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INFORMATION QUALITY MANAGEMENT: A NEW METHOD OF CONTRADICTION MODELLING

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The purpose of this work is to develop a method for modelling contradictions that emerge when evaluating the quality of marketing information. The work refers to the basics of Qualitology, the science of quality. The essence of the Principle of Quality Mapping and the Principle of Quality Evaluation of objects was presented, turning attention to the problem of qualitative contradictions. The marketing information quality model was defined and the method for testing and assessing the quality of marketing information was adopted. A model of qualitative contradictions emerging while improving the quality of marketing information has been developed. The sequences of actions leading to the identification and arrangement of qualitative contradictions in relation to their impact on the quality of marketing information have been determined. Methods for solving qualitative contradictions have been indicated. While designing the above activities, Grey System Theory and Relations and Regression Theory were referred to at the stage of identification and ordering of qualitative contradictions, and to the Theory of Inventive Problem Solving at the stage of defining methods of solving the problem of quality contradictions for improving the quality of marketing information. Directions for further research and improvement of the method are indicated, in order to improve the management of marketing information quality.

Keywords: Information Quality Management, Marketing, Qualitology, Grey Incidence Analysis, OTSM model of TRIZ contradiction

1. INTRODUCTION

Concepts and methods of quality management have been developing since the beginning of the 20th century, when for the first time the quality control of prod-

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ucts during the series production of products (including the methods of Ford Motor Company inspection) began to be introduced. At the initial stage, the research on the quality of the items was mainly related to planning and statistical quality control (including Shewhart Control Charts) and quality assurance of the company's products (including Ishikawa Quality Control Methods). In the following years, quality considerations included the quality of products and the quality of the company's overall activities. The basics of Total Quality Management (TQM) are determined by a set of methods and techniques developed by, among others, Deming (including Quality Control Program, Statistical Quality Control Methods, the Chain Reaction for Quality Improvement, the Shewhart Cycle as described by Deming, Deming' 14 Points), Juran (including Breakthrough Sequence, Spiral of Progress in Quality, "Juran trilogy", Quality Control Handbook); Crosby (among others "do it right the first time", Zero Defects, Crosby's 14 Steps), Feigenbaum (including Quality Control Principles; Total Quality Control) (Suarez, 1992). A significant contribution to the development of the TQM concept have also the concepts and methods developed in the industry, such as Kaizen (i.e. a concept derived from Kaizen Philosophy, which assumes constant improvement of the way of work, social and personal life), Total Quality Control (TQC, Toyota), Six Sigma (Motorola) and others (Imai, 2007; Thompson, Kornacki, Nieckuła, 2005; Hamrol, 2007). Identification of appropriate methods, techniques and tools of quality management, tailored to the specifics of the company, for quality management, is the current problem of industrial enterprises. In this paper, when developing a method for modelling contradictions to improve the quality of marketing information, the basics of Qualitology were referred to. Qualitology is the concept of introducing an interdisciplinary domain of knowledge dealing with any issues regarding quality. This concept appeared quite recently, introduced by the work published in 1973 by Romuald Kolman. That science of quality, which is treated as the holistic view and organization of the existing knowledge of quality, creates the foundation for designing qualitative models of objects (Kolman, 1973; 2009; Kolman, Grudowski, Pytko, 2009; Mantura, 2010; 2012; Borys, 1980; Azgaldov, Kostin, Omiste, 2015). The two basic fields of research referring to the fundamentals of Qualitology can be distinguished (Borys, 2012), i.e. Qualitonomy (the descriptive field of the quality theory) and Qualimetry (the formal field in quality theory dealing with the use of numeric, mathematical-statistical methods in quality theory) and their application. Qualitology is still a developing concept for which the need for further research is indicated. This paper presents how to improve the Quality Evaluation Operation by developing a method for identifying quality contradictions.

2. LITERATURE BACKGROUND

2.1. Defining Quality

Quality has a lot of special meanings in literature and in practice, and terminological discussions on the category of quality have a long and extensive literature on the subject (Borys, 1984). Garvin (1984) classified the concepts of quality determination into five classes of approaches, such as the transcendental approach, the product-oriented approach, the customer-oriented approach, the manufacturing-oriented approach, and the value-for-money approach. In the transcendent approach, quality is derived from philosophy and borrows heavily from Plato's discussion of beauty. Quality is here synonymous with innate excellence. In the product-based approach, differences in the ingredient or attribute possessed by the product are considered (Sebastianelli, Tamimi, 2002). In this approach, epistemological definitions of quality are adopted as a set of features from which emerges the quality that distinguishes a given object from other objects, the so-called difference of the essence (Aristotle, 2012). In a user-based approach, quality means the extent to which a product or service meets and/or exceeds customers' expectations. This approach includes axiological quality determinations, expressed in an arrangement with the system of customers' needs, goals and requirements. One can distinguish such definitions of quality as "fitness for use" (Juran, 1974): "quality is the degree to which a specific product satisfies the wants of a specific consumer" (Gilmore, 1974). In the manufacturing-based approach, quality is identified as the conformance to requirements, to specifications. It is assumed here that any deviation from the specification implies a reduction in quality. Excellence is understood as "making it right the first time" (Crosby, 1979). In the value-based approach, customers consider quality in relation to its price. Quality is understood as "the degree of excellence at an acceptable price" (Broh, 1982), or "quality means best for certain customer conditions" related with the actual use and the selling price of the product (Feigenbaum, 1961). Borys (1984) distinguishes two basic interpretations in the whole set of quality definitions: comparative (evaluating) and descriptive (describing). The first highlighted quality interpretation allows you to answer the question: what is the object or set of objects like? content: what is the evaluation of an object or set of objects? The second, descriptive, understands quality as a set of features whose values describe the nature of a relatively homogeneous set of objects (Borys, 1984). This work adopts an epistemological (descriptive) definition of quality and the axiological criterion of the value of objects defining the evaluated (relative) quality of objects.

Definition 1. The quality of the object Q^p is a set of features belonging to it (Mantura, 2010, 49).

$$Q^p = \{f_1^p, f_2^p, \dots, f_n^p\}.$$

Here, Q^p – quality of the object p , $f_1^p, f_2^p, \dots, f_n^p$ – a set of features belonging to the object p .

Determining the quality of any object consists of recognizing, postulating and formulating a set of features belonging to it. The quality of the object is described by a finite set of features. The quality of the object is treated in a holistic approach, i.e., it is expressed by a set of features that belong to it and their structure. In fact, the features are identified in objects only in the form of specific own conditions/states. The state of the quality of the object determines at least one state of each feature belonging to it.

Definition 2. In the state of the quality of Q_s^p the object p is a set of states of the features belonging to it (Mantura, 2010, 51).

$$Q_s^p = \{s_{f_1}^p, s_{f_2}^p, \dots, s_{f_n}^p\}.$$

Here, Q_s^p – the quality of the object p ; $s_{f_1}^p, s_{f_2}^p, \dots, s_{f_n}^p$ – a set of states of features $f_1^p, f_2^p, \dots, f_n^p$ belonging to the object p .

The conceptualization of features belonging to the object and their states in the relationship of value (R_v) with a defined system of human needs, goals and requirements is the basis for transforming the quality of the object into an evaluated (relative) state of the object's quality.

Definition 3. In the evaluated state of the quality of (Q_s^p, R_v) the object is a valuable characteristic and a value-ordered set of states of features belonging to it (Mantura, 2010, 52).

The general and universal criterion of quality evaluation is the effectiveness of satisfying the set of needs, achieving goals and meeting human requirements (Mantura, 2010). It is assumed that full satisfaction of certain quality requirements means achieving so-called relative perfection (Kolman, 1973). In Qualitology excellence is understood as: (a) absolute perfection, which “should reflect the highest possible level of achieved effects with the greatest development of technology and knowledge”, (b) relative perfection that “reflects the highest level of effects in the actual state of knowledge and technology and the requirements”. It is therefore assumed that the level of excellence can be changed over time, which is caused by “continuous development of knowledge, improvement of executive capabilities and increase in requirements” (Kolman, 1973). In Qualitology, relativization operations are used to transform qualitative categories into evaluated qualitative categories (Kolman, 2009). Each of the features belonging to a given object is classified into one of three classes of features, considering the accepted criterion of its value assessment, such as (Kolman, 2009):

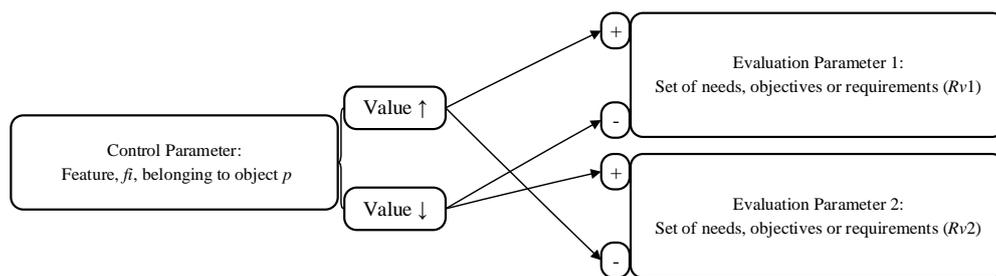
- a class of features of the maximum nature (value, stimulant), i.e., a dimension favourable for large values from the variability range of the feature,
- a class of features of the minimum nature (drawback, destimulant), i.e., a dimension advantageous for small values from the variability range of the feature,

- a class of features of the optimum nature (mediment), i.e., the dimension used for intermediate values from the variability range of the feature.

By converting quality categories into evaluated quality categories, the so-called problem of contradictions emerges. It means that a given feature in relation to a given criterion of its value assessment (resulting from the adopted set of human needs, goals and requirements, R_v1) is classified into the class of the value features of the maximum nature, and in relation to another criterion of its value assessment (resulting from another set of human needs, goals and requirements, R_v2) into the class of the value features of the minimum nature. In practice, this means that in order to improve the quality of the object in a holistic approach, i.e., considering different criteria for assessing the value of an object, we should simultaneously increase and decrease the value of a given feature. In order to illustrate the above-mentioned problem of qualitative contradictions, reference was made to the OTSM model (General Theory of Powerful Thinking) of contradiction, derived from the Theory of Inventive Problem Solving (Altszuller, 1975; Khomenko, Ashtiani, 2007; Altszuller, Filkovsky, 1975, in: Cascini, 2012). In this model, the problem of contradictions is determined using the model of a contradiction that comprehends three parameters (Khomenko et al., 2007), where:

- Evaluation Parameters (EP), constituting a measure of system requirements satisfaction,
- Control Parameter (CP) whose value impacts, with opposite results, both of the Evaluation Parameters.

In qualitative contradictions, the Control Parameter denotes the feature f_i^p belonging to the object, p , and increasing the value of the state of this feature $S_{f_i}^p$ positively affects one set of R_v1 needs, goals or requirements, and negatively the second set of R_v2 needs, goals or requirements. In this approach, the sets of needs, objectives or requirements are the Evaluation Parameters (EP), as shown in Fig. 1.



Here, R_v1 , R_v2 – the evaluation relationship refers to the relation between the feature, f_i , belonging to the object p and its impact on the implementation of a specified set of needs, goals or requirements, $v1$ and $v2$.

Fig. 1. Model of contradiction for the evaluated quality of the object.
Own elaboration

In the following chapters of the paper, first of all, the author presents how to define, research and evaluate the quality of marketing information. Secondly, a system of actions was designed to identify and solve the problem of quality contradictions for improving the quality of marketing information. Methods and tools that aid the achievement of the goals of individual actions in the developed method of qualitative contradiction modelling are indicated.

2.2. Quality of Marketing Information

The quality of marketing information is studied, among others, in the context of its impact on enterprises' performance (Keh, Nguyen, Ng, 2007), areas of the company's activity in which the quality of marketing information is particularly important, such as, among others (Leonidou, Theodosiou, 2004): to understand better the major actors in the marketplace, to monitor changes in a business environment, to design reliable marketing plans and strategies, to offer sound solutions to specific marketing problems, to improve marketing control or the factors influencing the quality of information (e.g., trust or organization culture) (Ayadi, Cheikhrouhou, Masmoudi, 2013). The issue of determining a set of features of the values belonging to information is the subject of considerations of numerous studies. In most of the works, specific sets of features are features of values expressed in relation to a specific system of needs, goals and requirements of the recipients of marketing information. Selected sets of information value features are summarized in Table 1.

This paper adopts the information quality model used in the methodology for information quality assessment AIMQ (Wang et al., 1998; Lee et al., 2002). The information quality model and the AIMQ methodology were developed based on the literature review and analysis of information quality models applied in the practical operations of companies. For specific features of information, Cronbach alphas were computed, factor analysis was performed, and features that did not add to the reliability of the scale or did not measure the same construct were eliminated. A questionnaire for assessing the quality of information was prepared, including a set of questions to assess the state of the fifteen adopted features that belong to the information, and a 0 to 10 scale where 0 is not at all and 10 is completely. Items labeled with "(R)" are reverse coded (Lee et al., 2002, 144):

- f_1^{Im} to Accessibility (4 items, Cronbach's Alpha = .92): This information is easily retrievable; This information is easily accessible; This information is easily obtainable; This information is quickly accessible when needed.
- f_2^{Im} to Appropriate Amount (4 items, Cronbach's Alpha = .76): This information is of sufficient volume for our needs; The amount of information does not match our needs. (R); The amount of information is not sufficient for our needs (R); The amount of information is neither too much nor too little.

Table 1. Selected sets of information value features

Source	A set of information value features
Mazur, 1976	(1) Usefulness in solving decision problems.
Nowicki, 1979	(1) The information is complete (according to the criterion of the purpose for which we collect information), (2) Information is true (free from errors consisting of missing or distorting important features), (3) Information is fast (received at a time that is shorter than the change in the state of the object it concerns), (4) Information reaches the appropriate recipient in the company.
Monczka et al., 1998	(1) Accuracy, precision, (2) Timeliness, (3) Adequacy, (4) Credibility of information exchanged, reliability, (5) Completeness.
Salaün, Flores, 2001	(1) Continuous and repeated exchanges, (2) Reliability of exchanges, (3) Information relevancy, (4) Personalization of information exchanges, (5) Information accessibility, (6) Understanding the contents.
Lee et al., 2002	(1) Intrinsic Information Quality (IQ): objective (objectivity), free-of-error, credible (credibility), reputation, (2) Contextual IQ: importance, timeliness, completeness, (3) Representative IQ: consistent representation, understandable, interpretable, concise representation, (4) IQ accessibility: secure transmission, ease of operation, accessibility.
Bizer, Cyganiak, 2009	(1) The content itself, (2) Collection of references necessary to understand the conditions resulting in the information being claimed, (3) Evaluation of the value of the information or the source of information (ratings about the information itself or the information provider).
Stefanowicz, 2010	(1) Up-to-date (relevance of information, as sufficient compliance of information with the actual state of the object), (2) Reliability of information, resulting from the reliability and correctness of the methods of gathering and processing information, (3) Accuracy of information, meaning the degree of proximity of known values of attributes to their true values, (4) Completeness of information means obtaining all data related to a given object, (5) Unambiguity of information, depending on the use of unambiguous language and precisely defined terms, (6) Communicativeness, comprehensibility of information, enabling the recipient to understand the information, (7) Flexibility of information as the ability to use information by different recipients, for different purposes and in different arrangements, (8) Relevance of information, as a degree of approximation of information to the problem dealt with by the recipient, (9) Coherence of information as a substantive, methodological, linguistic, technical and organizational compatibility of the communication process elements.

Source: Majchrzak, 2018, 183, on the basis of Mazur, 1976, 239; Nowicki, 1979, 22; Monczka et al., 1998, 5553–5577; Salaün, Flores, 2001, 21–37; Lee et al., 2002, 133–146; Bizer, Cyganiak, 2009, 1–10; Stefanowicz, 2010, 95–114).

– f_3^{lm} to Believability (4 items, Cronbach's Alpha = .89): This information is believable; This information is of doubtful credibility (R); This information is trustworthy; This information is credible.

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- f_4^{Im} to Completeness (6 items, Cronbach's Alpha = .87): This information includes all necessary values; This information is incomplete (*R*); This information is complete; This information is sufficiently complete for our needs; This information covers the needs of our tasks; This information has sufficient breadth and depth for our task.
 - f_5^{Im} to Concise Representation (4 items, Cronbach's Alpha = .88): This information is formatted compactly; This information is presented concisely; This information is presented in a compact form; The representation of this information is compact and concise.
 - f_6^{Im} to Consistent Representation (4 items, Cronbach's Alpha = .83): This information is consistently presented in the same format.; This information is not represented consistently (*R*); This information is presented consistently; This information is represented in a consistent format.
 - f_7^{Im} to Ease of Operation (5 items, Cronbach's Alpha = .85): This information is easy to manipulate to meet our needs; This information is easy to aggregate; This information is difficult to manipulate to meet our needs (*R*); This information is difficult to aggregate (*R*); This information is easy to combine with other information.
 - f_8^{Im} to Free of Error (4 items, Cronbach's Alpha = .91): This information is correct; This information is incorrect (*R*); This information is accurate; This information is reliable.
 - f_9^{Im} to Interpretability (5 items, Cronbach's Alpha = .77): It is easy to interpret; This information is difficult to interpret (*R*); It is difficult to interpret the coded information (*R*); This information is easily interpretable; The measurement units for this information are clear.
 - f_{10}^{Im} to Objectivity (4 items, Cronbach's Alpha = .72): This information was objectively collected; This information is based on facts; This information is objective; This information presents an impartial view.
 - f_{11}^{Im} to Relevancy (4 items, Cronbach's Alpha = .94): This information is useful to our work; This information is relevant to our work; This information is appropriate for our work; This information is applicable to our work.
 - f_{12}^{Im} to Reputation (4 items, Cronbach's Alpha = .85): This information has a poor reputation for quality (*R*); This information has a good reputation; This information has a reputation for quality; This information comes from good sources.
 - f_{13}^{Im} to Security (4 items, Cronbach's Alpha = .81): This information is protected against unauthorized access; This information is not protected with adequate security (*R*); Access to this information is sufficiently restricted; This information can only be accessed by people who should see it.
 - f_{14}^{Im} to Timeliness (5 items, Cronbach's Alpha = .88): This information is sufficiently current for our work; This information is not sufficiently timely (*R*);

- This information is not sufficiently current for our work (*R*); This information is sufficiently timely; This information is sufficiently up-to-date for our work.
- f_{15}^{Im} to Understandability (4 items, Cronbach's Alpha = .90): This information is easy to understand; The meaning of this information is difficult to understand (*R*); This information is easy to comprehend; The meaning of this information is easy to understand.

The status of individual features related to marketing information is assessed using the selected quality status indicator, e.g., taking the average rating from individual questions (Lee et al., 2002), or Kolman's averaging quality rating method to calculate the quality indicator (Kolman, 2009). The results of the assessment of the states of the features of values belonging to marketing information constitute the basis for the study of their relations with other elements occurring in the so-called information situation, i.e., when obtaining information.

2.3. Structure of the marketing information quality

In the information situation, i.e. when obtaining information regarding a given object, the relations between the following elements are noted: (1) the properties of the object, (2) the characteristics of the recipient of information, (3) the conditions for obtaining information. The conditions for obtaining information refer to the relations binding the recipient with the object (e.g., physical conditions, cognitive tools, measurement and observation methods). The property of the object refers to the specificity of marketing information, which is associated with a specific set of marketing functions and goals, including marketing research, marketing shaping products and assortment, company and product promotion, distribution, shaping economic exchange conditions, shaping pro-market enterprise development, competition, supply, sales, trade negotiations, shaping customer relations, integration with other company functions, budget management marketing (Mantura, 2015). Taking into account the influence of the recipient of information is related to the infological concept of information adopted in this work. Information, in the infological sense (Sundgren, 1973; Langefors, 1980), is the representation (description) of a specific part of the reality in the observer's mind and is subjective, dependent on the observer. The infological concept of information states that information depends on time in which the recipient assimilates and analyses information, the recipient's thesaurus, the problem-task context that accompanies the recipient, the recipient's emotional state, the totality of the circumstances occurring when receiving the message (Mantura, 2012). Defining the set of features belonging to the recipient of information, one can refer to research on human functioning in organizations. Hofstede and Hofstede (2000) distinguishes here a group of features defined by human nature (i.e., universal features that define basic physical and psychological functions), a group of features defined by culture (i.e., features

specific to a given group or category, learned features common to people living in a given environment (e.g., for a specific type of organization, specialization or job position), and a group of features defined by human personality (i.e., specific individual characteristics). By defining the quality of the human, the recipient of information, one can also refer to the concept of determining the quality of a human (Kolman, 2009), or refer to the competences and job position of the recipient of marketing information. In the literature on marketing, the conditions for obtaining marketing information are often defined by the specificity of marketing information transmission channels. The marketing information transmission channel is most frequently characterized by: the reach of information transmission, the frequency of using a specific form of marketing communication channel, the ability to influence recipients of marketing messages (contribution) by, for example, strengthening the sense of brand commonality, or creating brand awareness (Keller, 2001), as well as by the frequency of using various marketing communication tools (e.g., advertising tools, public, sales activation, direct marketing, personal sales, personal promotion and partnership with market entities, or internal marketing communication tools) (Majchrzak, 2018). When developing the method of modelling quality contradictions to improve the quality of marketing information, it is assumed that the set of features, properties, characteristics of the marketing information recipient and marketing communication channel (conditions for obtaining information) is a Control Parameter set in a specific model of quality contradictions. The evaluated state of marketing information quality Q_S^{Im} defined by a set of value features belonging to it, $\{s_{f1}^{Im}, s_{f2}^{Im}, \dots, s_{f15}^{Im}\}$ is the Evaluation Parameters set in the model of qualitative contradictions.

3. SEQUENCE OF ACTIVITIES IN QUALITATIVE CONTRADICTION MODELLING

In developing a method for modelling quality contradictions to improve the quality of marketing information, selected methods and tools of Grey System Theory (GST) (Liu, Yang, Forrest, 2016) as well as basics of the Theory of Inventive Problems Solving (TRIZ) (Altszuller, 1975) are used.

The Theory of Inventive Problems Solving was developed by Genrich Saulovich Altszuller in period from 1946 to 1998 to, in the most general terms, “help the inventor use his knowledge and experience most effectively” (Altszuller, 1975). The theory adopts a systematic approach to solving complex problems, applying a set of specific principles that guide our thinking in solving inventive tasks, and for organizing creative thinking regardless of the area of human activity (Altszuller, 1975). Initially, TRIZ was used only to solve technical problems, but

over time its application has expanded into organizational, educational and social problems as well as the ones related to business (Boratyńska-Sala, 2008).

Grey Systems Theory was created relatively recently in China, in 1982. It was created by a Chinese scholar, Professor Deng Julong, and presented in the publication titled “The Control Problems of Grey Systems” (Liu, Lin, 2006; Cempel, 2014). For developing the method of qualitative contradiction modelling for improving the quality of marketing information, Grey Incidence Analysis (GIA) methods are applied. These methods are used to solve problems such as, among others, which factors among the many are more important than others, have a greater effect on the future development of the systems than others, cause desirable changes in the systems (so these factors need to be amplified) or hinder desirable development of the systems (so they need to be controlled) (Liu, Lin, 2006). What distinguishes grey methods and research procedures developed within the framework of grey systems theory is the fact that they enable one to infer based on incomplete, uncertain and few information about the systems being studied (Liu, Lin, 2006). The sequences of the designed activities leading to qualitative contradiction modelling to improve the quality of marketing information are presented below. This paper precisely defines the set of Evaluation Parameters, i.e., features belonging to marketing information. In the chapter on the Structure of Marketing Information Quality, the way of defining the set of Control Parameters is indicated as referring to a set of features, properties, or characteristics of the recipient of marketing information or a marketing communication channel. At this stage of the research the qualitative model of the information recipient and the marketing information channel has not yet been developed, therefore individual elements of the model are presented in general terms as Control Parameters (*CP*).

Operation 1. Determination of sequences, vectors of variable values of features belonging to the Control Parameter (*CP*) and Evaluation Parameters (*EP* – states of the value features of marketing information).

$$\begin{aligned}
 CP_1 &= [cp_1(1), cp_1(2), \dots, cp_1(n)], \\
 CP_{\dots} &= [cp_{\dots}(1), cp_{\dots}(2), \dots, cp_{\dots}(n)], \\
 CP_n &= [cp_n(1), cp_n(2), \dots, cp_n(n)], \\
 s_{f1}^{lm} &= [s_{f1}^{lm}(1), s_{f1}^{lm}(2), \dots, s_{f1}^{lm}(n)], \\
 s_{f2}^{lm} &= [s_{f2}^{lm}(1), s_{f2}^{lm}(2), \dots, s_{f2}^{lm}(n)], \\
 s_{f\dots}^{lm} &= [s_{f\dots}^{lm}(1), s_{f\dots}^{lm}(2), \dots, s_{f\dots}^{lm}(n)], \\
 s_{f15}^{lm} &= [s_{f15}^{lm}(1), s_{f15}^{lm}(2), \dots, s_{f15}^{lm}(n)].
 \end{aligned}$$

Here: CP_1 – vector of the variable values of the Control Parameter; $s_{f1}^{lm}, s_{f2}^{lm}, \dots, s_{f15}^{lm}$ – vector of the variable values of states of features of the marketing information values, n – size of the research sample, i.e., the number of recipients of information, which evaluates the status of individual features belonging to marketing information.

Operation 2. Application of the Grey Incidence Analysis method and calculation of the value of the influence coefficient between particular Control Parameters and the state of value features belonging to marketing information (Liu, Yang, Forrest, 2016, 67–103). At this stage, it is important to choose the appropriate influence coefficient, which should consider the number and type and the method of Control Parameter testing, as well as the form of testing the quality of marketing information. The Grey Incidence Analysis methods most often apply coefficients such as degrees of greyness (γ), absolute degree of greyness (ε), relative degree of greyness (r), synthetic degree of greyness (ρ), the similitude and closeness degree of incidence (Liu, Lin, 2006, 85–138; Liu, Lin, 2010, 64; Xie, Liu, 2009, 304–309).

Operation 3. Adding the value of influence coefficients between particular Control Parameters and the status of the marketing information value features. This leads to the ordering of Control Parameters in terms of the strength of their influence on the state of the quality of marketing information being evaluated (Liu, Lin, 2006).

Example:

$$CP_1 > CP_{\dots} > CP_n$$

Thus, for the given example, the Control Parameter CP_1 has the greatest impact on changes in the status of the quality of marketing information being evaluated.

Operation 4. Determination of the correlation direction between the Control Parameter and individual features of the marketing information value. Positive correlation means that a given Control Parameter is a feature of a maximum nature, and a negative correlation that a Control Parameter is a feature of a minimum nature in relation to particular features of marketing information value. The recognized character of Control Parameters in relation to the set of states of the value features belonging to marketing information is compiled in the so-called matrix of contradictions.

Example:

$$CM = \begin{array}{c} \\ \\ \\ \end{array} \begin{array}{cccc} f_1^{lm} & f_2^{lm} & \dots & f_{15}^{lm} \\ \uparrow & \downarrow & \dots & \uparrow \\ \dots & \dots & \dots & \dots \\ \downarrow & \downarrow & \dots & \downarrow \end{array}$$

Here, CM – contradiction matrix; \uparrow – Control Parameter with the nature of a maximum; \downarrow – minimum in relation to individual features of the marketing information value.

Thus, referring to the example shown, it is recognized that:

- Control Parameter CP_n is a minimum parameter in relation to all the features of marketing information value. This means that to improve the status of the quali-

ty of marketing information being evaluated, the Control Parameter CP_n value should be increased.

- Control Parameter CP_1 indicates the problem of contradiction. CP_1 is a parameter of the nature of a minimum in relation to the value feature f_2^{Im} belonging to marketing information, and a parameter of the nature of a maximum in relation to the value feature f_1^{Im} and f_{15}^{Im} belonging to marketing information. Therefore, to improve the state of the quality of the evaluated marketing information, the value of CP_1 should be reduced f_2^{Im} and the value of CP_1 should be increased simultaneously to improve the state of value features f_1^{Im} and f_{15}^{Im} of marketing information, as shown in Fig. 2.

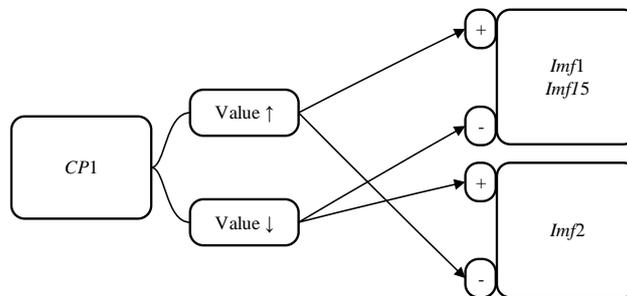


Fig. 2. Model of contradiction for the evaluated state of marketing information quality (example). Own elaboration

Operation 4. In this paper, it is pointed out that the problem of qualitative contradictions can be solved by referring to the contradiction toolkit (Gadd, 2011) developed as part of the Theory of Inventive Problem Solving. When solving the problem of qualitative contradictions, it is first recommended to use a set of the so-called Principles of Separation, and then to refer to a set of appropriately selected Inventive Principles for solving problems of technical contradictions (Gadd, 2011, 120–134). A specific set of inventive principles is of a general nature and should be adapted and applied considering the specifics of the problem being resolved (Altszuller, 1975). When solving the problem of qualitative contradictions in the area of marketing, it is recommended to use interpretations of standard inventive principles developed for solving problems in the area of marketing (Retseptor, 2005).

4. CONCLUSION AND OUTLOOKS

The paper presents the results of the study involving research, evaluation and improvement of the quality of marketing information. In the first part of the work reference was made to the basics of qualatology, i.e., quality science, defining the basic concepts used in the work, i.e., the quality of the object, the state of quality of

the object, the quality evaluation and the evaluated quality of the object. Attention was paid to the problem of qualitative contradictions emerging during quality evaluation operations, i.e., transforming the quality of an object into an evaluated quality of an object. The problem of contradictions results from the multidimensionality and complexity of the quality of objects, the occurring antinomy of features (properties, characteristics) of objects, the relativism of the concept of value and diverse needs, goals, requirements defined in terms of the quality of a given object. Selected models of information quality were analysed, and a quality information model that is appropriate for studying and evaluating the quality of marketing information was adopted. Sequences of actions were developed in the method of modelling qualitative contradictions emerging in the process of improving the quality of marketing information, as shown in Fig. 3.

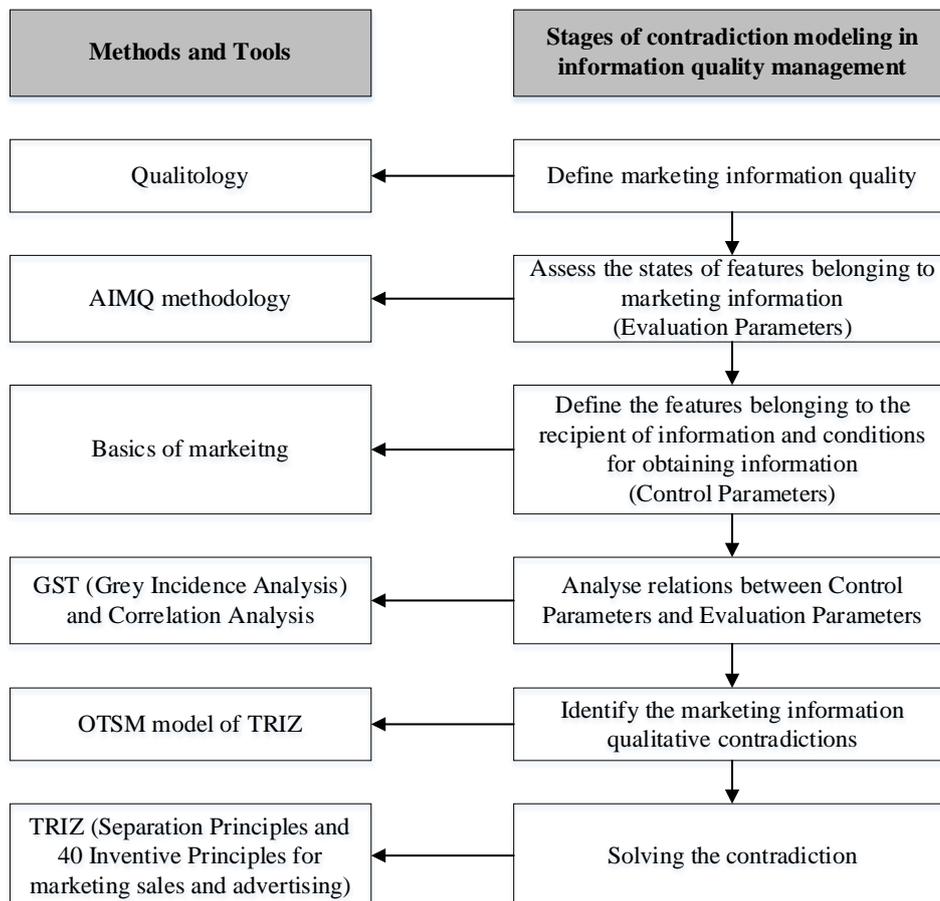


Fig. 3. The course of the method of contradiction modelling in information quality management. Own elaboration

The objective of further research is to develop a quality model of Control Parameters, i.e., to determine a set of attributes belonging to the recipients of marketing information and a marketing communication channel, and to develop a method for testing and assessing their condition. Other directions for further research include: the verification of the developed method of modelling contradictions and solving qualitative contradictions emerging while improving the quality of marketing information; the application of the mathematical optimization function at the stage of ordering quality contradictions with respect to their impact on the changes in the quality of marketing information being evaluated, and at the stage of solving the problem of qualitative contradictions; the design of IT software supporting particular computational activities and visualizations of qualitative contradictions.

LITERATURE

- Altszuller, G. (1975). *Algorytm wynalazku*. Warszawa: Wiedza Powszechna.
- Aristotle (2012). *The Metaphysics*. Translated by W.D. Ross. Ed. R.B. Jones.
- Ayadi, O., Cheikhrouhou, N., Masmoudi, F. (2013). A decision support system assessing the trust level in supply chains based on information sharing dimensions. *Computers & Industrial Engineering*, 66(2), 242–257.
- Azgaldov, G.G., Kostin, A.V., Omiste, A.E.P. (2015). *The ABC of Qualimetry*. Ridero.
- Bizer, Ch., Cyganiak, R. (2009). Quality-driven information filtering using the WIQA policy framework. *Web Semantics: Science, Services and Agents on the World Wide Web*, 7, 1–10.
- Boratyńska-Sala, A. (2008). Zastosowanie teorii rozwiązywania innowacyjnych zadań w dziedzinie biznesu i zarządzania. *Zarządzanie Przedsiębiorstwem*, 1, 13–23.
- Borys, T. (1980). *Elementy teorii jakości*. Warszawa: Państwowe Wydawnictwo Naukowe.
- Borys, T. (1984). *Kategoria jakości w statystycznej analizie porównawczej*. Wrocław: Wydawnictwo Uczelniane Akademii Ekonomicznej.
- Borys, T. (2012). Interdyscyplinarność nauk o jakości. *Zarządzanie i Finanse*, 10(3), 7–23.
- Broh, R.A. (1982). *Managing Quality for Higher Profits*. New York: McGraw-Hill.
- Cascini, G. (2012). TRIZ-based anticipatory design of future products and processes. *Journal of Integrated Design and Process Science*, 16(3), 29–63.
- Cempel, C. (2014). Teoria szarych systemów – nowa metodologia analizy i oceny złożonych systemów. Przegląd możliwości. *Zeszyty Naukowe Politechniki Poznańskiej, seria „Organizacja i Zarządzanie”*, 63, 9–20.
- Crosby, P.B. (1979). *Quality Is Free*. New York: McGraw-Hill.
- Feigenbaum, A.V. (1961). *Total Quality Control*. New York: McGraw-Hill.
- Gadd, K. (2011). *TRIZ for engineers: enabling inventive problem solving*. Chichester: Wiley.

- Garvin, D.A. (1984). What Does “Product Quality” Really Mean. *Sloan Management Review*, 25.
- Gilmore, H.L. (1974). Product Conformance Cost. *Quality Progress*, June.
- Hamrol, A. (2007). *Zarządzanie jakością z przykładami*. Warszawa: Wydawnictwo Naukowe PWN.
- Hofstede, G., Hofstede, G.J. (2000). *Kultury i organizacje. Zaprogramowanie umysłu*. Warszawa: Polskie Wydawnictwo Ekonomiczne.
- Imai, M. (2007). *Kaizen. The key to Japan's competitive success*. Kraków: Kaizen Institute Polska s.c., MT Biznes Sp. z o.o.
- Juran, J.M. (Ed.) (1974). *Quality Control Handbook*, 3rd ed. New York: McGraw-Hill.
- Keh, H.T., Nguyen, T.T.M., Ng, H.P. (2007). The effects of entrepreneurial orientation and marketing information on the performance of SMEs. *Journal of Business Venturing*, 22 (4), 592–611.
- Keller, K.L. (2001). Mastering the Marketing Communications Mix: Micro and Macro Perspectives on Integrated Marketing Communication Programs. *Journal of Marketing Management*, 17 (7–8), 819–847.
- Khomenko, N., Ashtiani, M., (2007). *Classical TRIZ and OTSM as a scientific theoretical background for non-typical problem solving instruments*. Frankfurt: ETRIA Future.
- Khomenko, N., De Guio, R., Lelait, L., Kaikov, I. (2007). A framework for OTSM TRIZ-based computer support to be used in complex problem management. *International Journal of Computer Applications in Technology*, 30 (1/2), 88–104.
- Kolman, R. (1973). *Ilościowe określanie jakości*. Warszawa: Państwowe Wydawnictwo Ekonomiczne.
- Kolman, R. (2009). *Kwalitologia: wiedza o różnych dziedzinach jakości*. Warszawa: Wydawnictwo Placet.
- Kolman, R., Grudowski, P., Pytko, B. (2009). Cross-cultural problem of quality. In: Ł. Sułkowski, K. Waniek (Eds.). *Studia z zarządzania międzykulturowego*, 2, 275–283. Łódź: Społeczna Wyższa Szkoła Przedsiębiorczości i Zarządzania.
- Langefors, B. (1980). Infological Models and Information Users View. *Information Systems*, 5, 17–32.
- Lee, Y.W., Strong, D.M., Kahn, B.K., Wang, R.Y. (2002). AIMQ: a methodology for information quality assessment. *Information & Management*, 40, 133–146.
- Leonidou, L.C., Theodosiou, M. (2004). The export marketing information system: an integration of the extant knowledge. *Journal of World Business*, 39(1), 12–36.
- Liu, S., Lin, Y. (2006). *Grey information: theory and practical applications*. London: Springer.
- Liu, S., Lin, Y. (2010). *Grey systems: theory and applications*. Berlin–Heidelberg: Springer.
- Liu, S., Yang, Y., Forrest, J. (2016). *Grey data analysis*. Berlin: Springer.
- Majchrzak, J. (2018). *The integrated marketing communication quality management method of an industrial company. PhD thesis*. Poznań: Poznan University of Technology, Faculty of Engineering Management.
- Mantura, W. (2010). *Zarys kwalitologii*. Poznań: Wydawnictwo Politechniki Poznańskiej.

- Mantura, W. (2012). Comparative analysis of the category of quality information. In: M. Goliński, M. Szafranski (Eds.). *Integrated support system for access to information in urban space with use of GPS and GIS systems*, 7–30. Poznan: Publishing House of Poznań University of Technology.
- Mantura, W. (2015). Rozważania o współczesnych problemach marketingu. *Zeszyty Naukowe Uniwersytetu Szczecińskiego. Studia i Prace Wydziału Nauk Ekonomicznych i Zarządzania*, 39 (2), 11–23.
- Mazur, M. (1976). *Cybernetyka i charakter*. Warszawa: Państwowy Instytut Wydawniczy.
- Monczka, R.M., Petersen, K.J., Handfield, R.B., Ragatz, G.L. (1998). Success factors in strategic supplier alliances: the buying company perspective. *Decision Science*, 29(3), 5553–5577.
- Nowicki, A. (1979). *Modernizacja systemu informacyjnego w przedsiębiorstwie przemysłowym*. Warszawa: Państwowe Wydawnictwo Ekonomiczne.
- Retseptor, G. (2005). 40 inventive principles in marketing, sales and advertising. *TRIZ Journal*.
- Salaün, Y., Flores, K. (2001). Information quality: meeting the needs of the consumer. *International Journal of Information Management*, 21, 21–37.
- Sebastianelli, R., Tamimi, N. (2002). How product quality dimensions relate to defining quality. *International Journal of Quality & Reliability Management*, 19(4), 442–453.
- Stefanowicz, B. (2010). *Informacja*. Warszawa: Oficyna Wydawnicza SGH.
- Suarez, J.G. (1992). *Three Experts on Quality Management: Philip B. Crosby, W. Edwards Deming, Joseph M. Juran.*, Arlington, VA: Total Quality Leadership Office, TQLO-PUB-92-02.
- Sundgren, B. (1973). *An infological approach to data bases*. Stockholm: Skriftserie.
- Thompson, J.R., Kornacki, J., Nieckuła, J. (2005). *Techniki zarządzania jakością, od Shewharta do metody „SixSigma”*. Warszawa: Akademicka Oficyna Wydawnicza Exit.
- Wang, R.Y., Lee, Y.W., Pipino, L.L., Strong, D.M. (1998). Manage your information as a product. *Sloan Management Review*, 39(4), 95–105.
- Xie, N., Liu, S. (2009). Research on evaluations of several grey relational models adapt to grey relational axioms. *Journal of Systems Engineering and Electronics*, 20(2), 304–309.

ZARZĄDZANIE JAKOŚCIĄ INFORMACJI: NOWA METODA MODELOWANIA SPRZECZNOŚCI

Streszczenie

Celem pracy jest opracowanie metody modelowania sprzeczności, które wyłaniają się przy wartościowaniu jakości informacji marketingowej. W artykule odwołano się do podstaw kwalitologii, nauki o jakości. Przedstawiono istotę zasady jakościowego odwzorowania i zasady wartościowania jakości przedmiotów, zwracając uwagę na problem sprzeczno-

ści jakościowych. Określono model jakości informacji marketingowej i przyjęto metodę badania i oceny stanu jakości informacji marketingowej. Opracowano model sprzeczności jakościowych wyłaniających się przy doskonaleniu wartościowanej jakości informacji marketingowej. Określono sekwencje działań prowadzących do identyfikacji i uporządkowania sprzeczności jakościowych względem ich wpływu na stan jakości informacji marketingowej. Wskazano metody rozwiązania sprzeczności jakościowych. Projektując powyższe działania, odwołano się do podstaw teorii szarych systemów oraz teorii relacji i regresji na etapie identyfikacji i porządkowania sprzeczności jakościowych, a także do teorii rozwiązywania zagadnień wynalazczych na etapie określania metod rozwiązania problemu sprzeczności jakościowych w celu doskonalenia jakości informacji marketingowej. W ostatniej części pracy wskazano kierunek dalszych badań prowadzących do doskonalenia zarządzania jakością informacji marketingowej.

Słowa kluczowe: zarządzanie jakością informacji, marketing, kwalitologia, *Grey Incidence Analysis, OTSM model of TRIZ contradiction*