to consider the problem of producer's and consumer's compatibility. With reference to the results of preconceived scientific literature review it has been noticed that there is a lack of investigation in the sphere of a new product price forming process as well as in search of mathematical programming methods in the sphere of optimal search of practical application; change of time factor influence and expectation gap have been disregarded.

Scientific problem – in a period of preconceived research it has been established that when consumer's solvency lessens, requirements for the quality of a product increase. Therefore, the necessity to investigate possibilities of product price and quality optimisation appears applying precise scientifically grounded mathematical methods; however, there is a lack of practical application of the results of such methods in the scientific works.

The tendencies of improving the quality of product are often related to design and production of similar products, with reference to opportunities of reducing the costs [1] – [5]. Many researchers point out different issues of quality improvement, such as necessity to acquire a product, physical and aesthetic qualities of a product [7] – [8]. A comprehensive analysis of the problem on relating quality and price started in 1995 [9] – [11]. Other scholarly literature provides a fragmented analysis of a manufacturer and consumer expectations, the underlying idea is advertising [10] – [20]. This article includes a lot of bibliographic references on issues of product design and sales. However, the issues on the development of the gap between manufacturers and consumers expectations have not been analysed. It is also difficult to find examples of applying the theory of mathematical models in practice; in particular, there is a need for interpretations in using computer programmes for solving optimization problems. Thus this article focuses on the development of the gap between the manufacturer and the consumer expectations, as well as the application of mathematical programming in solving practical problems.

Object of the research – to perform the analysis of product price and quality ratio, applying linear programming method.

Goals of the research are the following:

- to systemise tendencies of development optimisation of sister products' design;
- to prepare the scheme of the change of expectation gap between the product price and quality;
- to analyse methods of the optimisation of designed objects structure and to perform the research of price and quality ratio of certain products;
- to present the psychological interpretation of research results.

Research methods – comparative analysis of scientific literature and application of mathematical programming theory for solving certain tasks with specialized computer program.

II. CONCEPTION OF PRODUCT VALUE AND QUALITY RATIO

As world economy had receded a pessimistic approach to consumption sphere dominated according to the downtrend of consumers' solvency. Economic downturn essentially changed attitude towards both tangible and intangible valuables, emphasizing the product quality. Necessity to balance price and quality ratio in the market environment, where the option is delegated to consumer, is emphasized in the majority of scientific works. However, in our opinion, more attention should be paid to the improvement of input quality, research of input structure and volume. Ability to react fast to the variation of consumers' needs is generally determined by the implementation of flexible production technologies. New strategies for appearing on the market are created in service and manufacturing sectors after appraising the motivation of consumer choice, which was formed under conditions of economic growth, when the huge supply of various products was oriented towards growing consumer solvency, and generally the choice of product was determined by its originality or simply "newness" but not by the quality. Recently requirements for

product quality have increased as consumer solvency had decreased. Product price as usually remains a deciding factor.

Usually quality in service sector is evaluated according to the consumer response towards the supplied product and quality improvement is related to technological development estimating the incurred costs [1], [2], [3]. Stungurienė presents unconventional approach towards the product quality as quality is evaluated not by the satisfaction of consumers, but by the objective of a manufacturer or service company to supply an economical product [21]. According to the author, economical product should be the one whose ratio between quality and factory costs most of all meets the manufacturer expectation.

III. Formation Process of Expectation Gap between Product Price and Quality

Input for the product manufacturing in the environment of economic activity is generally estimated according to the expectations of consumers. Incurred expenses are calculated using accounting methods. However, the formalization of consumer expectations can be described as a complex problem due to the different conceptions of product value: a consumer always expects to purchase a valuable product but generally estimates product value intuitively according to the self-chosen criterion. Impartially the evaluation of the product quality is formed in the market environment by estimating demand factors such as: (i) the necessity to purchase product, (ii) price, (iii) physical and aesthetical product characteristics [6], [7], [8].

Companies placing a new product on the market try to inform about the quality of the product. Methods of quality description used in the advertisement generally do not reflect the real product quality [22]. Besides, while increasing costs of advertising, sales expenses also increase but the perception of product quality generally does not improve [4]. Wassouf Fadi presents the idea that price and advertisement might be perceived as the indicator of product quality [12]. For example, advertisement in the practice of pharmaceutical companies gives a signal about high quality products [23]. The main principle applied in a classical theory is that the price of products placed on the market forms pursuant to ratio of supply and demand. Under competitive conditions a price has tendency to decrease and therefore manufacturers seek to reduce net costs that receivable profit would not come to a critically low margin. There are propositions in the scientific literature that the profitability of better quality products should be higher and the assumption is made that consumers realise product quality and are able to relate it to the price [9]. However while analysing the strategies of companies' advertisement and products' costing the problem of quality uncertainty appears: the defined price of both high quality and low quality products might be the same. In such case consumer loses capability to evaluate product quality according to the price [24], [25]. The conception of the product quality and price ratio is adjusted according to goods' acquisition costs incurred by consumers [5]. If acquisition costs of better quality products are higher consumers might choose cheaper goods.

Prices of the new model products are associated with consumer needs to purchase a better quality goods. However, generally the price of a new product does not accord with the quality: in fact consumer pays not for the quality but for the image of the item. The newer the product is, the higher consumer satisfaction is expressed through the pride against the other users who have older model products. As model ages the price gradually recedes, and a manufacturer must improve the quality with the purpose to retain a high product price. Determined price of a new product must maximise demand. Low price naturally is very attractive to consumers but it is necessary to assess the expected profit considering the sensitivity of potential consumers to the product price [10], [11].

Problems of establishing monopolistic prices are determined by the following factors: (i) factor costs; (ii) records of consumers; (iii) seller's propensity to reduce price by discounts [26]. Since monopoly does not incur competence on the market, the possibility to sell production more expensively would emerge. If monopoly would establish a very high price unilaterally, a big expectation gap would appear with monopoly on one side and consumer on the other side. Depending on the purpose of production and specification of manufacturing (e.g. energy production), monopolistic prices are limited by the state which determines allowable net costs, rates of depreciation and profit [27] or by the solvency of consumers. Expectation gap between a manufacturer and consumer can considerably decrease when applying price-control mechanisms. Consumer solvency is one of the most important factors making monopolies and non-monopolies to react in one or another way. Besides, consumers always tend to pay even less then the net cost is, if the excess of products was observed [28]. If the solvency of consumers is low, product price must be depressed for the following two reasons: (i) products must be purchased to become better known, and (ii) a manufacturer attempts to receive income during all the time when the product is presented to a consumer because manufacturer cannot wait for ideally favourable terms.

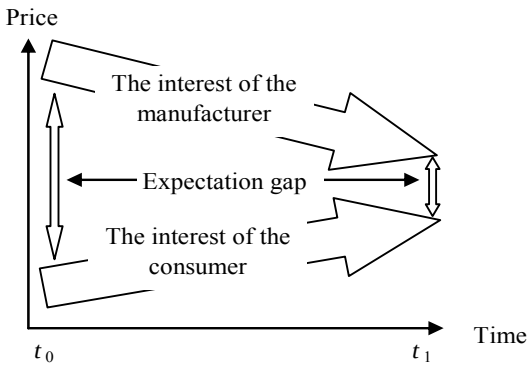

Fig. 1. Expectation gap of manufacturer and consumer

Consumers also should not expect markdown only to buy all products. Expectations of a company and a consumer differ, and absolute coordination of their interests is possible only in theory. Therefore, the real product price forms gap in expectations and in its edges the contradiction appears: a company always wants to increase the price while a consumer expects to lower the price (fig. 1).

The price relatively eligible for both sides stabilizes in certain time, at the moment t_1. Time difference between establishment of a real price and product presentation for the consumers Δt is calculated [21]:

$$\Delta t = t_1 - t_0 ,$$

Here (1)

t_1 - Moment of the real price determination,

t_0 - Moment of presenting a product to the consumer.

It is obvious that product purchase satisfying both sides starts from the time t_1. In our opinion, a manufacturer should always be interested in selling the product as quickly as possible, i.e. to reduce Δt. A monopolist is always interested in maximising the income and therefore it is important for him to balance the amount and the quality. Company supplies the same quality goods for all consumers but consumers assess the quality differently [13].

Several authors point out the group of customers who assess the product quality by the price [14]. Such buyers often become victims of manufacturers swindle and purchase expensive and low quality products. In this case the process of the formation of gap between manufacturer and consumer expectations is not adequate to the real situation. The moral context of price changes is also noteworthy, especially when ecological problems are analysed [29]. Dropping price can raise doubts to buyers about product usefulness and moral environment of its manufacture. Fairly working companies try to match the price with product quality. Recent studies have showed that more than half of the price of new hard goods is related to their quality [10].

Ratio of product quality and price for distributors might be determined by the manufacturer but generally distributor chooses the price by the quality. Newest research has showed that a manufacturer chooses level of product quality according to the form of marginal revenue function (concave or convex) [30]. However, it is necessary to take into account how the equilibrium of manufacturer and seller strategies concerning products' amount, quality of every product and price settled by a manufacturer and seller in every market segment in regard of a purchased product has been achieved [31].

IV. Process of New Product Creation

According to many authors, success of product development or new product design is determined by the formalization of this process [15] – [20].

Product design is another factor relating market with operations' system [32], [33]. Importance of exclusion of product design can be explained by specification of product development which is necessary for creating environment for product manufacturing. These two aspects are closely related while providing services because process of product development is a part of supplied services. But relations between product design and its manufacturing are not so clearly seen in the manufacturing process. A few decades ago designers could "throw" product specification for manufacturing engineers who had to think how to make that product. Modern ideas of parallel compatibility of engineering and manufacturing capacities admit integrity of product design as well [34].

Good design in business sphere starts with the exploration what do people want. According to demand specification, measures must be assumed to fulfil that demand. Market experts know that buyers, who purchase good product, will tell about it several persons who might be interested in that product as well. But consumers dissatisfied with purchased product will disseminate negative responses much longer and to a wider circle of consumers. Thereby product design which does not seem important from the first sight is actually the stage from which success of product sales depends by 90% [2]. In other words design function has major influence on operations function. Product design and its development have so many common features that in many organizations experts consider them as undivided totality. Differences appear when determining beginning of process execution. Design starts with conception of consumer needs and their expression. For example, fashion designer creates a collection for a new season; furniture designer creates new chair with more comfortable headrest; scene painter creates decorations according to the order. And all that is done in consideration of consumer needs and requests. But when the product reaches consumer its practical application must be analysed again in various aspects noticing advantages and drawbacks. One can think that improvement of the product starts only when results of research of product practical application are available. From the viewpoint of operation control, improvement of product starts from the primary research stage where vision of launching product to the market is formed because this vision might be changed after the analysis of results of every other stage.

Decisions of product design and its improvement may have much in common with other management solutions including operation control. The essence of decisions might be in the indication of process terms or in the employment of methodology which influence decision making from the perception of the problem until launching of the completed product to the market [35], [36], [37].

V. Topics of Product Optimal Design Theory

Manufacturing of new products is related to serious design challenges such as: what product and how it should be manufactured, and how a consumer will assess the

product. Design based on decisions made using various mathematical methods has huge perspectives when optimising the product value in respect of minimizing a manufacturer and consumer expectation gap [38], [39], [40], [21]. Although the progress of decision based design in recent years is obvious, the relation between stages of product design is hardly structured. The most complicated part in the initial design stage is to decide which technical parameters mostly influence economical factors of product manufacturing such as product net cost and possible selling price, as well as qualitative factors such as reliability, aesthetics, modernity etc. Attention to technical parameters of the product remains during the whole process of its design and improvement. Traditionally evaluation of technical product parameters depends on the knowledge based on a designer experience. The need to coordinate the processes of communication, design scheduling and usage of resources forms in management practice [41], [42], [43]. In practice, a product structure is related to the quality which is accepted by the consumer as a technical characteristic (usage time, reliability) replenished with an aesthetical satisfaction (dimensions, colour and convenience).

However, generally the price but not the quality is a priority, and therefore the optimisation of product structure becomes particularly important because it is necessary to find a best ratio of product structure and price according to limited resources receivable, applying special methods, is necessary for the coordination of these processes [44], [45], [38], [39] [46].

Competitive manufacturing environment has encouraged majority of companies to produce sister products with common characteristics or using typical components [47] - [53]. The manufacturing of sister products has determined progress in the spheres of product design and manufacturing. Thus standard, formerly dominating methods of satisfying wholesale demand (some products are changed by others) lost their relevance [54]. Three types of sister products design and manufacturing are excluded in the literature and practice: (i) scalable; (ii) modular; and (iii) adaptive. Scientific researches generally summarize the experience of certain product creation [8], [55] – [57].

Li and Huang presented comprehensive study about the peculiarities of sister products design [48]. Approaches of different authors towards methods and possibilities of product design development are systemized in this study [56] – [64], [7], [49], [65], [8]. The author of this review has generalized the peculiarities of sister products design in respect of possibilities to apply optimisation methods (see Table 1). Scientific literature generally describes sister product optimisation applying theory of solution of linear and non-linear integer programming tasks, where minimal or maximal value of goal function, limitations of available resources and marginal conditions of searched variables are specified as optimum criterion.

VI. Optimization of Structure in Designed Products

Volume control devices, used at home and physically perceptible by consumer, that prices and technical characteristics (power) depend on amount of physical elements were chosen for the research of optimal design of sister products. Problems of structure optimisation of designed products are solved in case when choice of elements has many options. It is necessary to determine the amount of choice options and elements, so that object would have the optimal structure.

Problems of object structure optimisation can be of two types:

$$\begin{aligned} &F_1 = C \to \min \\ &T \ge T_{uzd} \end{aligned} \quad (1); \qquad \begin{aligned} &F_2 = T_{\max} \\ &C \le C_{uzd} \end{aligned} \quad (2)$$

T is the technical parameters and C is the value of designed object in the problem formulation.

Works of designed object structure optimisation are divided in stages and are parallel to works of optimisation of technological process parameters and product parameters [66].

Designed volume control device consisting of different elements whose main parameters are power, value and probability of operation without malfunction, has been chosen for research.

Device consists of two types of elements: low frequency elements $E_{\check{z}1}$ and $E_{\check{z}2}$ and high frequency elements $E_{a_1}, E_{a_2}, E_{a_3}$. Requirements of elements ratio raised for device structure: high frequency elements/low frequency elements ≥ 3; not less than two low frequency elements must be in the device.

TABLE 1
Peculiarities of Sister Products Design

Types of sister products design and manufacture	General characteristic	Application of optimisation methods
Scalable	Product design according to variability of components is based on principles of assessing values of product's variable characteristics	Optimisation is based on strict mathematical model with commonly accepted rules of engineering analysis
Modular	Modular sister products are created on purpose to find optimal composition of product ingredients in respect of quality satisfying consumer and minimization of factory costs	Various complex, one or two stage optimisation models with one or more criteria are applied
Adaptive	Flexible application of design principles of first two design types based on analysis of practical results	Three optimisation methods are tried to apply: *branch-and-bound*, genetic algorithm and quadratic programming

Formulation of 1st type problem is used for solution of the problem (2):

$$\begin{cases} F = \sum_{j=1}^{n} C_j x_j \rightarrow \min \\ \sum_{j\check{z}1}^{n} W_j x_j \geq W_{u\check{z}d} \\ \prod_{j\check{z}}^{n} Pj^{xj} \geq P_{u\check{z}d} \\ x_{\check{z}_1} + x_{\check{z}_2} \geq 2 \\ \dfrac{x_{a_1} + x_{a_2} + x_{a_3}}{x_{\check{z}_1} + x_{\check{z}_2}} \geq 3 \\ x_j \geq 0 - sveikieji\,;\; j = \overline{1,n} \end{cases} \qquad (3)$$

here C_j - value, Litas (Lt)

W_j - element power, Watt (W)

P_j - probability of element operation without malfunction

x_j - elements' amount

$W_{u\check{z}d}$ ir $P_{u\check{z}d}$ - given values of parameters

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The problem is solved using worksheet Solver. It is specified in limitation field that only integers must be in solution x_j. Total probability is calculated as follows: given probability of element is raised by a power equal to elements amount found in the optimal solution. The example of solution is given in Fig. 2. Additional dependencies are imposed due to the requirements raised for device structure in respect to elements ratio. All limitations are taken into account in optimal solution of product structure and the result is interpreted as follows: i) product must consist of two low frequency elements $E_{\check{z}1}$ and six high frequency elements E_{a3}; ii) if product comprises all necessary elements which are calculated in optimal solution, then maximal product value (goal function) would be 1112 units.

Element	$x_{\check{z}1}$	$x_{\check{z}2}$	x_{a1}	x_{a2}	x_{a3}	Value of goal function	1112
Amount	2	0	0	0	6		
Inferior limit	0	0	0	0	0		

Constraints

Value	190	245	27	68	122	Total power		Limit
Power	280	100	20	110	170	1580	≥	1500
Probability	0,90	0,95	0,90	0,90	0,98	Total probability		Limit
Total probability	0,81	1,00	1,00	1,00	0,89	0,717532328	≥	0,7

Exstra conditions

$x_{\check{z}1}+x_{\check{z}2}$	1	1				2	≥	2
$x_{a1}+x_{a2}+x_{a3}$			1	1	1	6		
$x_{a1}+x_{a2}+x_{a3}/x_{\check{z}1}+x_{\check{z}2}$						3	≥	3

Fig. 2. Solution of product optimal structure

Product power is specified in initial problem condition and cannot be less than specified, but it is appropriate to analyse how product structure and value would vary when changing total determined product power while designing sister products. By changing product power and the rest initial data keeping constant in the computer model, optimisation problem is solved many times and the results are recorded.

Results of problem solutions and graphic variation of product value depending on power limitations are presented in Fig. 3. It is obvious that product value increases if requested product power is enlarged. Jump of value rise is explained by the fact that calculated amount of elements must be integer. In other words sharp value rise is determined by requirement that values of variables x_j must be integers.

When specified product power changes, product structure, determined by limitations of every element power and requested probability of product reliability specified in initial condition, also change.

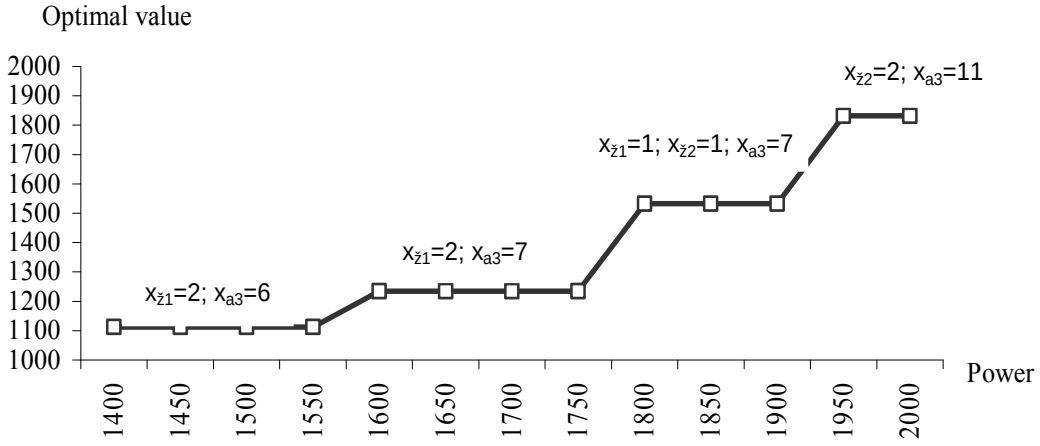

Fig. 3. Variation of product optimal structure

VII. Change of Evaluation of Product Quality from a Viewpoint of Time

Market faces serious challenges in these latter years due to global competence and diversification of consumer needs [2], [67]. Tremendous variety of products must be presented for consumers to satisfy their individual needs. Thus different products must be provided for different consumers. However, manufacturing of products adjusting to individual needs faces difficulties in design stage: generally products are created for mass production because creation of unit products from idea to a particular result (product or service) is expensive [69]. Therefore usually net costs of sister products are less and a consumer appraises it by choosing a cheaper item. The main problem for the manufacturer is to provide for the consumer the product which would satisfy consumer needs and would be appraised in respect of compatibility of price and quality.

Accomplished research has showed that the application of mathematical methods for optimisation of a product structure might be useful for product designers and manufacturers when making decisions concerning price and quality of products provided for the consumer. For example, structure of volume control device varies when requirements for product power are changing (Fig. 2, Table 2).

It is logical to think that product price should depend only on the amount of elements. In this case the manufacturer would deliver a consumer a product specifying the level of product complexity. But the consumer is interested in reliability and power of product but not its structure. Thereby a manufacturer must convince a consumer that more expensive and more powerful device should be assessed better in the respect of quality.

The manufacturing of better quality products is generally related to modern technologies and uncertainty on the market: application of new technologies for improvement of product quality increases factory costs and the consumer assesses product quality only after certain time because attraction of more expensive product is reduced by the price [20], [68]. The manufacturer must look for solutions how to present the product that a consumer would correctly relate product quality with the price. Therefore more powerful and more expensive products should attract a consumer not only by technical characteristics but also with exceptional design and ingenious advertisement. In the authors' opinion traditional market analysis assessing level of consumer satisfaction should be supplemented with psychological analysis in context of needs, solvency and advertising development. Particular attention should be paid to time factor. Interval of time variation where situation satisfying needs of both a consumer and manufacturer appears is shown in expectation gap scheme (Fig. 1.). Time factor of relations between business functions in the process of product improvement (Fig. 2) is not evaluated but it is necessary to take into account that it might take relatively long time from the capacity or conception of the problem to develop or make new product until experimental production and changes of market, technologies or consumers' approach are possible as well. If many cheap goods are placed on the market the consumer might prefer them ignoring the quality and even the necessity of the product. The possible consequence of applying new technologies is the production of cheap, qualitative products, but consumers might misunderstand their necessity. Thus uncertainty dominates in the relations between consumers and manufacturers at every moment in the prospect of future: manufacturers cannot accurately describe variation of consumer needs and consumers cannot orient towards future assortment of particular products on the market and even to predict their own needs in the definite time interval (Fig. 4).

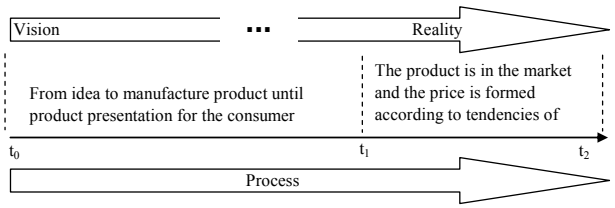

Fig. 4. Projection of manufacturers' and consumers' prospects

At time t_0 a manufacturer predicts result at time t_1, and a consumer "sees" the product at time t_1. At time interval from t_1 until t_2 the price satisfying expectations of both manufacturer and consumer is formed. Thereby, from the viewpoint of a manufacturer the chain from time t_0 to t_2 can be described by the scheme "vision – process - reality". At time t_0 a consumer does not think about products that might be presented by the manufacturer in the future, and therefore he starts to perceive the result of a manufacturer only from time t_1.

TABLE 2
Optimal Product Composition

Power intervals	1400-1550	1600-1750	1800-1900	1950-2000
Product composition	$x_{z1}=2$; $x_{a3}=6$	$x_{z1}=2$; $x_{a3}=7$	$x_{z1}=1$; $x_{z2}=1$; $x_{a3}=7$	$x_{z2}=2$; $x_{a3}=11$
Value	1112	1234	1553	1882

As time factor has deciding influence when forming relations of a manufacturer and consumer, according to authors it is necessary to analyse and assess psychology of consumers and to find the methods how a manufacturer could change their behaviour. It means that after new or improved product has been placed on the market the consumer is able to evaluate the product in respect of its price and quality and be sure that this particular product meets consumer expectations.

Practice and theory of planning and prediction show that it is necessary to evaluate future consequences of decisions made at the moment. Decision making under uncertainty and risk conditions is done according to various criteria of these decisions evaluation though there is no single well-defined criterion pursuant to which the best decision could be made. Assessment of decision made under definite conditions also can be arguable because possession of accurate information does not always lead to the choice of the best decision. Scientists who researched importance of information in decision making process emphasize that it is necessary to define period of time within which information has meaning. It was observed that after certain time information loses its meaning because the predicted result parallel with reality [70]. Thereby product price and demand predicted in the stages of design and manufacturing might conflict with reality even before the product is placed on the market. Besides, as consumer needs or conception of product quality change, expectations of a manufacturer might essentially be odds with planned results. Therefore decision making persons must continually follow novelties of decision making theory and practice. Recently particular attention is paid to the capacity of decision making person to assess the influence of environmental factors on decision making and usefulness of information. Work success of subject, expressed in units of efficiency in management decision, essentially depends on how person adopts the decision. Management decisions often must be made under uncertainty conditions, i.e. according to behaviour of an environmental factor. Environmental factors in econometric models usually are understood as something that influences the activity of analyzed system but acts irrespective of the system. Problems of analyzing influence of an environmental factor in decision support systems are related to receipt of accurate information about the state of this factor. Studies have showed that in practice of economical activity the majority of econometric models cannot be applied due to particularity of their preparation because these models are created for multiplex usage. Necessity of development of methods for decision making under risk and uncertainty conditions raises as economic situation in many cases is unique and decisions are made once and term of uncertainty is usually related to probabilistic fruition of expected events. Several authors for solution of management problems under above-mentioned conditions recommend the theory of games and environmental factors and to create respective models on the basis of this theory.

VIII. CONCLUSIONS

1. The research has shown that optimisation of product structure according to appointed quality requirements is applicable when technological issues of sister products are solved: quality changes as the product structure changes.

2. Consumers always tend to pay even less then net cost, if excess of products is observed. If solvency of consumers is low, a product price must be depressed for the following reasons: products must be purchased to become better known, and a manufacturer attempts to receive income during all the time when the product is presented to a consumer because the manufacturer cannot wait for ideally favourable terms. The consumer also should not expect markdown only to buy all products. Expectations of a company and a consumer differ, and absolute coordination of their interests is possible only in theory. Therefore real product price forms in expectation gap and within its edges contradiction appears: the company always wants to increase the price while the consumer expects lower price.

3. Methods of linear and non-linear modelling applied for optimisation of product structure should be used wider: tendencies of price and quality variations are studied on the basis of optional calculations that are performed with correct mathematical model by changing argument values.

4. Results of research of product structure optimisation presented in the article validate the meaning of optional calculations of mathematical dependencies between product structure and price, and can help a manufacturer to make the right decision about what product should be supplied to a consumer.

5. While solving problems of linear and non-linear modelling where variables must be only integers, equal solution results are distributed by intervals and both manufacturer and consumer face problems unambiguously describing product quality according to its structure.

6. Results of structure optimisation of volume control devices apparently prove dependence of elements amount and quality ratio on the main requested product characteristics according to consumer needs. It was determined that product value increases as its power increases. However it is complicated to prove enhancement of such a product quality in respect of reliability. Therefore product value is directly related to the assessment of technical specifications: higher power means higher value.

7. From the viewpoint of operation control, the process of delivering new or improved product to the market lasts for a certain period of time. The majority of manufacturers direct their attention to the stages of product design and manufacture predicting result in advance. According to our opinion it is necessary to evaluate market uncertainty which is determined by the development of conception of consumer needs.

8. Making decisions at the given moment, it is necessary to assess the consequences of these decisions in the future. Decision making under uncertainty and risk conditions is performed according to various criteria of decision assessment, but there is no single well-defined criterion which could be used when choosing the best solution. Results of the research show that it is important to assess price and quality when optimising product structure, and to find the ratio of these two factors satisfying both a consumer and manufacturer.

9. Time factor should be evaluated from the viewpoint of changes of a consumer psychology because the consumer sees the results expected by a manufacturer only after the product is launched to the market. A manufacturer purposefully seeks for result hoping to satisfy consumer expectations pursuant to information available at the initial stage of product design. Changes of a consumer behaviour during the time, while manufactured product reaches the market, often are not appraised and therefore a manufacturer must take into account the risk related to changed market conditions.

REFERENCES

[1] Resende, M. and Tupper, H. C. 2009. Service quality in Brazilian mobile telephony: an efficiency frontier analysis. Applied Economics Volume: 41 Issue: 18, 2299-2307.

[2] Kang C. M. and Hong Y. S. 2009. A framework designing balanced product platforms by estimating the versality of components. International Journal of Production Research Vol. 47, No. 19, 5271-5295.

[3] Thevenot, H., et al., 2007. An index-based method to manage the tradeoff between diversity and commonality during product family design. Concurrent Engineering: Research and Applications, 15 (2), 127–139.

[4] Clark, C. R.; Doraszelski, U.; Draganska, M. 2009. The effect of advertising on brand awareness and perceived quality: An empirical investigation using panel data. QME-Quantitative Marketing and Economics Volume: 7 Issue: 2 Pages: 207-236.

[5] Tyagi, R. K. 2004. Technological Advances, Transaction Costs, and Consumer Welfare. Marketing Science Vol. 23 Issue 3, p335-344.

[6] Clarkson, P., Simons, C., and Eckert, C., 2004. Predicting change propagation in complex design. Journal of Mechanical Design, 126 (5), 788–797.

[7] Fellini, R., 2003. A model-based methodology for product family design. Thesis(PhD).Mechanical Engineering, The University of Michigan.

[8] Fujita, K. and Yoshida, S., 2004. Product variety optimization: simultaneously designing module combination and module attributes. Concurrent Engineering Research and Applications, 12 (2), 105–118.

[9] Moorthy, S. and Srinivasan, K. 1995. Signaling Quality with a Money-Back Guarantee: the Role of Transaction Costs. Marketing Science, Vol. 14 Issue 4, 442-467.

[10] Bils, M. 2009. Do Higher Prices for New Goods Reflect Quality Growth on Inflation? Quarterly Journal of Economics Volume: 124 Issue: 2 Pages: 637-675.

[11] Harmon, R. R.; Unni, R.; Anderson, T. R. 2007. Price sensitivity measurement and new product pricing: A cognitive response approach. Picmet ’07:Portland International Center for management of Engineering and Technology, Vols 1-6, Proceedings - Management of Converging Technologies, 1961-1967.

[12] Wassouf, Fadi. 2008. The Influence of Product Price and Advertisement on Customer's Perception of Product. Proceedings of the 5th International Conference on Innovation & Management Vols I and II, 1061-1065.

[13] Sibly, H. 2009. The derterminants of Quantity-Quality Balance in Monopoly. Australian Economic Papers Volume: 48 Issue: 1 Pages: 65-79.

[14] Amstrong, M; Chen, Y. 2009. Inattentive Consumers and Product Quality. Journal of the European Economic Association Volume: 7 Issue: 2-3, 411-422.

[15] Cooper, R.G. and Kleinschmindt, E.J. 1991. New product processes at leading industrial firms. Industrial Marketing Management, 20(2), 137–147.

[16] Jeong, M. and Oh, D. 1998. Quality function deployment: an extended framework for service quality and customer satisfaction in the hospitality industry. International Journal o f Hospitality Management, 17, 375–390.

[17] Murdick, R.G., Render, B. & Russell, R.S. 1990. Service Operations Management. Newton, MA: Allyn & Bacon.

[18] Dougherty, D. 2001. Reimagining the differentiation and integration of work for sustained product innovation. Organization Science, 12, pp. 612–631.

[19] Slack, N., Chambers, S., Harland, C., Harrison, A. & Johnston, R. 1998. Operations Management. London: Pitman Publishing.

[20] Tatikonda, M.V. 1999. An empirical study of platform and derivative product development projects. Journal of Product Innovation Management, 16, 3–26.

[21] Stungurienė S. (2010). Optimization of the Ratio of the Bank Payment Cards Price and Quality. Engineering Economics, 2010, vol. 21 (1), 12-18.

[22] Nelson, Ph. 1974. Advertising as information. J. Polit. Econom. 91, 729-754.

[23] Hellstrom, J. and Rudholm, N. 2008. Advertising as a signaling device: Simulated maximum likelihood estimation of a multiple random effects count data model. Economics Letters Volume: 101 Issue: 3 Pages: 227-229.

[24] Hao Zhao. 2000. Raising Awareness and Signaling Quality to Uninformed Consumers: A Price-Advertising Model.Full Text Available Marketing Science, Fall2000, Vol. 19 Issue 4, 390-396.

[25] Allen, F. 1984. Reputation and product quality. RAND Journal of Economics, Autumn84, Vol. 15 Issue 3, 311-327.

[26] Bose, S.; Orosel, G.; Ottaviani, M.; Vesterlund, L. 2008. Monopoly Pricing in the Binary Herding Model. Economic Theory Volume: 37 Issue: 2 , 203-241.

[27] Sedlacek, J. and Valouch, P. 2009. Fair Value in the Price regulation of Natural Monopoly. E & M Economie a Management Volume: 12 Issue: 2 Pages: 6-14.

[28] Anderson, E. T., Dana, J. D., Jr. 2009. When Is Price Discrimination Profitable? Management Science Volume: 55 Issue 6, 980-989.

[29] Freitas, L. and Wagner, J. 2009. The uncertain Moral Context of Price Changes. Ecological Economics Volume: 68 Issue: 4, 1100-1105.

[30] Xu, Xiaowei. 2009. Optimal Price and Product Quality Decisions in a Distribution Channel. Management Science Volume: 55 Issue: 8 Pages: 1347-1352.

[31] Villas-Boas J. 1998. Product line design for a distribution channel. Marketing Science Volume: 17 Issue: 2, 156-169.

[32] Huertas-García, R. and Consolación-Segura, C. 2009. A framework for designing new products and services. International Journal of Market Research, Vol. 51 Issue 6, 819-840.

[33] Griffin, A. and Hauser, J.R. 1992. Patterns of communication among marketing, engineering and manufacturing – a comparison between two new product teams. Management Science,38(3) (March), 360–373.

[34] Wheelwright, S.C. & Clark, K.B. 1992. Competing through manufacturing. Harvard Business Review, 70(2), 70–82.

[35] Alizon, F., Shooter, S. and Simpson, T., 2006a. Assessing and improving commonality and diversity within a product family. n: Proceedings of the 2006 ASME international design engineering technical conference, 10–13 September 2006, Philadelphia, PA.

[36] Alizon, F., Shooter, S. and Simpson, T., 2006b. Assessing and increasing product and family differentiation in the market. In: Proceedings of the 2006 ASME international design engineering technical conference, 10–13 September 2006, Philadelphia, PA.

[37] Anderson, S., de Palma, A., and Thisse, J., 1992. Discrete choice theory of product differentiation. Cambridge: MIT Press.

[38] Hazelrigg, G. 1998. A framework for decision-based engineering design. ASME J. Mech. Design, 1998, 120, 653–658.

[39] Kaldate A., Thurston D., Emamipour H. and Rood M. 2006. Engineering parameter selection for design optimization during preliminary design. Journal of Engineering Design Vol. 17, No. 4, 291–310.

[40] Michalek, J., et al., 2006. Balancing marketing and manufacturing objectives in product line design. Journal of Mechanical Design, 128 (6), 1196–1204.
[41] Coates, G., Duffy, A., Whitfield, I. and Hills,W. Engineering management: operational design coordination. J. Eng. Design, 2004, 15, 433–477.
[42] Moore, W., Louviere, J., and Verma, R., 1999. Using conjoint analysis to help design product platforms. The Journal of Product Innovation Management, 16 (1), 27–39.
[43] Olewnik, A. and Lewis, K., 2006. A decision support framework for flexible system design. Journal of Engineering Design, 17 (1), 75–97.
[44] Taguchi, G., Elsayed, E. and Hsiang, T. 1989. Quality Engineering in Production Systems, McGraw Hill: NewYork.
[45] Hauser, J.R. and Clausing, D., 1988. The House of Quality. Harvard Business Review, May–June, 63–73.
[46] Wu, F.-C. 2007. Sequential optimization of parameter and tolerance design for multiple dynamic quality characteristics. International Journal of Production Research, Vol. 45 Issue 13, 2939-2954.
[47] Jiao, J. and Tseng, M. 1999. A methodology of developing product family architecture for mass customization. Journal of Intelligent Manufacturing, 10/1, 3–20.
[48] Li L. and Huang G.Q. 2009. Multiobjective evolutionary optimization for adaptive product family design. International Journal of Computer Integrated Manufacturing Vol. 22, No. 4, 299–314.
[49] Rai, R. and Allada, V., 2003. Modular product family design: agent-based Pareto-optimization and quality loss function-based post-optimal analysis. International Journal of Production Research, 41 (17), 4075–4098.
[50] Suh, E., deWeck, O., and Chang, D., 2007. Flexible product platforms: framework and case study. Research in Engineering Design, 18 (2), 67–89.
[51] Thevenot, H.J. and Simpson, T.W., 2006a. Commonality indices for product family design: a detailed comparison. Journal of Engineering Design, 17 (2), 99–119.
[52] Thevenot, H. and Simpson, T., 2006b. A comprehensive metric for evaluating component commonality in a product family. In: Proceedings of the 2006 ASME international design engineering technical conference, 10–13 September 2006, Philadelphia, PA.
[53] Martin, M. and Ishii, K., 2002. Design for variety: developing standardized and modularized product platform architecture. Research in Engineering Design, 13 (4), 213–235.
[54] Meyer, M. and Lehnerd, A., 1997. The power of product platforms: building value and cost leadership. New York, NY: Free Press.
[55] Huang, G.Q., Li, L., and Chen, X., 2007. A tandem evolutionary algorithm for platform product customization. Journal of Computing & Information Science in Engineering, 7 (2), 151–159.
[56] Simpson, T., Maier, J., and Mistree, F., 2001. Product platform design: method and application. Research in Engineering Design, 13 (1), 2–22.
[57] Simpson, T.W., 2004. Product platform design and customization: status and promise. Artificial Intelligence for Engineering Design, Analysis and Manufacturing, 18, 3–20.
[58] Nayak, R.U., Chen, W., and Simpson, T.W., 2002. A variation-based method for product family design. Engineering Optimization, 34 (1), 65–81.
[59] Messac, A., Martinez, M.P., and Simpson, T.W., 2002a. Effective product family design using physical programming. Engineering Optimization, 34 (3), 245–261.
[60] Messac, A., Martinez, M.P., and Simpson, T.W., 2002b. Apenalty function for product family design using physical programming. ASME Journal of Mechanical Design, 124 (2), 164–172.
[61] Simpson, T.W. and D'Souza, B., 2002. Assessment variable levels of platform commonality within a product family using a multiobjective genetic algorithm. 9th AIAA/ISSMO Symposium in Multidisciplinary Analysis and Optimization, Atlanta, GA, AIAA, AIAA-2002-5427.
[62] Nelson, S.A. II, Parkinson, M.B., and Papalambros, P.Y., 2001. Multicriteria optimization in product platform design. Journal of Mechanical Design, 123 (2), 199–204.
[63] Simpson, T.W., Maier Jonathan, R.A., and Mistree, F., 2001. Product platform design: method and application. Research of Engineering Design, 13, 2–22.
[64] Fellini, R., Kokkolaras, M., Papalambros, P., and Perez-Duarte, A., 2002. Platform selection under performance loss constraints in optimal design of product families. In: G. Fadel, ed. ASME Design Engineering Technical Conferences – Design Automation Conference. Montreal, Quebec, ASME. Paper No. DETC2002/DAC-34099.
[65] Li, H. and Azarm, S., 2002. Product design selection under uncertainty and with competitive advantage. ASME Journal of Mechanical Design, 122 (4), 411–418.
[66] Kurickij B. 1997. Poisk optimalnich rešenij. BHV, Sanct-Peterburg.
[67] Hill T. J. 2004. Manufacturing strategy: keeping it relevant by addressingthe needs of the market. Manuscript of opening address, 3rd conference of the oropean Operations Management Association (EurOMA), London.
[68] Rindova, V.P. & Petkova, A.P. (2007) When is a new thing a good thing? Technological change, product form design, and perceptions of value for product innovations. Organization Science, 18(2), pp. 217–232.
[69] VolmanT. E., Berry W.L., Whybark D. C., Jacobs F. R. 2005. Manufactoring Planning and ontrol Systems, 5th ed. Bur Ridge, Il, McGraw-Hill/Irwin.
[70] Christauskas, Č. and Stungurienė S. 2007. Motivation factors of decision making person // Engineering economics = Inžinerinė ekonomika / Kaunas University of Technology. ISSN 1392-2785. 2007, no. 3(53). p. 51-56.

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Staņislava Stungurienė, Česlovas Christauskas. Jauna produkta cenas optimizācija
Pasaules pieredze rāda, ka jaunam produktam ieviešanas stadijā, t.i., mēģinot iekarojot pozīcijas tirgū, ir ļoti lielas pretrunas starp patērētājiem un ražotājiem, tomēr vēlāk šī plaisa mazinās. Tieši tādēļ ir ļoti svarīgi pastāvīgi pētīt un analizēt produkta kvalitāti un cenas veidošanas optimizēšanu. Rakstā parādīti pētījuma rezultāti, kā notiek jauna produkta cenas veidošana, izmantojot produkta struktūras optimizācijas metodi. Par pētījuma bāzi tika izvēlēti tradicionāli produkti (audio iekārtas). Cenu struktūras procesu optimizēšanai un kvalitātes novērtējumam tika izmantota programmēšana un matemātiskās metodes. Detalizētā pētījumā tika ņemtas vērā pētāmās grupas īpatnības un ierobežojumi, t.sk. tehniskais raksturojums un izmaksu ierobežojums. Optimizācija skaņas regulēšanas iekārtām veikta jau projektēšanas stadijā. Konstatēts, ka struktūras optimizācijas problēmas atrisinās gadījumos, kad elementi jāizvēlas no daudziem variantiem. Struktūras optimizācijai tiek noteikti objekta raksturlielumi, kad elementi jāizvēlas no daudziem variantiem. Lai atrisinātu objekta struktūras optimizācijas uzdevumu, tika izvēlēts uzdevuma formulējums *T* – tips, kad mērķa funkcija korelē ar tehniskajiem raksturlielumiem un to nepieciešams maksimizēt, ierobežojot produkta cenu. Izpētot pēdējo gadu zinātnisko darbu rezultātus, jāatzīmē, ka ieviešot tirgū jaunu produktu, ražotāji cer uz lielu patērētāju interesi un atbilstoši – arī lielu cenu, tomēr vienlaicīgi konstatēts, ka patērētājs ne vienmēr ir gatavs maksāt vairāk par jauno un atšķirīgo. Tādējādi sākumā tirgū ir liela plaisa starp ražotāja cerēto un patērētāju gaidām, tomēr vēlāk tā mazinās. Tā kā šī attieksme dažādiem jaunajiem produktiem var atšķirties, tad rakstā apskatīta iespēja plašāk pētīt piedāvāto problēmu gan no patērētāja koncepcijas, gan psiholoģiskā viedokļa.

Станислава Стунгуриене, Чесловас Христаускас. **Оптимизации цены нового продукта.**
Мировой опыт показывает, что при выпуске нового продукта разрыв между потребителями и производителями очень широкий (особенно при размещении нового продукта на рынке), но через некоторое время он сокращается. Поэтому процессы оптимизации структуры цены и качества продуктов необходимо проводить постоянно. В данной статье представлены результаты исследования формирования цены нового продукта, используя методы оптимизации структуры продукта. Для исследования оптимального проектирования родственных продуктов были выбраны традиционные продукты (аудиооборудование). Для оптимизации процессов структуры цены и качества продуктов использовались математические методы программирования. Детально исследуется поиск оптимальной структуры продукта согласно указанным техническим характеристиками и стоимостными ограничениями. Оптимизация структуры устройств регулирования громкости выполнены на стадии проектирования продукта. Проблемы оптимизации структуры объектов решаются в случае, если выбор элементов производится из множества вариантов. В целях оптимизации структуры объектов задаются параметры для выбора элементов из множества разных вариантов. Для решения задачи оптимизации структуры объекта выбрана формулировка задачи *T* - типа, когда функция цели коррелирована с техническими параметрами и должна быть максимизирована при ограничении цены продукта. Обобщив научные результаты работ последних лет, можно отметить, что при выпуске на рынок нового продукта, производитель надеется на большую заинтересованность потребителей и хорошую соответствующую цену, однако потребитель не всегда склонен платить больше за новшество и особенность. Представляя на рынок новый продук, разрыв ожиданий между производителем и потребителем очень широк, а через некоторое время значительно уменьшается. Поскольку ожидание производителя и потребителя могут быть различными. В статье также обсуждается возможность более широкого исследования представленных потребителю продуктов и развития потребительской концепции с психологической точки зрения.