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# Towards the fine-tuning of a predictive Kano model for supporting product and service design

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Kano's theory analyses only the 'current situation' concerning the extent of customer satisfaction, which results from fulfilling monitored product/service attributes. Such an issue hinders the exploitation of Kano surveys for long-time design projects. On the other hand, trends regarding the shift of quality attributes reported in literature are not supported by rigorous research. In order to highlight evidence about changes in the main drivers for customer satisfaction, the authors have individuated and subsequently examined surveys of three analogous products or services performed by different research groups. The use of a quantitative reference model linking the performance of quality attributes to the ensuing satisfaction provides a clear picture of the transformation occurring within the role played by a plurality of customer requirements. The results of the investigation show remarkable differences in the evolution of quality attributes and point out new needs for the organisation of an experiment to validate the existing hypotheses that concern the transformation of Kano categories. More specifically, the paper stresses the importance of performing repeated tests with the same group of customers, paying attention to industrial sectors where performance is progressing quickly, considering uncertainties related to the output of Kano surveys.

Keywords: Kano's theory; dynamics of Kano categories; quantitative Kano model; product/service design

## 1. Introduction

The Kano model of customer satisfaction (or 'of attractive quality' as reported in several sources), developed in the 1980s (Kano, Seraku, Takahashi, & Tsuji, 1984), ranks among the most powerful and popular tools to scrutinise the contribution of product/service features within the overall generation of value for consumers (e.g. Berger et al., 1993; Löfgren & Witell, 2008).

Kano's theory has challenged the idea of a linear relationship between the offering level of any product feature and the extent of customer satisfaction that is consequently generated, as highlighted, for instance, by Tsai, Chen, Chan, and Lin (2011). The model subdivides the most valuable product attributes into three categories (must-be, attractive, one-dimensional). These classes show dissimilar and asymmetrical impacts on the capability to generate customer satisfaction and avoid severe discontent (see Figure 1 for the sake of clarity). Additional categories are represented by the following quality attributes:

- † indifferent, playing a limited role in the delivery of customer satisfaction;
- † questionable, for which the relationship between performance and consumer appreciation is unclear;
- † reverse, where its presence contributes to dislike.

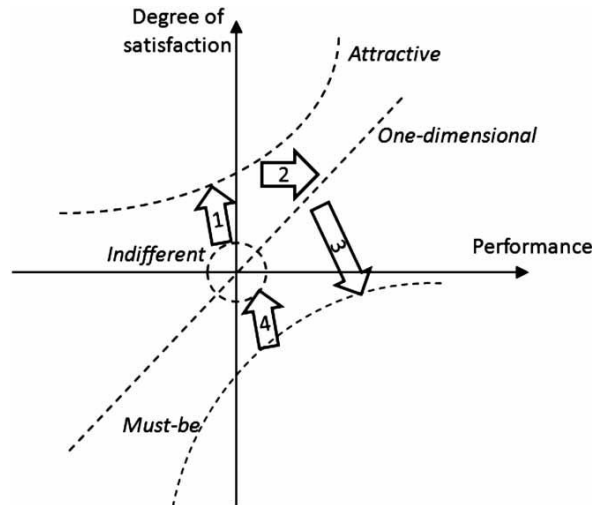


Figure 1. Representation of the dynamic model concerning successful Kano quality attributes.

Classification is performed by exploiting the results of ad-hoc customer interviews aimed at revealing the appreciation level of products and services when a specific need is either met or conversely unfulfilled.

The intuition of non-linear relationships between performance and customer value has led towards the development of tools for supporting decisions benefitting from Kano's theory (Chen & Chuan, 2011; Delice & Güngör, 2009; Rejeb, Boly, & Morel-Guimaraes, 2011). However, such contributions do not aid in tackling design decisions in projects with a long-time horizon. On the other hand, according to the authors' vision, the dispersed knowledge of the Kano model could be exploited to build advanced models applying to long-term New Product Development initiatives. To such an aim, few proposals exploit the hypotheses of evolving quality attributes according to a set of predetermined paths. These patterns have been conceived by Kano (2001) and require further investigation and experimentation.

In this context, the present paper attempts to obtain additional knowledge from the growing amount of literature (Luor, Lu, Chien, & Wu, 2012) that reports case studies about the employment of the Kano model. More specifically, the objective of the investigation consists in evaluating the reliability of evolutionary hypotheses of quality attributes. As better motivated in the following section, these patterns and the proposals about quantitative Kano curves represent the topics of major interest for building decision support systems capable of anticipating the future value of new products or services. Section 3 proposes a roadmap to exploit literary resources for the purpose of extracting empirical evidence regarding the reliability of evolutionary Kano models. The results of the investigation are contextually illustrated and the extracted data are analysed more closely by means of available quantitative models. Whereas Section 4 discusses the emerging results and further analyses the limitations due to the use of data extracted from the literature, the concluding remarks are entrusted to Section 5.

## 2. Open issues to build a quantitative forecasting Kano model

The literature witnesses open issues and misalignments among the scholars with respect to relevant aspects that concern the employment of the Kano model, its scope and the

reliability of its developments. Some researchers put directly into question the actual capability of Kano theory to support decisions within product development projects (Wu & Wang, 2012; Xu, Jiao, Yang, & Helander, 2009). The disputed questions include, among others, the definition of the set of product features to be assessed through the Kano framework, the ways to associate each attribute with its pertinent category (Chen & Lee, 2009; Mikulić & Prebežac, 2011), the acceptability of quantitative models relating performance and satisfaction. The last item represents a crucial aspect in light of building systems for supporting decisions in industry, since quantitative models better support the selection of the most valuable alternatives.

Indeed, within the general purpose of the present work, the most desirable result would consist in a model for computing the future share of customer value provided by the fulfilment of each attribute. Such a system would then be capable of guiding the choices of companies by individuating the most promising investments.

Such an outcome is, however, hindered by the recalled misalignments towards a shared quantitative Kano model viable to describe a static situation; a current lack of a Kano toolkit, according to Zhang, Auriol, Eres, and Baron (2013). In this sense, the first attempt to compensate for this lack has been the use of the adjusted improving ratio, suggested by Tan and Shen (2000). It allows for the consideration, within quality function deployment (QFD), of the different performance/satisfaction trajectories of quality attributes. Such a proposal, of quantitative and evolutionary Kano models, represent those topics which impact, to the greatest extent, the possibility of creating the desired forecasting model. Hence, these will be separately discussed in the following subsections.

For the sake of clarity, some basic concepts included in the classic version of the Kano model (see e.g. Berger et al., 1993) are taken for granted in the remainder of the article. More specifically, no explanation is provided for the coefficients standing for the degree of Customer Satisfaction (CS) and Dissatisfaction (DS), as well as for the way they are calculated.

### *2.1 Adjusted improving ratio as a means to introduce asymmetry of satisfaction–performance*

The Kano concept of non-linear dependence between the enhancement of product performance and the growth of customer satisfaction has been exploited in the context of QFD. The objective of matching Kano's theory and QFD is to consider dissimilar competitive advantages resulting from increasing the offering level of any attribute. The most common approach is the recalled adjusted improving ratio, i.e. a differentiated increase in satisfaction provoked by an identical shift of product performance according to its representative Kano category (i.e. attractive, one-dimensional or must-be). From a mathematical viewpoint, the above adjustment stands in a varying exponent (applied to the ratio between the performance of two product variants in order to derive the relative increase in performance. According to (Tan & Shen, 2000) it results that:

$$IR_{adj} = s_1/s_0 = (p_1/p_0)^{1/k} \quad (1)$$

where:

†  $IR_{adj}$  is the actual adjusted improving ratio;

†  $s_1$  and  $s_0$  represent the levels of satisfaction arising from new and actual solutions;

- †  $p_1$  and  $p_0$  stand for the matching performances with respect to the investigated customer requirement;
- †  $k$  is the corrective factor depending on the corresponding Kano category ('1/2', '1' and '2' for must-be, one-dimensional and attractive attributes, respectively).

Such a correction arises by considering the shape of classic satisfaction– performance curves depicting the Kano categories; indeed, the linearity of one-dimensional attributes determines no adjustment.

Hsu, Chang, Wang, and Lin (2007) multiply the so-formulated  $IR_{adj}$  and the raw importance of product attributes to determine the extent of the benefits arising from the increase of performance. The adjusted improving ratios are further employed in Garibay, Gutiérrez, and Figueroa (2010) to determine the major priorities of services redesign.

An alternative way of adjusting the improving ratio with respect to the original proposal is reported in Chaudha, Jain, Singh, and Mishra (2011), which takes into account CS and DS coefficients in addition to the characterisation of attributes through the Kano categories.

## *2.2 Hypotheses to quantitatively interpret the characteristic curves of Kano categories*

In recent years, some models have been proposed and implemented in more complex optimisation methods which relate satisfaction and performance by means of mathematical functions.

For instance, Földesi, Kóczy, and Botzheim (2007) employ a model which assigns an exponent to the variable standing for the performance of the customer requirement. The exponent is determined by the associated quality attribute, while its variability, according to customers' opinion, is taken into account by extending the Kano model through fuzzy systems.

Tontini and Silveira (2007), by blending cues from Kano's theory and importance performance analysis (IPA), describe the relationship between perceived satisfaction and the offering level of product features through broken lines. The slope of the lines changes at the point depicting the performance of the investigated service at the current standard. The idea of extrapolating the curves through broken lines is assumed also in the 'piecewise regression' model (Xi, Lee, Teng, & Lin, 2010). The latter observes three different slopes by considering the satisfaction level at minimum, maximum and two intermediate performance degrees.

Wang and Ji (2010) adhere to the shape of qualitative Kano curves by using exponential functions for non-linear quality attributes. However, their model differs from the original design of the curves, since all kinds of customer requirements are deemed to impact the capability to generate satisfaction and avoid dissatisfaction. Indeed, the extent of dissatisfaction and satisfaction represents the extremes of the curves. In other words, they stand for the conditions of minimum and maximum performance with reference to the treated quality factors. On the other hand, Borgianni, Cascini, and Rotini (2011) depict the curves by assigning, just to one-dimensional product features, the possibility of influencing the perception of satisfaction and discontent, regarded as very different dimensions of value within the re-engineering of industrial processes. The extremes of the functions depend on the importance level assigned to each customer requirement, while the shape of the curves reflects the proposal illustrated in Tan and Shen (2000).

Ultimately, it is possible to assess that a different kind of information is required to build the diagrams pertaining to the Kano-wise models devoted to quantitatively interpreting the role of customer requirements in determining the appreciation of a product. The proposals to be considered for such a purpose (Borgianni et al. 2011; Földesi et al., 2007; Tontini & Silveira, 2007; Wang & Ji, 2010; Xi et al., 2010) include, overall, the need of assessing (see Table 1 for major detail of the single contributions):

- † the Kano category attributed to each customer requirement;
- † the share of customer answers which delineate a certain Kano category;
- † the quantity of respondents declaring their actual state of satisfaction or discontentment with respect to any product characteristic;
- † the importance related to each customer requirement;
- † the computation of CS and DS;
- † the performance (and the matching satisfaction degrees) of the current product design, of best and worst options, intermediate values of offering levels regarding the quality attributes.

### 2.3 Expected evolution of Kano categories

Besides the missing convergence on quantitative proposals, the potential of the Kano model to support strategic product development decisions is affected by the often- disregarded dynamics of customer preferences, whose impact is extensively underlined in Chong and Chen (2010). In this sense, as already mentioned in the Introduction, hypotheses about the evolutionary nature of quality attributes can partially represent a cue for filling the gap.

Table 1. Quantitative Kano models and required information to build the diagrams.

Model	Attributed Kano category	Share of respondents for each Kano category	Relevance	CS/DS indexes	Multiple performance levels and matching satisfaction
Fuzzy extension of the Kano model (Földesi et al., 2007)	No	Yes	No	No	Yes
Kano + IPA (Tontini & Silveira, 2007)	No	No	No	Yes, in a modified form	Yes
Piecewise regression (Xi et al., 2010)	No	No	No	No	Yes
S-CR relationship functions (Wang & Ji, 2010)	Yes	No	No	Yes	No
Satisfaction equations (Borgianni et al., 2011)	Yes	No	Yes	No	No

Löfgren, Witell, and Gustafsson (2011), on the basis of the findings reported in Kano (2001), claim that the changes occurring to quality attributes can observe specific behaviours. Successful product attributes follow a cyclical pattern that initially foresees the shift from indifferent to attractive quality, once customers start to perceive the exciting value of a given product attribute. After this, consumers get used to the benefits ensuing from the fulfilment of such product features and the Kano category switches towards one-dimensional (and subsequently must-be) quality. In a certain sense, customer requirements tend to decrease their capability to generate satisfaction, and their fulfilment is devoted to maximally avoiding harm. It can eventually happen that radical innovations of the product determine the obsolescence of previously relevant characteristics. In these cases, certain attributes produce no more value for the customer. Hence, a novel transformation is observed that leads towards indifferent quality. Figure 1, which is reported for the sake of clarity, illustrates such a cycle in a graphical form.

Several sources dealing with the dynamics of Kano categories acknowledge only the patterns of successful quality attributes. Their evolutionary mechanism is confirmed in several contributions (e.g. Chaudha et al., 2011) and is motivated by the changes occurring as a result of accumulated user experience (Nilsson-Witell & Fundin, 2005). The dynamic logic of quality attributes is employed within tools to support product development by Sakao (2009) and Raharjo, Brombacher, Goh, and Bergman (2010). The former provides an additional graph depicting possible modifications for the surveyed product characteristics in the field of eco-design. The latter show an effective integration of the evolutionary logic, though the example is limited by the employment of illustrative and hypothetical data, giving rise to poor reliability of the proposed methodology. On the other hand, Zhao and Dholakia (2009) shed light on different shifts occurring for different kinds of users and hence remark mismatches with the dynamics of successful quality attributes.

The most acknowledged alternative cycles are still reported in Löfgren et al. (2011), which highlights the presence of flavour-of-the-month and stable Kano categories. The former rapidly turn from indifferent to one-dimensional and back to indifferent quality, standing for those characteristics of seasonal products contributing to satisfaction for a short period of time. The latter individuate those features whose role in determining satisfaction does not change over time and that are consequently characterised by longer life-cycles. Therefore, these quality attributes do not observe any transformation, unlike the other groups. Also in Löfgren et al. (2011), it is shown that just 4 customer requirements of 24 regarding the packaging industry do not follow any of the hypothesised patterns, with a wide majority of stable quality attributes.

#### *2.4 Remarks about the surveyed issues concerning the Kano model*

Criteria based solely on improving ratios results are unsuitable for the final scope of the present research (i.e. a system quantitatively estimating customer value of future product/services). This is due to the disregard of the asymmetric roles of customer satisfaction and dissatisfaction within the overall consideration of user value (Mittal, Ross, & Baldasare, 1998). Such limitation is overcome by the models described in Section 2.2, with the exception of the proposal reported by Földesi et al. (2007). At the same time, Table 1 shows how the proposed quantitative Kano models require different types of data in order to relate product performance and customer satisfaction. Such an aspect relentlessly impacts the applicability of these frameworks within the insightful analyses of products and services presented in the next section.

The dynamic models of quality attributes result then, in a chance to build a support system capable of expanding the employment field of the Kano model. Nevertheless, their reliability results are arguable, since no validation has been performed, nor have the constraints for their application been clarified. According to the authors' knowledge, no within-subjects repeated measures design, commonly entrusted to assess changes over time, has been employed to verify the effectiveness and further limitations of evolutionary Kano categories. Such a test would allow the evaluation of modifications in consumers' perception. It requires analysing a set of customer requirements pertaining to a given product or service in different moments and subsequently assessing the actual influence of time and accumulated experience.

With reference to the recalled lacks, the paper is devoted to better investigating the dynamic nature of quality attributes and providing an investigation approach to supporting the consistency of evolutionary hypotheses.

### 3. Outcomes of the investigation in different industrial sectors

The authors are aware of the difficulties in designing and carrying out a vast and long-lasting experiment, such as a within-subject test involving sufficient people to be considered statistically sound. In these circumstances, preliminary information can be attained by comparing the results of available surveys regarding the attributes of a specific product or service through the lenses of the Kano model in different periods. Such an approach may suffer from several biases, in terms of possible differences among the analyses with respect to boundary conditions, procedures through which the surveys have been conducted, samples of interviewed customers, and explored product features. Nevertheless, by reviewing industrial sectors for which a number of Kano investigations have been carried out, the authors try to highlight aspects to be further scrutinised through more rigorous tests.

With this objective, the authors have browsed the literature (more specifically journal and conference articles) to individuate papers reporting in detail the outcomes of surveys performed by means of the theory of attractive quality. The review revealed four sectors, including surveys of similar products or services capable of being compared. However, a case regarding hotel services is not exploitable, since comparable Kano surveys were performed roughly at the same time (if the publication dates of the papers are considered; Lin, Tsai, Wang, & Su, 2011; Yang, Jou, & Cheng, 2011). The remaining examples are reported in Sections 4.1 – 4.3. In the first instance, the modifications of Kano categories have been observed, with the aim of evaluating the compliance with at least one evolutionary model. Subsequently, the quantitative Kano framework reported in Wang and Ji (2010) has been employed to infer further empirical evidence through graphical outputs.

#### 3.1 Notebooks

Two papers have been retrieved by the authors that expose the results of Kano surveys in which consumers of notebooks participated. The older manuscript (Tang & Huang, 2004) aims at investigating the different perceptions of customers, manufacturers and dealers in terms of the role played by 28 product attributes in generating customer satisfaction. Beyond some dozens of participants belonging to the other groups of stakeholders, the questionnaires were responded to by a sample of 584 customers of computer shops in Taipei, including a significant amount of young people. In the more recent contribution

by Wang and Ji (2010), quantitative Kano curves are built on the basis of the answers provided by 125 undergraduate students, likely from Hong Kong (the provenience of the authors of the paper), in an investigation concerning 16 notebook attributes.

The interviewed samples show several affinities (e.g. consumers from a vibrant Asian city, mostly of young age), but the sets of investigated product attributes hardly overlap. Table 2 reports the similar attributes individuated by the authors and the matching Kano classifications according to the outcomes of the investigations. The last column of the Table reports whether any of the alternative evolutionary models described in Kano (2001) and Löfgren et al. (2011) fit the comparison between the first and the second surveys. Whereas product characteristics have observed no change in the Kano category, the occurrence of stable quality attributes has been indicated, although the presence of successful Kano categories showing a slow pace of transformation could be hypothesised. The same criteria are also applied in Sections 3.2 and 3.3.

In brief, the information presented in the table remarks that half of the product attributes infringe the patterns expected by any of the considered evolutionary Kano models. Whereas two categories of customer requirements stay unchanged, a product property (i.e. design) observes a transformation compliant with the hypothesised dynamics of successful attributes.

### 3.2 Websites

In Tan and Shen (2000), a case study regarding the quality of websites is employed to illustrate a methodology that integrates QFD and Kano theory. Unfortunately, no information is provided with respect to the sample of individuals that performed the evaluation of eight customer requirements. The same quality factors, in addition to four new emerging characteristics, are taken into account in the research reported in Chaudha et al. (2011), which involved the interview of 53 regular Internet users.<sup>1</sup> As already reported, Chaudha et al.

Table 2. Common attributes between two surveys, published in 2004 and 2010, respectively, and involving notebook consumers.

Attribute	Definition in (Tang & Huang, 2004)	Definition in (Wang & Ji, 2010)	Kano category in (Tang & Huang, 2004)	Kano category in (Wang & Ji, 2010)	Suitable model
Lightness	Product weight and size	Light and mobile	Must-be	One-dimensional	<i>None</i>
Design Memory capacity	Outlook design Capacity of saving device (memory)	Stylish design Large storage	Indifferent Must-be	Attractive Must-be	<i>Successful Stable</i>
Speed	Executing speed of CPU	High computing speed	One-dimensional	One-dimensional	<i>Stable</i>
Expandability	Function expandability	Expandable device	Must-be	Attractive	<i>None</i>
Repairing service	Repair and service by dealer after-	sales	Replacement and repair services	Must-be	One-dimensional

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(2011) discuss the comparison of the obtained results with those illustrated in Tan and Shen (2000) and the evolutionary concept of the Kano model is largely confirmed. Only the attribute named ‘interesting web page’ violates the cycle predicted by the models for the transformation of Kano categories. Nevertheless, the illustrative purposes of the case study exposed in Tan and Shen (2000) and the lack of any information of variability and uncertainty make the comparison poorly reliable.

In a previous research with respect to Chaudha et al. (2011), Zhang and von Dran (2001) aim at pinpointing the differences between websites with different purposes. The results of the investigation are presented, revealing the perception of 42 features by 60 users frequently surfing the Internet. Such outcomes are worth comparing to those arising from Chaudha et al. (2011), since both studies report surveys about general-purpose information web pages, and the sample sizes of the respondents to questionnaires are likely to provide reliable data. Once again the lists of the investigated attributes are substantially different and the authors have extrapolated those requirements and properties which are supposed to stimulate similar dimensions of value (Table 3).

The above results individuate no conflict with respect to the cycles foreseen by the evolutionary Kano models.

### 3.3 The banking industry

Two surveys from different periods investigating the drivers of satisfaction for customers of bank branches in Asia have been individuated. The older paper (Bhattacharyya & Rahman, 2004) reports the answers of 100 customers of a bank branch in India, who provided their perception of 39 potential triggers of customer satisfaction. The more recent study (Zarei, Hemati, & Rafeeian, 2012) describes a survey involving 125 clients of an Iranian bank branch, who expressed their opinion with respect to 21 service features. Although the sample of surveyed customer requirements strongly differs, six attributes (Table 4) have been identified which concern very similar characteristics of the offered service.

Such attributes, except for the last, comply with the guidelines offered by the evolutionary cycles under investigation.

Table 3. Common attributes between two surveys, published in 2001 and 2011, respectively, and involving the design of websites.

Attribute	Definition in (Zhang & von Dran, 2001)	Definition in (Chaudha et al., 2011)	Kano category in (Zhang & von Dran, 2001)	Kano category in (Chaudha et al., 2011)	Suitable model
Readability of the web page	Sharp displays	Reading of text	One-dimensional	Must-be	<i>Successful</i>
Quantity of information	Appropriate detail level of information	Sufficient information	One-dimensional	Must-be	<i>Successful</i>
Intuitiveness of information presentation	Structure of information presentation is logical	Locating of information	One-dimensional	One-dimensional	<i>Stable</i>

Table 4. Common attributes between two surveys, published in 2004 and 2012, respectively, and involving bank branches.

Attribute	Definition in (Bhattacharyya & Rahman, 2004)	Definition in (Zarei et al., 2012)	Kano category in (Bhattacharyya & Rahman, 2004)	Kano category in (Zarei et al., 2012)	Suitable model
Quickness of the services	Bank provides prompt service	The rapidity of giving services	One-dimensional	Must-be	<i>Successful</i>
Cheapness of the provided services	Low charges for banking services, i.e. issue of draft and overdraft charges	The cost of receiving bank services	One-dimensional	Must-be	<i>Successful</i>
Security	Bank keeps account holders' documents safely	Security in using of bank services	Must-be	Must-be	<i>Stable</i>
Branch environment	Bank has a good ambience	Tidiness of branches	Indifferent	Attractive	<i>Successful</i>
Electronic facilities	ATM facility	Using the electronic facilities	One-dimensional	Must-be	<i>Successful</i>
Accessibility of the branch	Bank is located at a convenient place	Place position of branches	Must-be	Attractive	<i>None</i>

### 3.4 Comparing the outcomes of the surveys through quantitative Kano models

The similar attributes belonging to surveys from different periods are viable to be analysed in greater detail through available quantitative Kano models, in order to shed light on further evidence thanks to the employment of graphical outputs. The selection of the quantitative models to be exploited has to be made according to the available information reported in the Kano surveys compared in Sections 3.1, 3.2 and 3.3. Beyond the most representative Kano category, all of them illustrate, for each competing factor, CS and DS coefficients or sufficient data to compute them, as reported in Table 5. Tang and Huang (2004) is a partial exception to this condition, since it provides richer information for only a subset of customer requirements.

Conversely, the quantity of designations for each Kano category, relevance indexes and satisfaction assessments at diverse quality levels are not included in the papers under investigation, or at least in a great part of them. Given the current situation, and according to Table 1, just the quantitative model described in Wang and Ji (2010) can be employed with the objective of graphically comparing the representative Kano curves belonging to different periods. A consistent limitation of such a model is represented by the missing means to represent Indifferent product attributes. This aspect does not allow the depiction of the transformations for the design of notebooks and the environment of bank branches (see Tables 2 and 4).

The extrapolation of the pairs of curves pertaining to the product attributes is then feasible only in 12 cases: the matching Figures A1–A12 are reported in the appendix. In all of these, dotted lines represent the relationship between performance and customer satisfac-

tion or dissatisfaction (whereas the value of the ordinate is lower than 0) for the situation of previous research; conversely, continuous curves refer to the same quantitative link with respect to later surveys.

Table 5. Transformation of CS and DS indexes for the product/service attributes extrapolated from research conducted at different times.

Product or service	Attribute	CS in the first research	CS in the second research	DS in the first research	DS in the second research
Notebook	Lightness	0.39	0.60	20.76	20.66
	Design	0.32	0.66	20.24	20.32
	Memory capacity	0.37	0.43	20.61	20.58
	Speed	0.29	0.59	20.74	20.71
	Expandability	0.18	0.56	20.84	20.23
	Repairing service	Missing data	0.54	Missing data	20.67
Web page	Readability of the web page	0.60	0.44	20.82	20.69
	Quantity of information	0.72	0.41	20.76	20.71
	Intuitiveness of information presentation	0.63	0.53	20.91	20.59
Bank branches	Quickness of the services	0.58	0.18	20.88	20.98
	Cheapness of the provided services	0.62	0.34	20.62	20.93
	Security	0.48	0.09	20.96	20.99
	Branch environment	0.81	0.64	20.70	20.15
	Electronic facilities	0.58	0.25	20.88	20.91
	Accessibility of the branch	0.32	0.78	20.86	20.14

#### 4. Discussion of the results

The built quantitative curves allow the highlight of circumstances otherwise neglected by the unique observation of the transformation of Kano categories.

The case concerning the changing role played by the product attributes of the notebook (Figures A1 – A4) reveals how no mapped factor markedly follows the increase of customer dissatisfaction and the diminishment of satisfaction generated by poor and optimal qualitative levels, respectively. This phenomenon is particularly evident with respect to speed (although reported as a stable quality attribute) and expandability of the notebook (infringing any evolutionary model). On the other hand, the lightness of the notebook seems to keep a quite constant relationship between performance and consequent customer value, despite the unexpected change of Kano category. Whereas a slightly more pronounced distinction seems to emerge just for high offering levels, the exploration of memory capacity reveals marginal differences in the whole field of observation. It then looks like a stable quality attribute, rather than a successful Kano category with a low pace of change. This evaluation is supported, in the authors' vision, by considering the memory of any computer as a basic feature that could be replaced only by radical innovations in the industry; not requiring any more space to store data.

A possible cause of the above misalignments with respect to the foreseen results may lie in the peculiarities of the ICT sector, which observes rapid technological growth. In this sense, surveys taken with a gap of a few years may refer to already-distinct technological eras. For instance, customers have very dissimilar expectations with regard to the speed of computers, even in relatively close time periods. In other words, with reference to the

representative satisfaction– performance curves, minimum and maximum offering levels belong to considerably different intervals and, as a consequence, the display of the graphs may be misleading. As a result, the need arises to better define, in the conducted surveys, what the accomplishment or missed fulfilment of the investigated customer requirements represent. In other words, it would be more suitable to indicate actual performance levels on the abscissas of the graphs. With these premises, a switch from qualitative to quantitative Kano models requires, at least in the authors' vision, major rigour in the definition of the quality attributes, their actual degree of fulfilment, and the resulting level of customer satisfaction or discontentment.

The case of the web page is, as already emerging from Section 4, the one showing the smallest incongruence with respect to the evolutionary models. The curves in Figures A5 – A7 show globally, in line of tendency, the growing risk arising from poor accurateness in fulfilling the mapped features and a decrement of their capability to generate satisfaction for the user. However, most of the modifications, regardless if they comply or disagree with the expected changes and the presence of successful or stable quality attributes, stand in hardly appreciable transformations (at least according to the adopted quantitative model) and the disregard of uncertainty issues may lead to wrong conclusions.

The example of bank branches presents remarkable affinities with the trends predicted through the evolutionary Kano models. Although uncertainties may play a misleading role also in this case, a majority of attributes observes growing degrees of potential dissatisfaction and a declining capability to provide unexpected value. Such phenomenon is observed also for the stable quality attribute (security), although with a minor intensity if compared to Kano categories classified as successful. In this situation, the accessibility of bank branches plainly represents an exception from all viewpoints. By examining specific branches under investigation and the samples of customers interviewed in Bhattacharyya and Rahman (2004) and Zarei et al. (2012), it emerges that a possible reason for such misalignment lies in the different clientele served by the banks. In the first survey, students from a University campus are interviewed about a very close branch and may not perceive hardships in reaching the bank, as potentially experienced by the second sample constituted by account holders living in a mid-sized town. Such a circumstance, if the authors' hypothesis is correct, remarks the need for employing similar samples of interviewed customers to compare Kano surveys.

Additionally, it has to be highlighted that no examined transformation has followed the classic pattern of flavour-of-the-month quality attributes. Such an issue is likely to be motivated by surveying case studies that do not belong to the world of seasonal products. In other words, the set of available industrial products or services, including a plurality of Kano investigations, can represent a bias in discovering the behaviour of flavour-of-the-month categories.

#### *4.1 Summary of emerging hypotheses and research questions*

Ultimately, the examination described in the present paper suggests further investigating the following issues or empirical evidence:

- † the dynamics of successful quality attributes works as a general tendency with reference to Kano categories observing transformations;
- † a non-negligible amount of customer requirements behave like stable quality attributes: for most of them, by observing quantitative Kano curves, the hypothesis of evolving at a different pace seems to be rejected;

- † the trend of the growing potential of customer requirements to provoke harm (if unfulfilled) and the diminishing capability to generate satisfaction (if accomplished) observes fluctuations;
- † the analysis of customer value through the lenses of Kano theory has to take into account uncertainties which can give rise to misleading conclusions, especially in the recurring cases of slight modifications observed in performance-satisfaction curves;
- † a convergence of scholars and practitioners on a rigorous quantitative model would be welcomed in order to avoid biases resulting from wrong mathematical relationships between satisfaction and performance;
- † the design of samples for comparative surveys taken at different times has to ensure the absence of diverging demographical factors, viable to impact, to a meaningful extent, the results of the investigation (Shahin & Zairi, 2009); in this sense, within-subject repeated measures experiments are the most reliable strategy;
- † an insightful analysis of the role played by product attributes in determining satisfaction has to clarify the range of their plausible offering levels at a certain point within the development history of the treated artefact; the disregard of technological development may lead to pitfalls mistakenly suggesting the infringement of evolutionary Kano models.

## 5. Conclusions

Given the large set of open issues concerning the extension of Kano's theory, the present paper strives to identify the most severe limitations that hinder a wider diffusion of the model of attractive quality as a tool for decision-making in product/service design. Whereas tasks to maximise customer satisfaction are commonly carried out by means of the Kano model and QFD, long-term strategic product development decisions cannot be currently supported because of ignoring upcoming drivers of customer satisfaction. The present paper claims that the refinement of the Kano toolkit could lead to the achievement of a forecasting instrument for identifying those customer needs capable of generating the greatest extent of satisfaction in the future and thus being prioritised in engineering design tasks requiring long development cycles. More specifically, it is inferred that such a result could be reached by obtaining insightful knowledge about the dynamics of quality attributes and fine-tuning reliable functions relating to performance and satisfaction.

However, the evolutionary hypotheses concerning Kano categories have received, up to now, only empirical confirmation. The authors have individuated, in repeated measures, design tests to be the most suitable way to validate (or reject) the intuitions of the evolutionary Kano model. Nevertheless, before embarking on such a long-lasting and time-consuming experiment, available surveys about similar products or services have been scrutinised and compared in order to gain further evidence. The analysis has included the building of quantitative curves by means of the only model that could be employed, according to the kind of information reported in the described Kano surveys. The whole analysis has pointed out a set of emergences to be verified and research questions requiring wider investigation, as discussed in the preceding section.

The authors would be glad to receive suggestions from other scholars or practitioners about surveys from different periods that have not been retrieved, in order to focus on further research questions and expand the scope of the reported discussions.

Whereas future activities should include the definition of the above, required experiment, candidates are welcome to support the preparation of the tests and to carry out vast surveys in different time periods.

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## Note

1. As resulting from private communication with the authors of the cited paper.

## References

- Berger, C., Blauth, R., Boger, D., Bolster, C., Burchill, G., DuMouchel, W., ... Walden, D. (1993). Kano’s methods for understanding customer-defined quality. *The Center for Quality Management Journal*, 2(4), 3 – 36.
- Bhattacharyya, S.K., & Rahman, Z. (2004). Capturing the customer’s voice, the centerpiece of strategy making: A case study in banking. *European Business Review*, 16(2), 128 – 138.
- Borgianni, Y., Cascini, G., & Rotini, F. (2011, March 27 – 29). Evaluating the effects of poorly performed product development phases on customer satisfaction. In A. Bernard (Ed.), *Proceedings of the 21st CIRP design conference* (pp. 108 – 115), Daejeon, South Korea. London: Springer.
- Chaudha, A., Jain, R., Singh, A.R., & Mishra, P.K. (2011). Integration of Kano’s model into quality function deployment (QFD). *International Journal of Advanced Manufacturing Technology*, 53(5 – 8), 689 – 698.
- Chen, C.-C., & Chuan, M.-C. (2011). *A design decision-making support model for prioritizing affective qualities of product*. Lecture Notes in Computer Science (Vol. 6677, pp. 21 – 30). Berlin, Heidelberg: Springer.
- Chen, J.-K., & Lee, Y.C. (2009). A new method to identify the category of the quality attribute. *Total Quality Management & Business Excellence*, 20(10), 1139 – 1152.
- Chong, Y.T., & Chen, C.H. (2010). Customer needs as moving targets of product development: A review. *International Journal of Advanced Manufacturing Technology*, 48(1 – 4), 395 – 406.
- Delice, E.K., & Güngör, Z. (2009). A new mixed integer linear programming model for product development using quality function deployment. *Computers & Industrial Engineering*, 57(3), 906–912.
- Földesi, P., Kóczy, L.T., & Botzheim, J. (2007, March 28–30). *Fuzzy extension for Kano’s model using bacterial evolutionary algorithm*. International symposium on computational intelligence and intelligent informatics, Agadir, Morocco, pp. 147 – 151.
- Garibay, C., Gutiérrez, H., & Figueroa, A. (2010). Evaluation of a digital library by means of quality function deployment (QFD) and the Kano model. *The Journal of Academic Librarianship*, 36(2), 125–132.
- Hsu, C.-H., Chang, T.-M., Wang, S.-Y., & Lin, P.-Y. (2007, June 19–21). Integrating Kano’s model into quality function deployment to facilitate decision analysis for service quality. In: A.K. Aggarwal (Ed.), *Proceedings of the 8th WSEAS international conference on mathematics and computers in business and economics* (pp. 226 – 232), Vancouver, Canada.
- Kano, N. (2001, September 12–14). Life cycle and creation of attractive quality. In S.M. Dahlgaard Park & J.J. Dahlgaard (Eds.), *Proceedings of the 4th international QMOD conference on quality management and organisational development* (pp. 18–36), Linköping, Sweden.
- Kano, N., Seraku, N., Takahashi, F., & Tsuji, S. (1984). Attractive quality and must-be quality. *Journal of the Japanese Society for Quality Control*, 14(2), 39 – 48.

- Lin, C.-N., Tsai, L.-F., Wang, P.-W., & Su, W.-J. (2011). Using the Kano two-dimensional quality model to evaluate service quality of resort hotels. *International Journal of Computer Science and Network Security*, 11(5), 84 – 87.
- Löfgren, M., & Witell, L. (2008). Two decades of using Kano's theory of attractive quality: A literature review. *Quality Management Journal*, 15(1), 59 – 75.
- Löfgren, M., Witell, L., & Gustafsson, A. (2011). Theory of attractive quality and life cycles of quality attributes. *The TQM Journal*, 23(2), 235 – 246.
- Luor, T., Lu, H.P., Chien, K.M., & Wu, T.C. (2012). Contribution to quality research: A literature review of Kano's model from 1998 to 2012. *Total Quality Management & Business Excellence*. doi: 10.1080/14783363.2012.733264
- Mikulić, J., & Prebežac, D. (2011). A critical review of techniques for classifying quality attributes in the Kano model. *Managing Service Quality*, 21(1), 44 – 66.
- Mittal, V., Ross, W.T., Jr., & Baldasare, P.M. (1998). The asymmetric impact of negative and positive attribute-level performance on overall satisfaction and repurchase intentions. *Journal of Marketing*, 62(1), 33 – 47.
- Nilsson-Witell, L., & Fundin, A. (2005). Dynamics of service attributes: A test of Kano's theory of attractive quality. *International Journal of Service Industry Management*, 16(2), 152 – 168.
- Raharjo, H., Brombacher, A.C., Goh, T.N., & Bergman, B. (2010). On integrating Kano's model dynamics into QFD for multiple product design. *Quality and Reliability Engineering International*, 26(4), 351 – 363.
- Rejeb, H.B., Boly, V., & Morel-Guimaraes, L. (2011). Attractive quality for requirement assessment during the front-end of innovation. *The TQM Journal*, 23(2), 216 – 234.
- Sakao, T. (2009). Quality engineering for early stage of environmentally conscious design. *The TQM Journal*, 21(2), 182 – 193.
- Shahin, A., & Zairi, M. (2009). Kano model: A dynamic approach for classifying and prioritising requirements of airline travellers with three case studies on international airlines. *Total Quality Management & Business Excellence*, 20(9), 1003 – 1028.
- Tan, K.C., & Shen, X.X. (2000). Integrating Kano's model in the planning matrix of quality function deployment. *Total Quality Management*, 11(8), 1141 – 1151.
- Tang, L.-L., & Huang, S.-L. (2004). A two-dimensional quality model for evaluating the quality attributes of notebook computers. *Asia Pacific Management Review*, 9(3), 539 – 555.
- Tontini, G., & Silveira, A. (2007). Identification of satisfaction attributes using competitive analysis of the improvement gap. *International Journal of Operations & Production Management*, 27(5), 482 – 500.
- Tsai, M.-C., Chen, L.-F., Chan, Y.-H., & Lin, S.P. (2011). Looking for potential service quality gaps to improve customer satisfaction by using a new GA approach. *Total Quality Management & Business Excellence*, 22(9), 941 – 956.
- Wang, T., & Ji, P. (2010). Understanding customer needs through quantitative analysis of Kano's model. *International Journal of Quality & Reliability Management*, 27(2), 173 – 184.
- Wu, M., & Wang, L. (2012). A continuous fuzzy Kano's model for customer requirements analysis in product development. *Proceedings of the Institution of Mechanical Engineers, Part B: Journal of Engineering Manufacture*, 226(3), 535 – 546.
- Xi, J.Y., Lee, C.-L., Teng, H.-L., & Lin, S.-B. (2010, January 26). *Piecewise regression: A tool for understanding the relationship between the attribute-level performance and customer satisfaction*. Conference on information management, Cheng Yun, Taiwan.
- Xu, Q., Jiao, R.J., Yang, X., & Helander, M. (2009). An analytical Kano model for customer need analysis. *Design Studies*, 30(1), 87 – 110.
- Yang, C.-C., Jou, Y.-T., & Cheng, L.-Y. (2011). Using integrated quality assessment for hotel service quality. *Quality & Quantity*, 45(2), 349 – 364.
- Zarei, A., Hemati, M., & Rafeeian, M. (2012). Prioritizing the effective factors for customers attraction: A case study of Sepah Bank. *Management Science Letters*, 2(3), 961 – 970.
- Zhang, P., & von Dran, G.M. (2001). User expectations and rankings of quality factors in different web site domains. *International Journal of Electronic Commerce*, 6(2), 9 – 33.
- Zhang, X., Auriol, G., Eres, H., & Baron, C. (2013). A prescriptive approach to qualify and quantify customer value for value-based requirements engineering. *International Journal of Computer Integrated Manufacturing*, 26(4), 327 – 345.
- Zhao, M., & Dholakia, R.R. (2009). A multi-attribute model of web site interactivity and customer satisfaction – an application of the Kano model. *Managing Service Quality*, 19(3), 286 – 307.

## Appendix

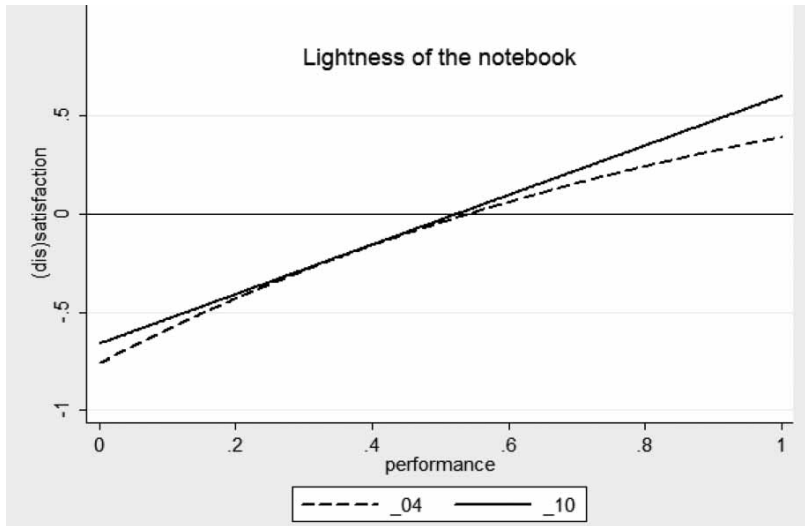


Figure A1. Link between customer satisfaction and the lightness of the notebook in two different researches published in 2004 (dotted line) and 2010 (continuous line), respectively.

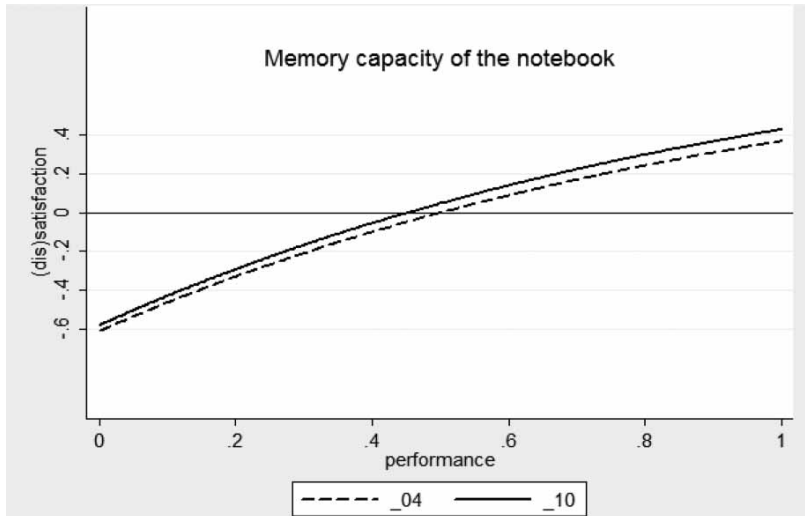


Figure A2. Link between customer satisfaction and the memory capacity of the notebook in two different researches published in 2004 (dotted line) and 2010 (continuous line), respectively.

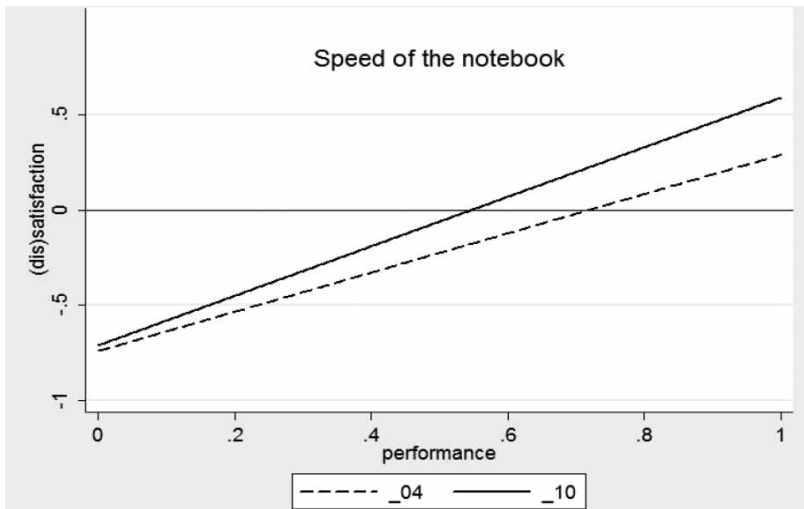


Figure A3. Link between customer satisfaction and the speed of the notebook in two different researches published in 2004 (dotted line) and 2010 (continuous line), respectively.

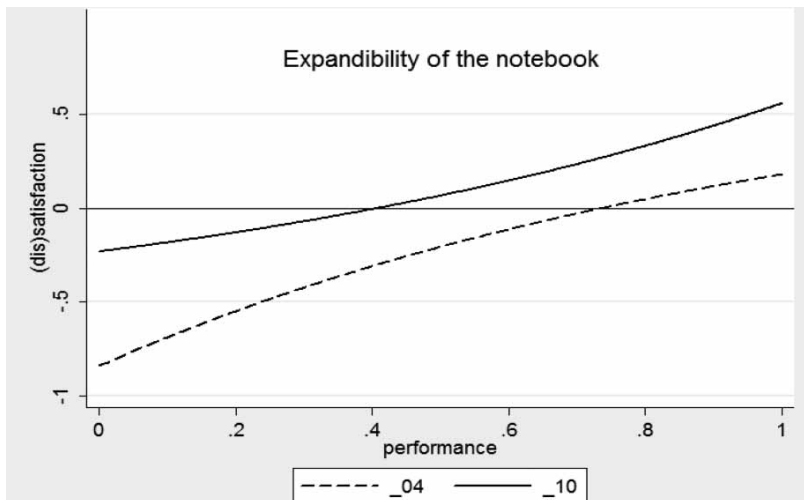


Figure A4. Link between customer satisfaction and the expandability of the notebook in two different researches published in 2004 (dotted line) and 2010 (continuous line), respectively.

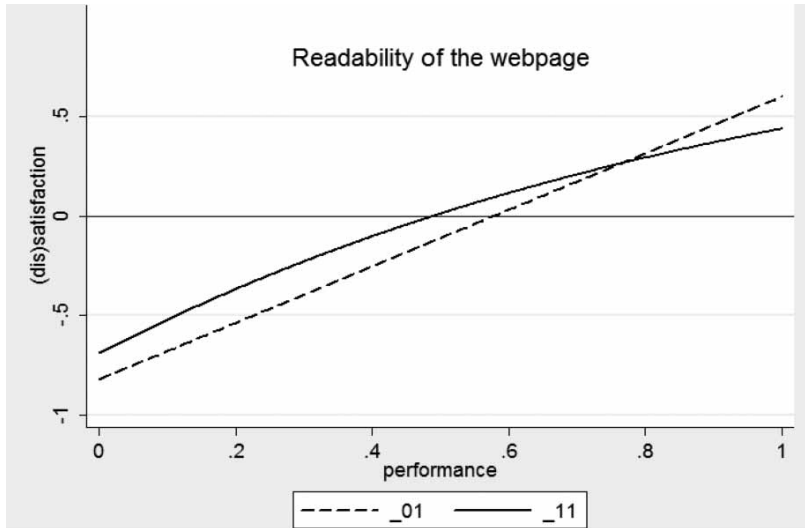


Figure A5. Link between customer satisfaction and the readability of the web page in two different researches published in 2001 (dotted line) and 2011 (continuous line), respectively.

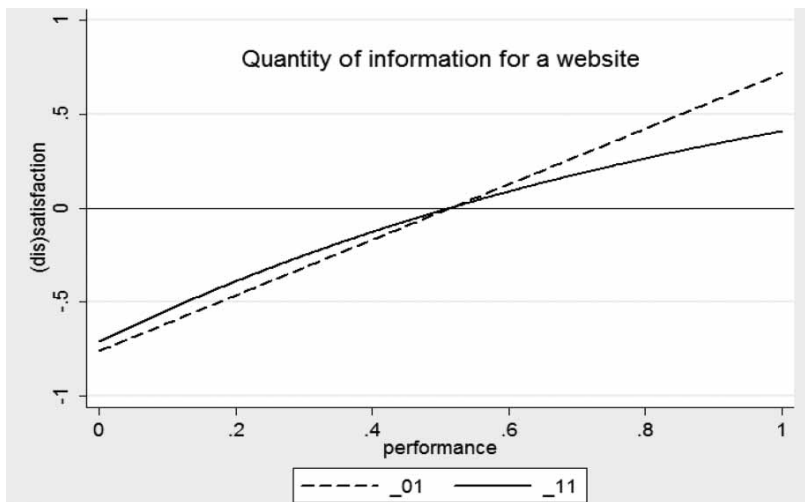


Figure A6. Link between the customer satisfaction provided and the quantity of information for a website in two different researches published in 2001 (dotted line) and 2011 (continuous line), respectively.

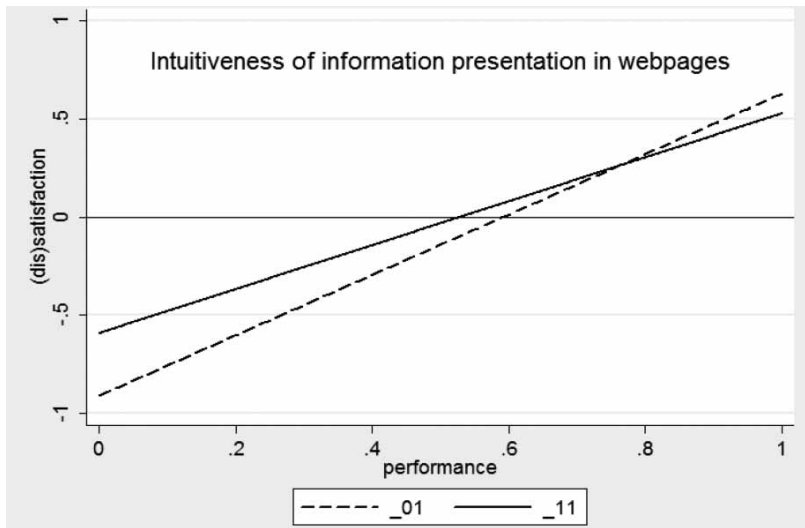


Figure A7. Link between the customer satisfaction provided and the intuitiveness of information presentation for a website in two different researches published in 2001 (dotted line) and 2011 (continuous line), respectively.

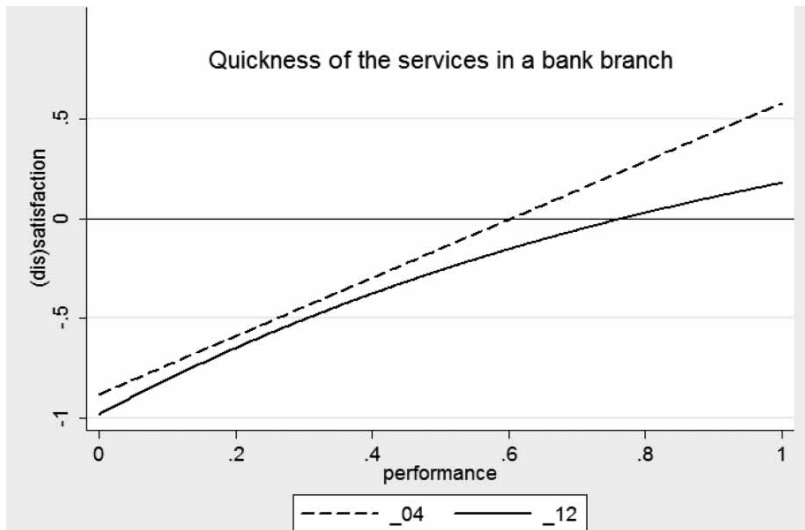


Figure A8. Link between the customer satisfaction provided and the quickness of the services in a bank branch in two different researches published in 2004 (dotted line) and 2012 (continuous line), respectively.

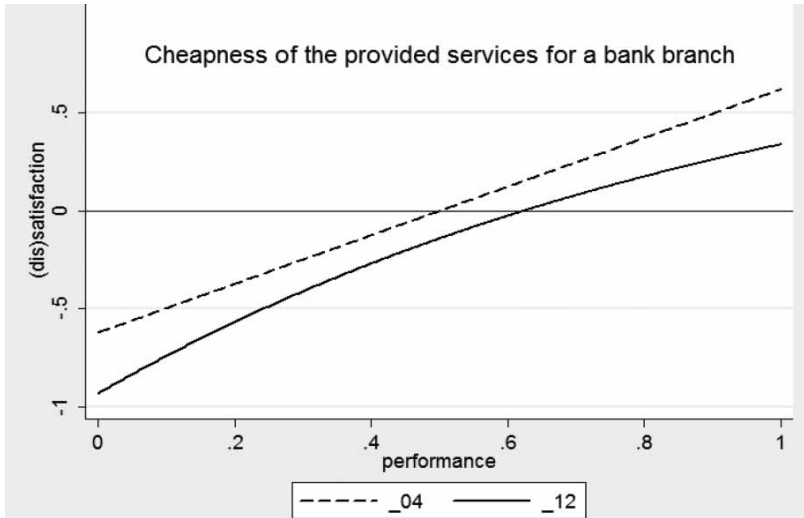


Figure A9. Link between the customer satisfaction provided and the cheapness of the provided services in a bank branch in two different researches published in 2004 (dotted line) and 2012 (continuous line), respectively.

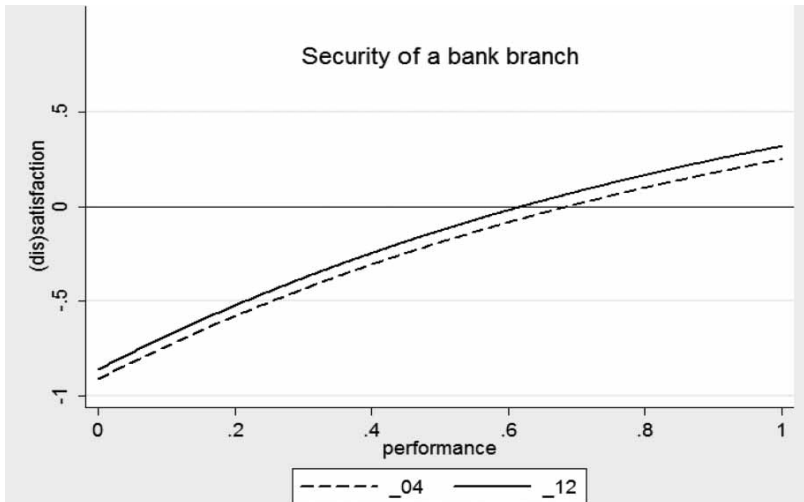


Figure A10. Link between the customer satisfaction provided and the security of a bank branch in two different researches published in 2004 (dotted line) and 2012 (continuous line), respectively.

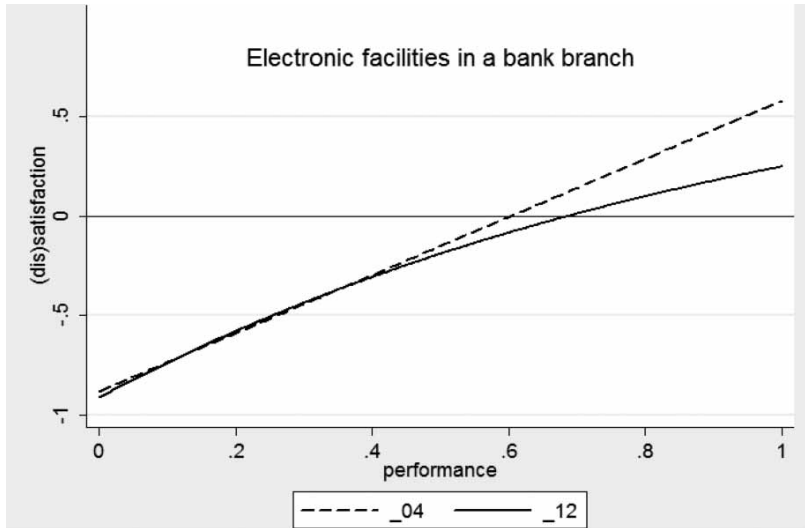


Figure A11. Link between the customer satisfaction provided and diffusion of electronic facilities in a bank branch in two different researches published in 2004 (dotted line) and 2012 (continuous line), respectively.

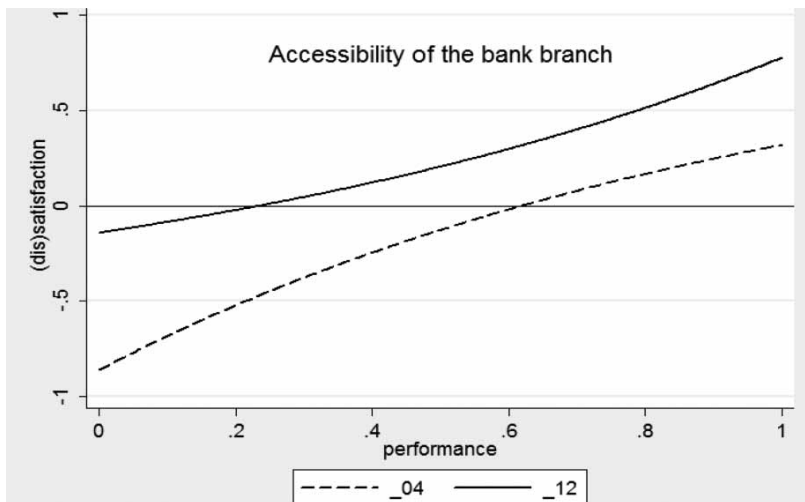


Figure A12. Link between the customer satisfaction provided and the accessibility of the bank branch in two different researches published in 2004 (dotted line) and 2012 (continuous line), respectively.