MODELLING QUALITY PERCEPTION IN THE DISTRIBUTION CHAIN: A CASE STUDY FOR TULIP BULBS

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1. Introduction

The increased emphasis on quality in agri-business and food industry has been one of the most important developments in recent years. Customers are demanding ever higher quality and producers are becoming increasingly aware of the benefits in terms of stronger customer loyalty, less vulnerability to price competition, increase in market share and so on (Morgan and Piercy [1]). In such circumstances it is imperative that the different links in the distribution chain are agreed on what constitutes high quality. Effective communication is important for the efficiency of distribution channels. Greater insight into quality perception within the distribution chain, particularly of those attributes which are affected by activities in the distribution chain, can be used to improve communication and therefore performance of the industry as a whole.

However, quality remains an elusive concept. One way of dealing with this is to develop a mathematical model to describe the way in which a quality judgement is formed, known as a Quality Perception Model (QPM). A formal model allows the comparison of the quality perception of different links in the chain or different groups within a link. In this paper a Quality Perception Model is presented and the application of such a model is illustrated with a case study for the distribution chain for tulip bulbs destined for the production of cut flowers.

2. Quality perception

2.1 Quality perception model

The concept of quality has been studied in many different contexts. Two viewpoints which are relevant for distribution chain modelling are that of producers in industry, leading to the *production management approach* and that of market researchers, leading to the *consumer perception approach* (Steenkamp [2]). The production management approach defines quality as "conformance to technical specifications" (Juran and Gryna [3]) and equates maximizing quality with minimizing defects. The consumer perception approach is concerned with the (subjective) quality as it is perceived by the user of the product, defining quality for example as "fitness for use". Although developed to describe quality perception by the consumer, the consumer perception approach can also be applied, with slight changes in emphasis, to other links in the distribution chain. Indeed, it is to be preferred over the production management approach for modelling quality in the distribution chain as it explicitly allows for individual differences.

Following the consumer perception approach, the QPM considers the perception of product quality as the act of integrating the values for the many product attributes into a "unidimensional evaluative judgement" (Steenkamp [2]). This act of integration can be represented in a regression model. Quality perception is then modelled as the sum of first or second order polynomial functions of the product attributes:

$$Q = b_0 + \sum_{i=1}^{k} b_i x_i + \sum_{i=1}^{k} b_{ii} x_i^2 + \sum_{i<j} b_{ij} x_i x_j$$

where

Q = perceived quality of product

$x_1 \ldots x_k$ = values for the k attributes

b_i, b_{ii}, b_{ij} = regression coefficients.

The regression coefficients b_i etc reflect the importance attached to that attribute by the person making the quality judgement. A linear function for a particular attribute is appropriate if more of an attribute always implies a higher (or lower) quality, while a quadratic function is appropriate if an optimum for that attribute exists. An interaction term between two attributes is required if the perceived importance of one attribute for quality is dependent on the value of another attribute.

2.2 Differences in quality perception

In principle, the regression coefficients, and hence the QPM, vary for each individual depending on individual preferences. However when modelling quality perception in the distribution chain, we are interested in whether the regression coefficients vary structurally between identifiable groups. The different links themselves may have different quality priorities, as was found by Hoogerwerf et al [4] for cut flowers and by Morgan [5] in General Electric.

Possible reasons for differences in the quality perception of different links in agri-business distribution chains are:
i) the different links consider the product at different stages in its physical development;
ii) links closest to the consumer or end user (for example, retail trader) will most closely reflect the demands of the consumer or end user;
iii) quality perception is determined by the experience of the link members with the product. The grower has a fundamentally different experience of the product compared with the distributor and exporter, generally expressed in more detailed knowledge of the product.
However differences within links are also of interest where they can be attributed to identifiable groups, for example different types of business. Steenkamp [2] discusses a number of personal and situational factors which lead to differences in perception by consumers. The most relevant in the context of the distribution chain are the prior level of experience with the product, the quality consciousness of the individual and the usage goals.

3. Case study: quality perception modelling for tulip bulb distribution chain

The development of a quality perception model will be illustrated with a case study for the distribution chain for tulips destined for the production of cut flowers (*forcing*).

3.1 Description of distribution chain.

The Dutch tulip industry is known for its high quality. However, the industry is currently facing a stagnating market while the high costs and limited availability of labour and the increasingly stringent environmental laws present threats to the continued high quality of the products (de Kleijn and Heybroek [6]). In these circumstances it is important to have a good idea of how the distribution chain performs with regard to quality and quality perception.
Bulb production is concentrated in a small area of Holland while bulbs are marketed throughout the developed world. Such a situation will tend to lead to long distribution channels (Stern and El-Ansary[7]), and there are typically about four links in bulb distribution channels (see Figure 1). The distribution chains for bulbs can be described as follows:
Bulb growers produce the bulbs. The bulbs are then sold to traders and exporters. The contracts are arranged by specialized intermediaries, usually associated with an auction house. The traders and exporters sell the bulbs to bulb forcers, in Holland or abroad, who produce the cut flowers.

3.2 Research methods

Research was carried out into quality perception in the distribution chain using the results from written questionnaires sent to representatives of the links. It was beyond the scope of this research project to attempt a survey of foreign bulb forcers or consumers. This is not as much of a disadvantage as it might

seem as there is little a priori reason to think that foreign cut flower forcers differ fundamentally from Dutch cut flower forcers while many of the quality attributes surveyed (bulb attributes and "economic" attributes such as greenhouse days) are not relevant for the consumers of cut flowers.

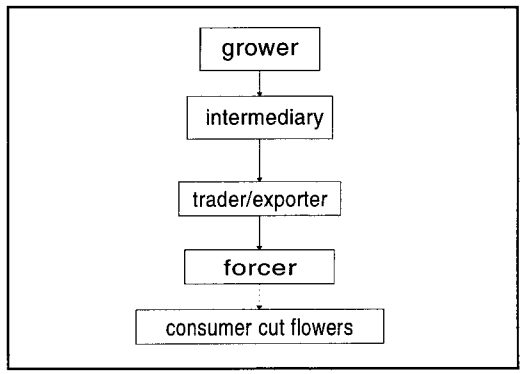

Figure 1: distribution chain for tulip bulbs for production of cut flowers

The questionnaires included questions on company characteristics, the quality of tulip bulbs marketed for forcing and the quality of tulips as cut flowers. Questions on cut flowers were included as conditions in the bulb distribution chain are a major determining factor in cut flower quality (de Hertogh et al [8]). Each question on quality perception presented the respondent with a number of hypothetical batches of bulbs or flowers (between 8 and 16), each of which was described using a limited number of quality attributes (between 3 and 6). The questions used a fractional factorial design. The respondent was asked to designate the quality of each batch by giving a report number ranging from 1 (low) to 10 (high).
Regression analysis was used to determine the coefficients for the Quality Perception Model for each questionnaire (individual link member). A further regression analysis was then carried out, this time with the estimated coefficients as response variables, to ascertain whether there were any significant differences between links and/or identifiable groups within links.

4. Results

4.1 Differences between links

The most noticeable result of the survey is the remarkable degree of agreement between the links in the most important quality attributes. All were agreed that bulb disease and flower loss are the most important attributes in determining batch quality. Also, where structural differences between links were found, they only accounted for a small proportion (less than 10%) of total between-questionnaire variance. Differences which were found tended to fall under category (ii), with the traders and exporters in closest agreement with the bulb forcers (the end users).

4.2 Differences within links

For the growers and forcers a number of significant within-link differences in quality perception were found. The significant main effects are shown in figures 2 to 5. The differences could be attributed to two basic sources:

i) the degree of product specialization - whether the link member deals in bulbs other than tulips, or in non-bulb crops (figures 2, 3 and 5) (this is likely to reflect differences in prior experience (see 2.2), with specialists having greater experience with the product);

ii) the degree of chain involvement - whether the link member is also active in other links in the distribution chain (figure 4) (this probably reflects differences in usage goals as growers who are also forcers will be producing bulbs partly for their own use).

Both a greater degree of specialization and involvement elsewhere in the chain are associated primarily with a greater emphasis on the absence of defects.

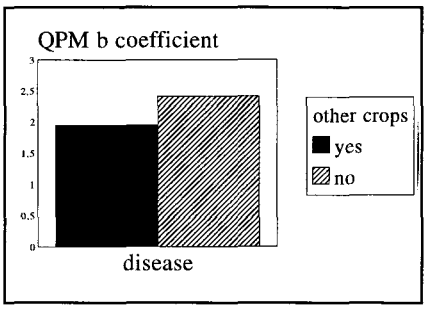

Figure 2: Growers' perception of bulb attributes

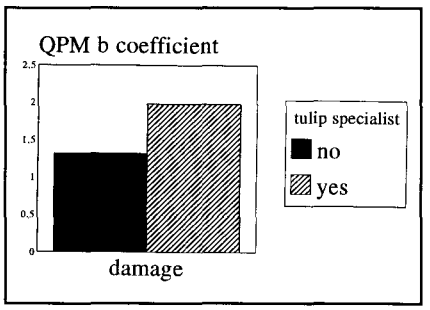

Figure 3: Forcers' perception of bulb attributes.

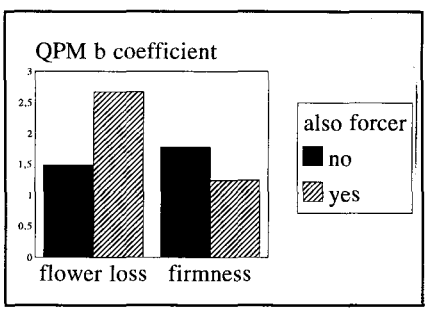

Figure 4: Growers' perception of flower attributes

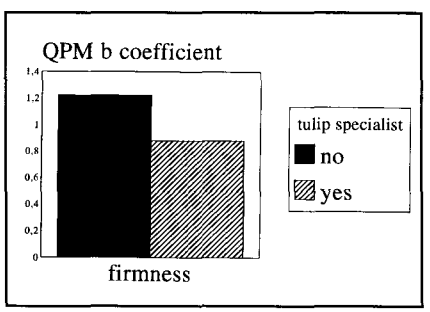

Figure 5: Forcers' perception of flower attributes

5. Conclusions

5.1 Case study

The degree of agreement between links in the distribution chain for tulip bulbs for the production of cut flowers is a positive result for the Dutch bulb sector. It undoubtedly reflects the geographical concentration and high level of organization of the Dutch bulb industry, as well as the large degree of overlap between links (de Kleijn and Heybroek [6]). However, it is a necessary but not sufficient condition for success which will also depend on the extent to which the different links translate their priorities into practice, as well as the degree of agreement with links not surveyed within this research project. Also differences in quality perception due to degree of specialization should strike a warning note, as more farmers in non-traditional bulb-growing areas are adding tulip bulbs to their usual crops.

5.2 *Quality perception models and chain management*

In general, the development of a QPM can draw attention to differences in quality perception within the distribution chain. The QPM described here can be used without alteration for the final link, the consumer, allowing the entire distribution chain to be modelled as a coherent whole. Within-link differences for consumers are likely to be particularly important and would need to be ascertained in a market segmentation study (see for an example Steenkamp [9]).

Quality Perception Models can also play an important role as part of larger chain simulation models, allowing the prediction of perceived quality under different scenarios (Wilkinson et al [10]).

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