Development Process with Regard to Customer Requirements

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CE CONCURRENT ENGINEERING: Research and Applications

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Abstract: Today, it can be maintained that the customer is a 'king' as he will buy only the products that satisfy his needs and wants. The companies of today are facing new challenges: global business and local operation, standardization, and individualization of products, demanding customers and fierce competition. The company wants to achieve shorter product development time, lower costs, high quality of the product, and finally, customer satisfaction. In order to achieve the set goals, the company has to take into account the customers wants and needs during the new-product-development process. This article presents the mode of description of processes that allow recognition of suitable natural systems and their transformation into technical systems and a model for management of development process. The phases of quality functions deployment (QFD) during the new product development process along with the location for collecting customer needs and wants are presented. A detailed description is given on information resources for obtaining data on customer needs; the methods for obtaining, structuring, and evaluation of the data obtained. The results of testing the proposed methodology of taking into account the voice of the customer in the process of developing a new Vario Flow product in a company that produces and sells medical equipment in domestic and foreign markets are also included.

Key Words: nature processes, technical processes, golden loop of continuous improvements, customer needs, decision-making process, house of quality.

1. Introduction

Product development activities are well known and recommended with various scientifically verified methods. The main difference between them is in understanding of the process itself. Designers understand development and design activities as a complex process which encompasses other fields as well, and they search for the best solution [1–4]. The researchers of product development try to define the new product development process as a new scientific field which should define development processes (by using scientific methods) from man's abstract idea to the actual product [2].

Product development and design within a global product realization concept allow a variety of services that enables a customer to use the product in different environments. This is the main demand in every product development and design process.

In continuation, a model of new product development and design, as well as the methods for obtaining and evaluating the information on wants and needs of the potential customers are presented.

2. Customer's Part in Development Process

Natural processes act in an environment consisting of interlinked and properly functioning natural systems (Figure 1). Man recognizes natural processes and searches for more or less ideal substitutes. Recognition and description of natural processes is carried out in various forms, either formalized or non-formalized. Description is based on the ontology of phenomena, described by natural or technical sciences. The modes of description of processes that allow recognition of suitable natural systems and their transformation into technical systems are carried out using specific knowledge, based on the ontology of the system transformations. The success of transformations can be estimated by several methods. Improvement of technical systems is based on teleological methods (target-oriented methods are defined according to a particular system or process under consideration). Because of this it is possible to say that the product requirements are being fulfilled either more or less, and it is possible to talk about the perfection of the product. The evaluation is general and does not consist of technical evaluation only [5].

While evaluating the products, certain starting points are used, based on attributes. Because the attributes are defined anew in each product (depending on the defined technical system), it can be expected that in product development activities it is essential that a goal

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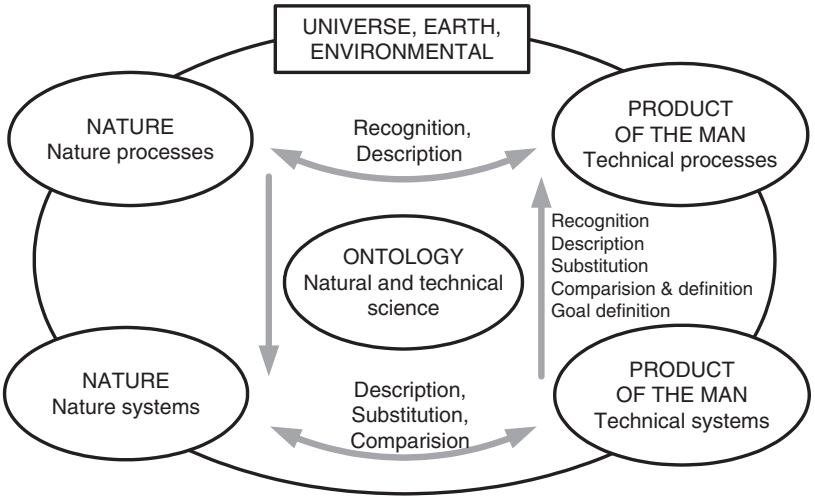

Figure 1. Nature and technical processes.

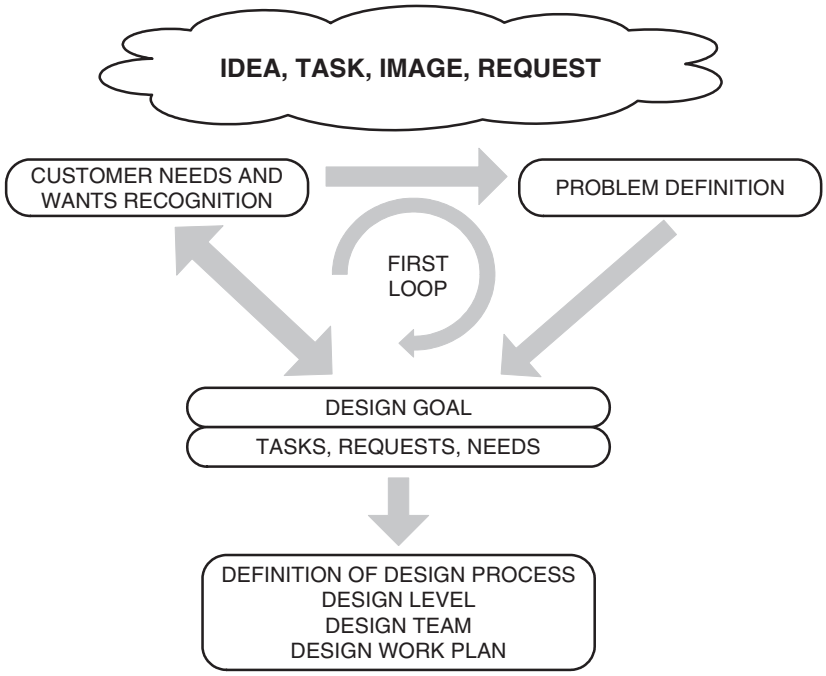

Figure 2. Customers voice in product development process.

should be defined properly (i.e., as clearly as possible). It has to be emphasized that the definition of a goal is the starting point that allows the qualitative product development process [6].

In this study the authors would like to identify the goal as clearly as possible, so as to define the essential environmental influences, in this case, those from nature. Before defining the goal the authors would like to present the general model of the product development process (Figure 2).

Product development and design process is carried out in numerous loops that follow one another in a logical sequence. Recognition of customer requirements is the most sensible and important process phase. It is understandable that here an attempt has been made to establish the product development goal from customer needs as soon as possible. Therefore the problem of direct transformation of customer needs into the goal itself appears. As a rule it is not possible, as the customer and product development team are not

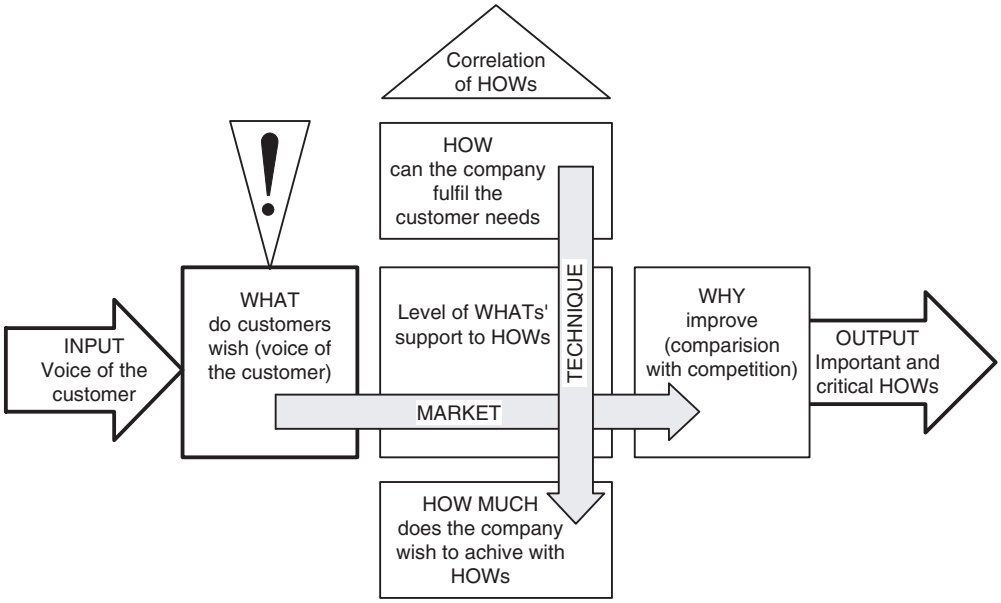

Figure 3. Product's quality-functions-deployment house.

the same. They have different knowledge and comprehension of the product and product development possibilities. Product development team has to identify the problem from the customer requirements and define the goal. The process is iterative (closed in a loop) as shown in Figure 2.

3. The Concept of Obtaining the Customer Needs and Wants

A new product development process starts with an abstract idea and ends with physical realization of the product (Figure 2). Experience has proven that in this mental and physical product development process the voice of the customers has to be taken into account in order to ensure that a globally competitive product is produced.

Quality functions deployment – QFD [7–10] is the only customer-oriented product-development method, where the 'voice of the customer' is the starting point of all activities.

The QFD starts with the question: 'What does the customer need and want?' and transforms the customer's expectations into the product features. The goal of the QFD method is to define, develop, design, manufacture, supply, and install the product in such a way that customer wishes are overfulfilled rather than only fulfilled.

The QFD method is a game of questions and answers with two basic questions:

- What do customers expect from the product?
- How can the company fulfill the customer needs?

The QFD method is used throughout the product development process: from the first abstract concept to the use of the product. 'Product's quality-functions-deployment house' (Figure 3) is used for recording mental and planned results.

Practical cases of QFD method introduction [10] have shown that finding customer's real requirements (INPUT – voice of the customer) is a necessity for forming a real product's quality-functions-deployment house. Therefore, further research was aimed at designing a concept for obtaining the data on customer needs and wants (Figure 4).

In order to take into account the customer needs during new product development, they must be identified and analyzed beforehand, so that they can be properly understood and fulfilled.

3.1 Sources of Customers' Voice

Voice of the customers is a concept that describes the uttered and unuttered customers' wants and needs; as such it must exist in order to start the new product development process. A customer need is a description, in the customer's own words, of the benefit to be fulfilled by the product. Customers often express their needs using statements that describe how these needs could be fulfilled and these statements are called 'customer requirements', which are considered as something required, something that is non-negotiable.

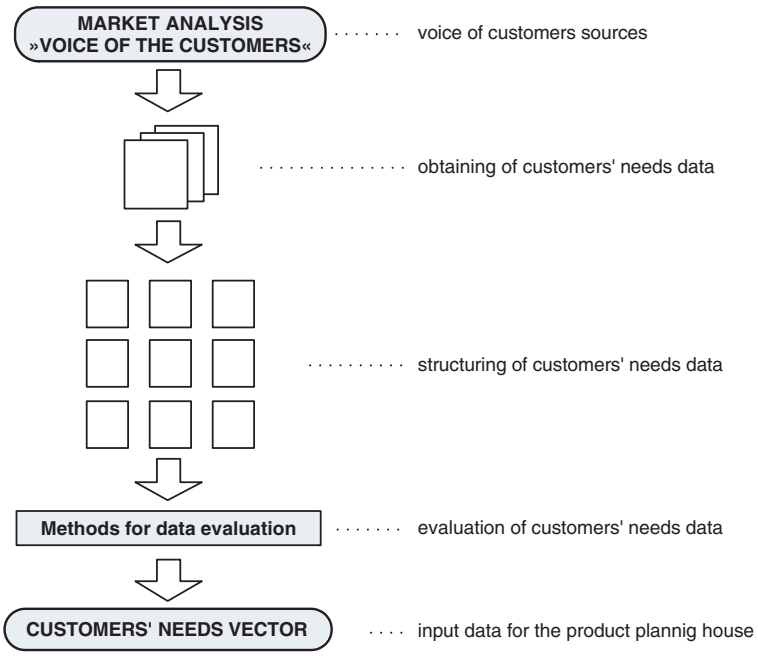

Figure 4. The concept of obtaining, structuring and evaluation of customer needs and wants.

The voice of the customer research scope depends on the product type, conditions and the size of the market, the number of products, funding, and the available human resources.

There are three major sources for obtaining the information on the voice of the customer [11,12]:

- external customers, internal customers, and information on products and processes.

External customers (product users, people influencing other people in the process of purchasing, and people making the final financial decisions) fall into several categories and sub-categories, depending on the vendors they buy the products from (buying one's products, buying the competitive products) and on their role in the supply chain (regular customers of competition, former customers, dissatisfied customers, satisfied customers).

Internal customers (company engineers, product designers, project managers, and suppliers) are customers who are from the company and most certainly use a different language than the external customers. Internal customers have a unique perspective on specific problems in the product and process development, and that is why their voice must be distinguished from the voice of external customers. The voice of internal customers can significantly contribute to the product and process development, as it is very important for them to improve the product development they are a part of. In this way they contribute to satisfying the needs of external customers.

Information on products and processes (data on errors, repairs and maintenance, customer complaints and observations, vendors product and competitive product specifications, warranty data, price-lists) is significantly helpful in discovering the needs of the customers, both the internal and external ones.

During product development it is necessary to initially define the level of product development, i.e., 'Will a completely new product be developed or will only an adaptation be made?'

A new product represents a complete novelty in the environment of new customers; it requires a new production environment, and usually generates new enterprises, profit centers or workshops. Adaptation of the product mostly requires total adaptation to the customer in all details; production process has to be adapted to the customer wants, too.

Customer needs and wants are therefore important in recognition of the level of product development.

3.2 Obtaining the Customer Needs and Wants Data

Various methods for obtaining the data on customer needs and wants were analyzed and evaluated [11–14]; the result of those analyses is a proposal of the most suitable practice for obtaining the data on customer needs and wants:

- Brainstorming, focus group method, interview, customer remarks and complaints method.

The brainstorming method is the most popular and the most widely used creative method for obtaining the data on customer needs. When using this method, four basic rules should be taken into account:

Rule 1: Any criticism or evaluation of ideas is strictly forbidden because it obstructs creative thinking.
Rule 2: Ideas of other team members can be used and developed further.
Rule 3: Team members should activate their imagination as much as possible during problem solving.
Rule 4: As many ideas as possible should be proposed in the shortest possible time.

The focus group method uses a selected group of customers who are discussing questions posed by the moderator. The discussion is initiated so that each group member first expresses his/her opinion on a particular problem, then other participants comment on it and then further discussion of their opinions follows. In this way the discussion of the focus group provides a qualitative view of a small number of people. The moderator can search for reasons causing dissatisfaction and can discuss possible solutions for particular problems. Normally, there are 6–12 people in a discussion group, each discussion lasting for 2–3 h.

To be able to provide a productive discussion on a particular subject, discussion members with similar interests and knowledge must be selected. Experience shows that care must be taken that the members are neither in superior nor in subordinate relationship to each other.

Normally, there are several focus groups formed in the research project (external and internal customers are grouped by different segments) with the goal of gathering different opinions on a problem.

The focus group work is directed by a moderator who starts with an introduction by presenting the focus group, its purpose and the reason why the members have been invited. Then the members are acquainted with the basic rules and explained the purpose of having the discussion recorded and discretion of the participating members ensured.

Then the members participating in the discussion are introduced and the moderator starts the discussion by asking the initial questions in order to gather different views regarding the topic of the discussion. The moderator's basic task is to keep the discussion group focused. After a question has been generally discussed, the moderator can search further to get more information by using additional teaser questions.

Normally, it is required for the moderator to be an expert in the field discussed by the group and to be acquainted with the subject of the study. It is his or her goal to help the group to create a productive discussion on the specified topic. The quality of data in the focus group mostly depends on how efficiently the moderator is asking questions and focusing the entire group on the topic. The moderator must work as a promoter, controlling the interaction between himself/herself and the members as well as between the members themselves. Some members of the focus group are usually more eloquent while others are more reserved, so the moderator has to find a way to silence the too eloquent people in order to make the quiet ones to start speaking as well. When all the issues have been discussed, the moderator concludes the work of the focus group.

The focus group discussion is normally carried out in a special room. The room can have a special one-way see-through wall, behind which there can be video and audio recording equipments, as well as additional observers.

The interview is a method of gathering qualitative information through a dialog between the interviewer and the interviewee. It enables them to gather detailed information on the customer needs and identify innovative solutions. The quality of the interview is measured by the number of recorded needs.

Depending on the area and size of the project, the following must be selected: the customers to be interviewed, the locations where the interviews are to be carried out, the interviewers, and the type of questions asked.

The most common form of an interview for obtaining the customer needs is a conference room interview. During the conference room interview it is necessary to rely upon the ability of the interviewees that they recall the things they liked or disliked in the product, and that they try to mention the things they missed. The interviewer has to have some sort of an interview guide that serves as a checklist of the subjects to be asked about during the interview.

The conference room interviews enable good time-planning and efficient use of time.

Figure 5 shows the course of obtaining the customer needs and wants data with the focus group method and the conference room interview method.

Contextual inquiry is carried out on the location where the product is being used. It allows the interview to be conducted during observation of the actual use of the product.

Contextual inquiry is used mostly for better understanding of the environment (weather, culture, values) where the customer uses the product. Contextual inquiry is a partnership between the customer and inquirer during their search for solution of the identified customer needs.

Customer requirements, obtained from the customer remark and complaint database are qualitative data, which cannot be generalized to a wider population because of the way they were obtained. It often happens

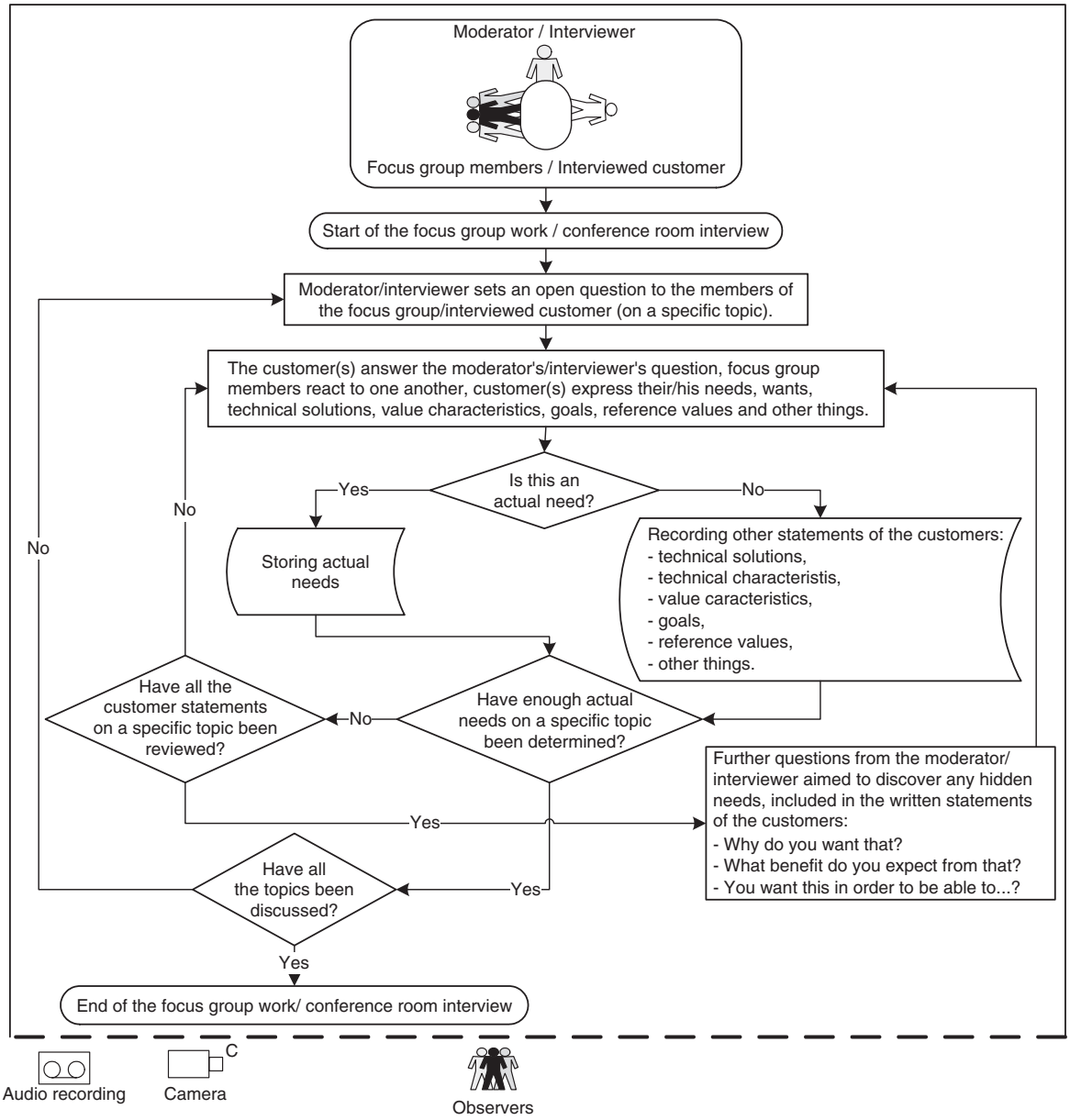

Figure 5. Obtaining the customer needs data – focus group/interiew.

that certain people complain out of a habit, or others who have had an especially bad experience, and particularly those who have time to complain. Customer complaints reveal the causes of dissatisfaction. The needs obtained from customer complaints can be used in addition to the customer needs obtained by interviews and focus groups.

The procedure of obtaining the customer needs from customer complaints consists of the following steps:

Step 1: random retrieval of a certain number of complaints from the database,
Step 2: translation of complaints into positive expressions and concepts, which represent hidden needs of the customers, expressed by the complaint,
Step 3: removal of duplicates,
Step 4: marking of each expression obtained from customer complaints, and
Step 5: combining customer complaints with the expressions obtained by other methods.

3.3 Structuring the Data on Customer Needs

Structuring of the data on customer needs and wants is carried out in the following sequence:

Step 1: Design of initial tables for the voices of the customers
Step 2: Design of the tree diagram.

3.3.1 STEP 1: DESIGN OF INITIAL TABLES FOR THE VOICES OF THE CUSTOMERS

Using data acquisition methods various statements of the customers are obtained, related to their problems, opportunities, ideas, solutions, wishes, and needs.

Separation of real customer needs from other expressions is a precondition for structuring the needs and evaluation of relative relevance of needs that are taken into account when planning the product. Those who analyze the quantitative data use the initial tables of the voice of the customers, which are filled out with literal customer statements. Table 1 presents the contents of initial voice-of-the-customer tables.

The 'ID' column identifies the source of the customer statement, e.g., interview number, page number, number of the line or the date of the interview. It is used for back-referencing the statements in case further information is required about the source.

The 'Customer demographics' column contains the age, income, occupation, and location of the customer.

The 'Use' section describes the context of use of the product in detail.

The 'Analyzed statement' marks whether the statement is a real customer need and/or a possible technical solution or goal.

3.3.2 STEP 2: DESIGN OF THE TREE DIAGRAM

In the tree diagram the needs are structured in a hierarchical way. It is built from top to bottom (or from left to right). In the tree diagram the primary, secondary, and tertiary customer needs are shown. Tertiary needs represent the entrance into the house of quality of the planned product. Figure 6 presents the principle of building the tree diagram for the value of the quality.

3.4 Evaluation of the Data on Customer Needs

On the basis of the data on customer needs, stored in the tree diagram, it is necessary to evaluate the needs, therefore, to define the relevance of each customer need.

The analysis and appraisal of the available methods for evaluation of the data on customer needs [12,15] has revealed that in order to evaluate the data on customer needs the most suitable tool is a survey (conducted either by phone or mail).

The sample for the survey should be selected randomly, so that each person in the population has a measurable probability of being selected and thus the survey results can be reliably extended to a larger population. The survey can be conducted in the state, region or municipality.

Phone surveys are expensive and the usual source for sampling are the phone directories.

Mail surveys cost less; they are very effective when they are targeted to the users of a particular group of products and they provide measurable data that can be generalized to the whole population. The

Table 1. Initial tables for the voice of the customers.

Table of products and processes data

ID No.	E/I	Customer demographics	Customer statement	Usage						Analyzed statement	Need/ characteristic	Type of need/ characteristic
				Who	What	When	Where	Why	How			

Table for the voice of the internal customers

ID No.	Customer demographics	Customer statement	Usage						Analyzed statement	Need/ characteristic	Type of need/ characteristic
			Who	What	When	Where	Why	How			

Table for the voice of the external customers

ID No.	Customer demographics	Customer statement	Usage						Analyzed statement	Need/ characteristic	Type of need/ characteristic
			Who	What	When	Where	Why	How			

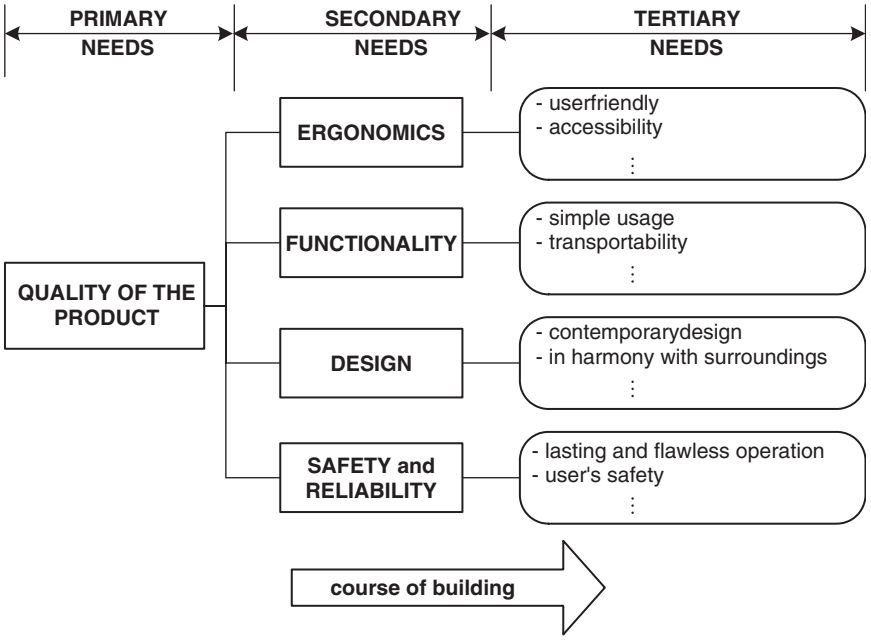

Figure 6. Principle of building the tree diagram for the value of the quality.

letter accompanying the mail survey should explain the reasons for the survey and give assurance of confidentiality.

To ensure a high response rate, the following rules should be followed when conducting mail surveys:

Rule no. 1: Multiple contacts should be used, including:

- sending an announcement of the survey by mail,
- sending the survey with a cover letter to all interviewees at the same time,
- sending a reminder with contact details, enabling the interviewees to request a substitute survey,
- sending the last substitute survey with registered mail,
- sending a letter or certificate as a symbol of appreciation for the cooperation.

Rule no. 2: Use printed paper and memos with letterheads and contact person details.
Rule no. 3: Use stamped envelopes with printed return addresses.
Rule no. 4: Enclose a symbolic gift with the first or consecutive surveys, for stimulation and as a symbol of respect.

When conducting a survey, the customers are requested to evaluate each individual need. There are several methods available for evaluation of the customer needs [10,15]. Their characteristics, advantages, and drawbacks are presented in Table 2.

With described methods obtained, structured and evaluated customer needs represent the input data for the first QFD house of new product development [7,10].

4. Case Study

A company that produces medical equipment wishes to improve its competitiveness on the domestic market and to offer its products to the global market.

The company management has decided that it will establish the customer needs and wants for Vario Flow product (Figure 7 – it is used in medicine as an aid in hysteroscopic, arthroscopic, and laparoscopic surgery), and later on, using the Qualica QFD software [16], consider these needs in the development of a new version of the product.

Previous to the procedure of obtaining, structuring, and evaluating the needs of Vario Flow customers the company had to ensure:

(i) Transition from individual to team work: Tasks and problems were till now solved individually. The potential team members were now acquainted with the advantages and weaknesses of team work, with organization and realization of creativeness methods (these are the bases of team problem solving), and with organization and of team members and their roles in team work.
(ii) Consideration of the voice of all customers: The analysis of existing situation showed that

Table 2. Methods for evaluation of the data on customer needs.

Evaluation method	Description of the method	Advantages of the method	Disadvantages of the method
Combined method of sorting by relevance and assigning points to the needs	In this method the customers first sort the needs by relevance in descending order. Then they assign numbers from a 100 point scale to the needs, giving the highest number to the most important need and the smallest number to the least important need.	The method is easily comprehensible to the customers. They already make comparative decisions when selecting the order of needs and can easily assign values from the 100 point scale to different needs.	This method is difficult to carry out when more than ten needs have to be evaluated.
Assigning 100 points among all customer needs	In this method, 100 points are distributed to the customer needs on the list.	The customers must make comparative decisions when assigning points and compare the needs relatively.	As the attention required from the interviewees is very high, a lot of time is necessary to assign the points to the needs, especially if there are more than ten needs.
Prioritization model 1-2-3	The prioritization model 1-2-3 is a method where customers first determine the needs they find most important. Then they select the second most important needs. The remaining needs are considered as the third most important.The analysts assign 5 points to the most important need of the customer, 3 points to the second most important needs and 1 point to the third most important needs. The sum of points for each need is the basis for determining the relative relevance of the needs.	The method is easy to comprehend and quick to fill in.	The method is slow when a large number of needs have to be dealt with.
Couple comparison method	In the couple comparison method, two needs are directly compared in order to determine the more important one. The need which was selected in favor of others most of the times, is ranked the highest, i.e., the most important need. The needs are sorted in matrix form and the results of comparisons are entered in the appropriate fields of the matrix.	The possibility to acquire relative relevance of needs.	The possibility of inconsistent judgments. Time-consuming when a lot of needs have to be evaluated.

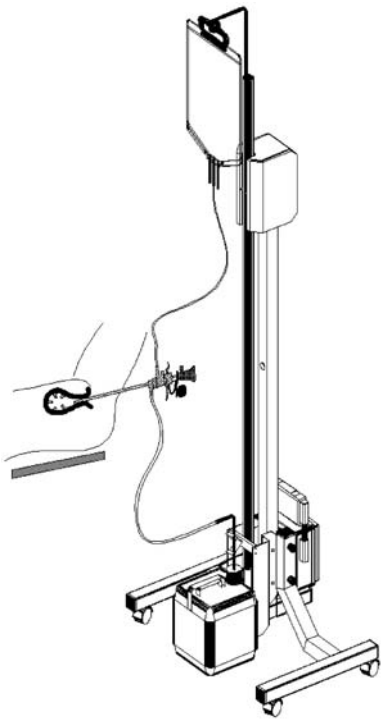

Figure 7. Vario Flow.

only internal customers' voice was included in product development without any regard to external customers or data on previously developed products and processes.

(iii) Implementation of project management of product development: Existing individually organized product development did not assure the goal orientation and it did not include concurrent engineering elements. Therefore, the desired scope often was not attained or it was attained after too long a period and with too high costs.

After successful implementation of team work and project management, the company management appointed a project team for obtaining, structuring, and evaluating the needs of Vario Flow customers and for establishment of the input WHAT vector of the house of QFD of the product. The project team was consisting of:

- Moderator: quality-planning engineer – knows well the QFD methodology and Vario Flow product,
- Team members:
- development engineer – knows design requirements of the product,
- physician – uses the product in surgical procedures,
- designer – is responsible for the design of the product,
- managing board member – is responsible for connecting the project team with the company management and he knows the customers,
- production process planning engineer – knows production processes,
- production engineer – knows possibilities and limitations of manufacturing in the company.

4.1 Sources of the Customers' Voice for Vario Flow Product

Project team has established that the following sources for the customers' voice for Vario Flow product are available:

- External customers (physicians who perform endoscopies, scrub nurses who participate in surgery, and representatives of the company management).
- Internal customers (engineers responsible for development of the product, processes, quality; suppliers of components and materials; maintenance crew which is responsible for normal operation of the product).
- Product and process data (data on performed maintenance works, customer remarks, and complaints).

4.2 Obtaining the Data on Customer needs for Vario Flow Product

In order to obtain the data on customer needs the project team selected the following forms of interview:

- conference room interviews and contextual inquiry.

The project team selected the first form of interview because of easier time management of interviewees; those were 10 people of various profiles: physicians, scrub nurses, engineers, maintenance personnel, and company management representatives. Participants were given general questions in advance so that they could prepare properly. By agreement the quality planning engineer was going to conduct the interviews and contextual inquiry while he is best acquainted with product and QFD methodology.

35 customer needs and wants were identified by the interview:

- Special requirements for laparoscopy, arthroscopy ...
- Stability of the system
- Quality control
- Low production costs
- Low warranty costs
- Low operation costs
- Requirement for suitable suppliers and cooperators
- Good system mobility design
- Aesthetical suitability for medical environment
- Independence of energy source

- Patient's safety
- Device's safety
- Reliable operation
- Durability of the device
- Safety of operation
- Safety of the product and responsibility for consequences
- Improvement of human factor errors
- Safety for user and responsibility for consequences
- Fast transport
- Safe transport
- Simple maintenance
- Simple and quick assembly/disassembly
- Simple manufacturability
- JIT – just in time
- Flexibility of operating environment
- Planning methodology
- Automatization
- Value system
- Improvement of organization/management
- Training of employees
- Workstation
- IT management
- Requirements of teams
- Integration
- Tool for response

Another 14 customer needs and wants were identified during contextual inquiry with users in the operation theatre:

- Good visibility in the surgical field
- Operator and/or scrub nurse can set the pressure
- System pressure is clearly visible
- System deficit is clearly visible
- Quick exchange of fluid
- Higher display resolution
- Interior of the body should be accessible
- Continuous set of pressure
- Heating of water
- Following water change, the previous pressure is taken into account
- Pressure can be pre-set
- Control of water amount in the system
- Battery status warnings
- Critical system state warnings

Altogether there were 49 customer requirements formed.

4.3 Structuring the Data on Customer Needs for Vario Flow product

After obtaining the data on customer needs and wants the moderator convened a sitting of project team where they carried out the structuring of data on customer needs in two steps:

4.3.1 STEP 1: FORMING THE INITIAL TABLES OF THE VOICE OF THE CUSTOMERS

Initial tables of the voice of the customers of Vario Flow product (Table 3) were formed especially for external and internal customers and according to the data on products and processes.

The table of external customers contains 21 needs, the table of internal customers contains 26 needs, and the table on product and process data contains 2 needs. For each need the table contains the following data: ID number of the need, customer demography, customer statement, use of the need (who, what, when, where, why, how), analyzed statement and the type of need or characteristics.

4.3.2 STEP 2: FORMING THE TREE DIAGRAM FOR VARIO FLOW PRODUCT

In the tree diagram for the value of quality the customer needs and wants are arranged hierarchically (divided into the primary, secondary, and tertiary needs). The tree diagram for the value of quality of Vario Flow product is shown in Figure 8.

4.4 Evaluation of the Data on Customer Needs and Wants for Vario Flow Product

After the analysis of available data evaluation methods the project team decided to use the postal survey. A survey form was composed where the primary, secondary, and tertiary customer needs were stated and it was sent for evaluation to 50 randomly selected potential customers of Vario Flow product.

Up to due date, 38 survey responses were received; in these, Vario Flow customers stated what, in their opinion, were the most important, less important, and least important needs. After that the quality planning engineer – moderator using the 'Prioritization model 1-2-3 assigned 5 points to the most important feature of a particular need, less important needs were assigned 3 points and the least important features were assigned 1 point.

By summing up the points obtained from all 38 surveys the project team finally obtained the results on absolute and relative relevance of a particular need, as presented in Table 4.

Customer needs, obtained, structured and evaluated in Table 4, are the input data for the first house of product planning – development process of Vario Flow product (Figure 9).

Table 3. Initial tables of the voice of the customers for Vario Flow product.

Table for the voice of the external customers

ID no.	Customer demography	Customer statement	Use						Analyzed statement	Need/ feature	Type of need/feature
			Who	What	When	Where	Why	How			
1.	Physicians	Continuous set of pressure	Surgeon	Good visibility	During entire surgery	Operation room	For uninter-rupted work		Pressure should be set continuously	Quality	Functionality
2.	Physicians, scrub nurses	Control of water amount in the system	Surgeon and scrub nurse	The right amount of water	During entire surgery	Operation theatre	Safety of the patient	Control device	Control of water amount in the device	Quality	Safety
:	:	:	:	:	:	:	:	:	:	:	:
21	Physicians	Critical system state warnings	Surgeon	Improvement of patient safety	During entire surgery	Operation theatre	Safety of the patient	Sound signal		Quality	Safety

Table for the voice of the internal customers

ID no.	Customer demography	Customer statement	Use						Analyzed statement	Need/ feature	Type of need/feature
			Who	What	When	Where	Why	How			
1.	Inspection engineers	Safety of the patient		Prevention of injuries	During surgery	Operation theatre		Safety system	Ensured safety of the patient	Quality	Safety
2.	Development engineer	Reliable operation		Prevention of deadlocks	During surgery	Operation theatre	Un-disturbed operation	Design solution	Design solution improvement	Quality	Reliability
:	:	:	:	:	:	:	:	:	:	:	:
26.	Maintenance personnel	Simple and quick assembly/ disassembly	Maintenance personnel	Easier access to damaged parts			Faster production	Design solution	Simple and quick assembly and disassembly	Quality	Design for assembly

Product and process data

ID no.	Customer demography	Customer statement	Use						Analyzed statement	Need/feature	Type of need/feature
			Who	What	When	Where	Why	How			
1.	Maintenance service	Quick exchange of fluid	Scrub nurse		Before and during surgery	On the product	Uninter-rupted fluid supply	Manual	Simple exchange of fluid	Quality	Functionality
2.	Physicians	Too small a display	Physician	Insufficient resolution	During surgery	On the product	To prevent errors		To ensure higher display resolution	Quality	Functionality

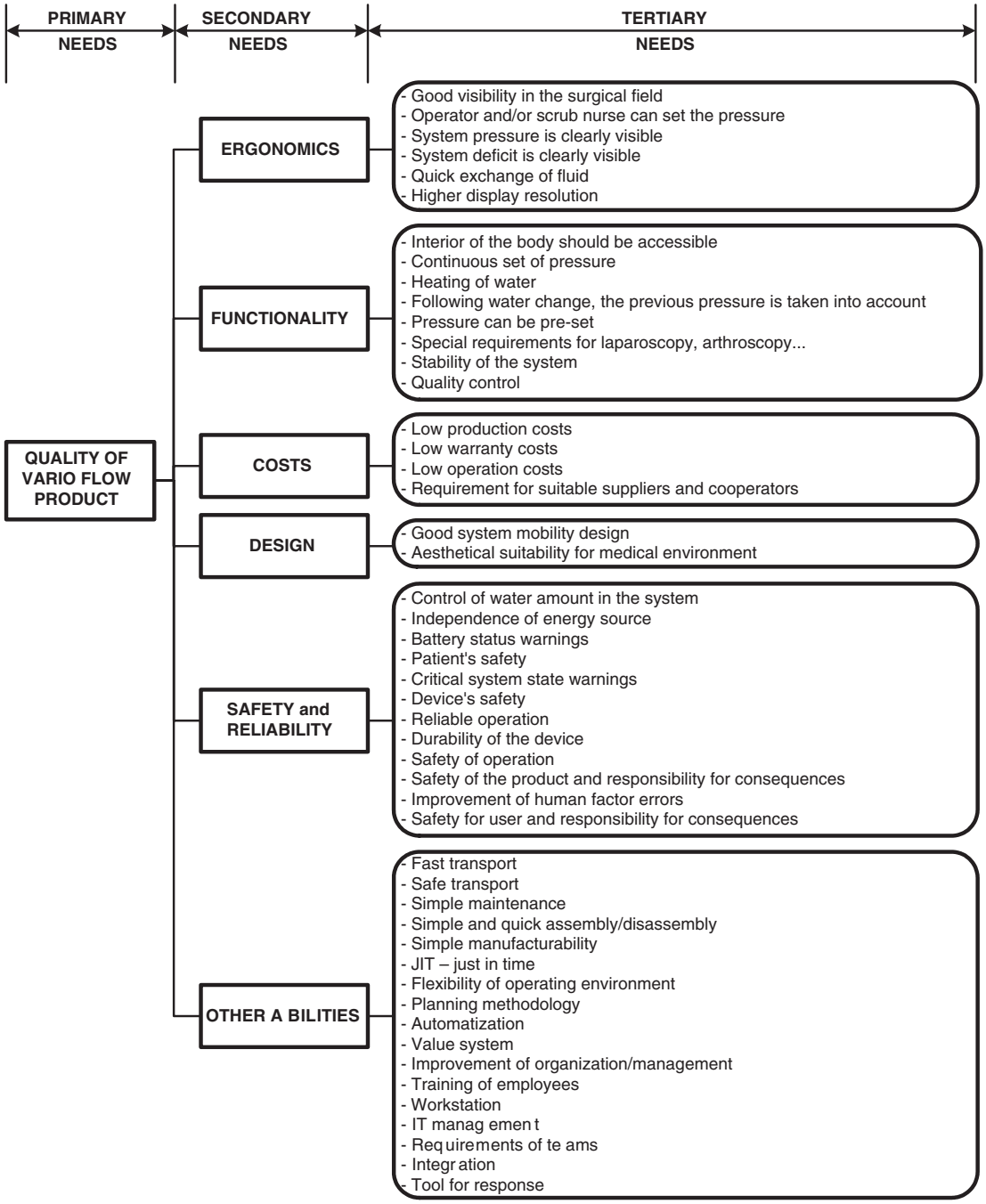

Figure 8. Tree diagram for the value of quality of Vario Flow product.

Table 4. Absolute and relative relevance of customer needs for Vario Flow product.

ID no.	Customers' needs	Absolute relevance (number of points)	Relative relevance (%)
1.	Good visibility in the surgical field	149	2.8
2.	Operator and/or scrub nurse can set the pressure	190	3.5
⋮	⋮	⋮	⋮
49.	Tool for response	63	1.2
	Total	5370	100.0

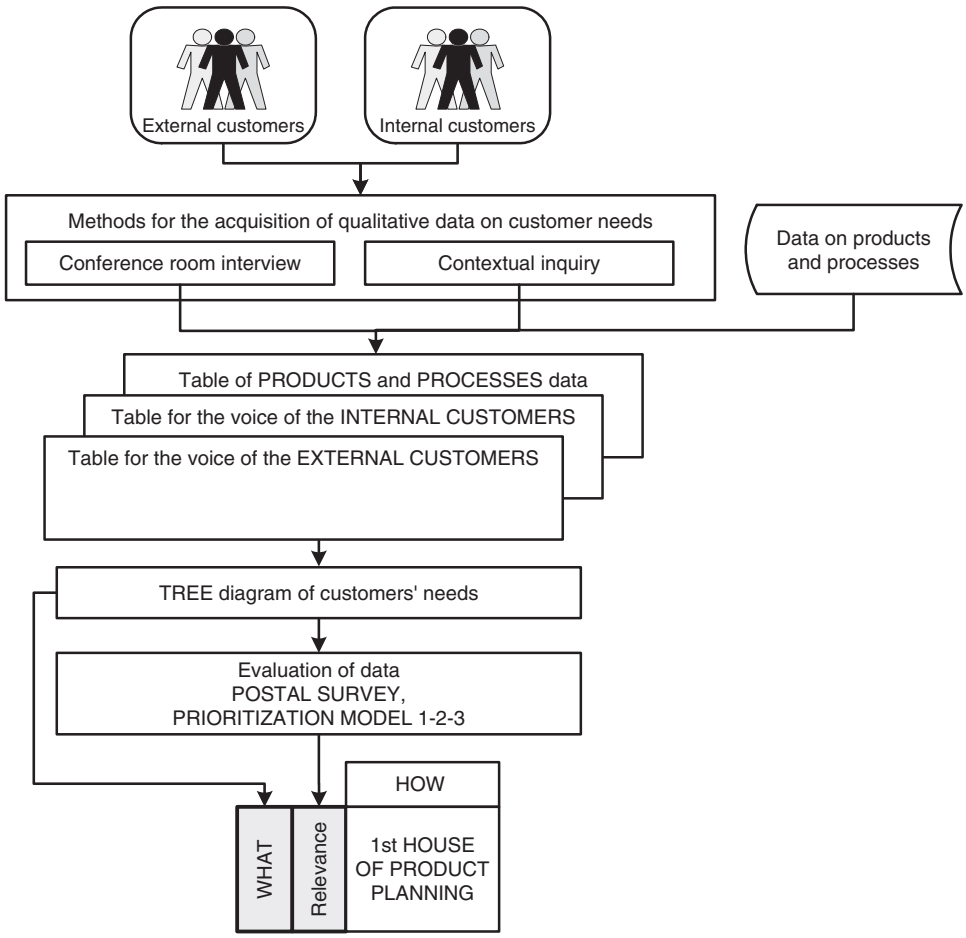

Figure 9. The input data for the first house of product planning of Vario Flow product.

5. Conclusions

A company cannot produce a competitive product unless the client (end user) takes part in the development process.

If the clients take part in the new product development process early enough, then the client (by expressing his needs) can influence the concept of the product and the whole product development process.

Past researches which analyzed the inclusion of the voice of the customers in the new product development process were related only to the quality of the product, i.e., the needs that were expressed mostly by external customers and which represent the source data for quality functions deployment (QFD) process [7,17].

Further research of the influence of the voice of the customers will be focused on establishing the needs for improvement of not only the quality but other features as well, such as simplicity, assemblability, recyclability, responsibility, costs, etc. which are expressed mostly by internal customers and which represent the source data for concurrent functions deployment [14].

By taking into account the needs for improvement of the required features and values of the product, the product will be more competitive on the market [18].

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