Measuring Perceived Pre-Purchase Risk for a New Industrial Product

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Risk is an important element in industrial adoption decisions. This paper proposes a method to investigate how different groups of individuals influencing the adoption of a new industrial product differ in their assessment of the risks. Two dimensions of risk are distinguished: (1) the likelihood that adoption of the new product will have undesirable consequences, and (2) the perceived intensity of these consequences both at the organizational and at the individual level. Purchase consequences are measured in terms of product economics and product reliability. Multivariate analysis of variance is used to assess how decision participants differ in their assessment of risk components. An attempt is made to assess the relative importance of these various components in the formation of individual preferences. The implications of the analysis for the development of better industrial marketing strategies are discussed.

In industrial marketing, recent models of organizational buying emphasize the importance of decision participants risk perception on their decision process ([1], [2]). Robinson and Faris [3] propose a typology of industrial buying decisions based on the amount of risk induced. Cardozo [4] reviews a number of factors both internal and external to the firm which affects decision participants risk perception. The incidence of risk perception on industrial buying decisions has been investigated empirically in a number of different settings. Wilson et al. [5] identify perceived risk as the most important factor affecting industrial buyers decision styles. Peters and Venkatesan [6] conclude at a significant negative relationship between perceived risk and industrial adoption behavior. McMillan [7] suggests the existence of risk perception differences between three groups of decision participants: purchasing agents, scientists, and managers.

This article proposes a methodology for investigating how different groups of individuals involved in industrial adoption decisions differ in their assessment of the two components—uncertainty and perceived intensity of consequences—of the risks associated with such decisions. An attempt is made to assess the relative importance of these various components in the formation of individual preferences.

MEASURING RISK PERCEPTION DIFFERENCES IN INDUSTRIAL BUYING

Figure 1 outlines the basic dimensions of risks involved in industrial adoption decisions. Following earlier

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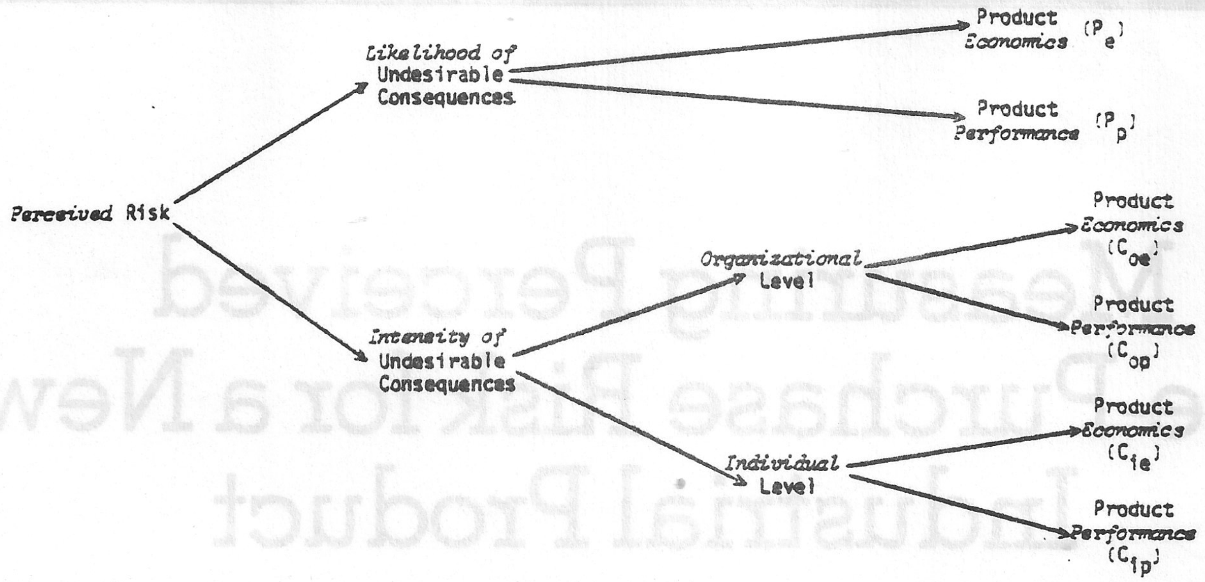

FIGURE 1. Dimensions of perceived risk

work by Cunningham [8] we distinguish the likelihood that adoption of a product will lead to undesirable consequences and the perceived intensity of these consequences. The latter dimension is further subdivided between personal consequences for the decision-maker and organizational consequences. This distinction follows existing theories of organizational buying behavior (see [1], [2]). Finally we distinguish two main types of potential consequences at all four levels: economic consequences, i.e., cost-effectiveness of the product, and performance consequences, i.e., reliability–dependability of the product. This article proposes methodology for investigating the heterogenity of risk perceptions among participants involved in the adoption of an industrial product. Specifically, the paper addresses two issues:

1. The measurement of risk perception differences between groups of participants with similar role positions, and
2. The assessment of the relative importance of the various components of risks in the formation of individual preferences.

Methodology

In this paper, risk perception is viewed as a vector-valued function. An individual's perception of risk has the following form:

$$R_j = [P_{ej}, P_{pj}, C_{oej}, C_{opj}, C_{iej}, C_{ipj}],$$

where subscript j refers to individuals' j (see Figure 1 for the notation).

Following Figure 2, the first step (A) in the methodology is the measurement of decision participants' risk perception and preferences for products in the class investigated. Methods to be used at this level are illustrated later in our empirical analysis. Decision participants are grouped on the basis of role position similarity (Step B). This decision is consistent with Sheth's [2] contention that perceptions tend to differ among decision participants as a result of differences in educational background, sources of information and reference groups.

The third step (C) uses Multivariate Analysis of Variance (MANOVA) to assess if decision participants groups differ in risk perceptions. Figure 3 depicts a simple MANOVA situation for a two-dimensional perceptual space. The ellipses represent the variation in risk perceptions for individuals who belong to each of the

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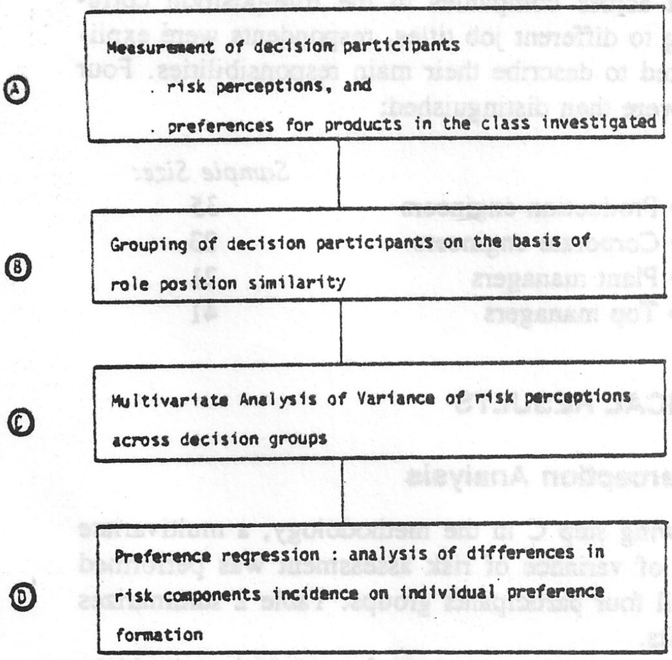

FIGURE 2. Outline of risk analysis methodology.

three groups of participants. The question is whether some of the groups are centered at different locations in this space. Here the three groups appear to have substantially different risk perceptions. We briefly describe the MANOVA model in more technical terms in Appendix 1.

The final step (D) uses preference regression to relate—within each participants group—individual preferences for the product investigated to perceptions of the various risk components. The model used in our empirical analysis related individual preferences to the *expected* intensity of consequences, as follows:

$$P_j = \alpha_0 + \alpha_1(P_{ej}C_{oej}) + \alpha_2(P_{ej}C_{iej}) + \alpha_3(P_{pj}C_{opj}) + \alpha_4(P_{pj}C_{ipj}) + \epsilon_j,$$

where P_j denotes individual j's preference score for the new product, α_0, α_1, α_2, α_3, α_4 are parameters to be estimated, and ϵ_j is the disturbance term.

The Chow test [9] is then used to assess equality of risk components coefficients (the αs) across decision participant groups. Rejection of the equality hypothesis suggests the existence of substantial differences in the incidence of risk perception components on individual preferences formation. Appendix 2 gives a brief description of that test.

THE DATA

The data used were collected as part of an EDA funded project to explore the U.S. market potential for a new industrial air conditioning system (see [10]). A sample of firms was selected by size, SIC code, and geographic area and a senior management member was identified. He was sent a personal letter asking for the names of two or three members of his organization most likely to be

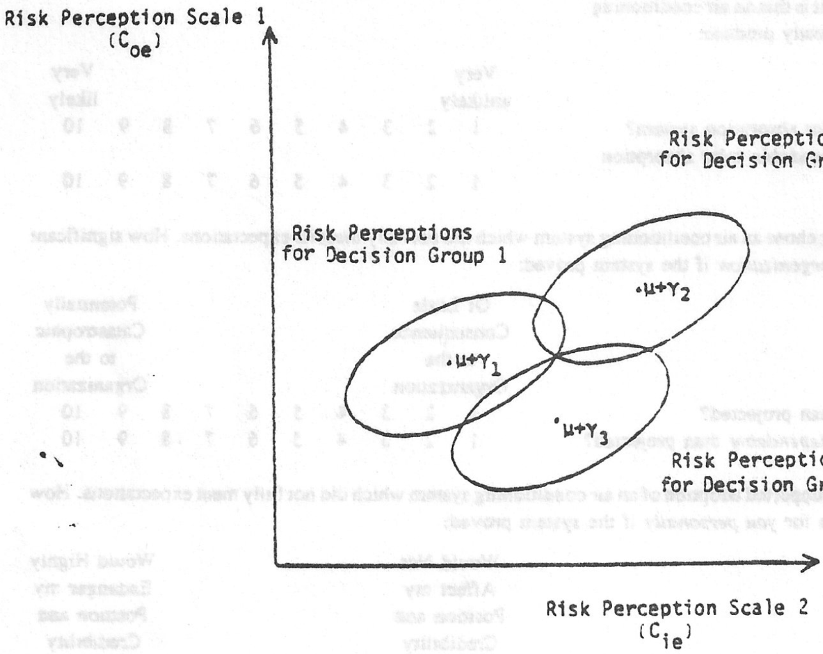

FIGURE 3. MANOVA design in the case of a two-dimensional perceptual space.

involved in purchasing air conditioning equipment. A detailed questionnaire was then sent only to the individuals mentioned. This two-step sampling procedure was used to increase the likelihood of reaching key people in the purchasing decision for this product class.

The questionnaire requested information about the company, its requirements for products in this class, its decision process and personal information. Each respondent was also sent product concept statements, accurately describing three industrial air conditioning systems—a compression system, an absorption system, and a new solar system. This approach is suitable in industrial markets as the technical complexity of product alternatives and the technical orientation of decision participants make accurate product descriptions a meaningful basis for evaluation.

Decision participants risk perception in the adoption of the new system was measured on 10-point scales shown in Table 1.

Individual preferences for the three systems were measured by the constant-sum paired comparison method. This information can be used to infer ratio-scaled individual preference scores (See Torgerson [11].

In this study, decision participants were grouped on the basis of job responsibility. As some variation must be expected across companies in the role-position corresponding to different job titles, respondents were explicitly asked to describe their main responsibilities. Four groups were then distinguished:

	Sample Size:
• Production engineers	35
• Corporate engineers	23
• Plant managers	21
• Top managers	41

EMPIRICAL RESULTS

Risk Perception Analysis

Following step C in the methodology, a multivariate analysis of variance of risk assessment was performed across all four participants groups. Table 2 summarizes the results.

The generalized correlation $\eta^2 = (1\text{-}\Lambda)$ is quite high, indicating sensible differences in risk perception across decision groups. This value is statistically significant at the level $\alpha < .05$.

It appears that decision groups differ mainly in terms of their assessment of

TABLE 1
Measurement of Risk Perception

1. How likely do you feel it is that an air conditioning manufacturer can currently produce:

	Very unlikely									Very likely
a) a *cost-effective* solar absorption system?	1	2	3	4	5	6	7	8	9	10
b) a *reliable* and *dependable* solar absorption sytem?	1	2	3	4	5	6	7	8	9	10

2. Suppose your company chose an air conditioning system which did not fully meet its expectations. How significant would it be for *your organization* if the system proved:

	Of Little Consequence to the Organization									Potentially Catastrophic to the Organization
a) less *economical* than projected?	1	2	3	4	5	6	7	8	9	10
b) less *reliable and dependable* than projected?	1	2	3	4	5	6	7	8	9	10

3. Suppose you *actively* supported adoption of an air conditioning system which did not fully meet expectations. How significant would it be for *you personally* if the system proved:

	Would Not Affect my Position and Credibility									Would Highly Endanger my Position and Credibility
a) less *economical* than projected?	1	2	3	4	5	6	7	8	9	10
b) less *reliable and dependable* than projected?	1	2	3	4	5	6	7	8	9	10

TABLE 2
Multivariate Analysis of Variance for Risk Assessment[a]

	Production Engineers	Corporate Engineers	Plant Managers	Top Managers	F (3;116)
Likelihood of a cost-effective solar system	8.34	5.81	7.76	6.61	2.43[b]
Likelihood of a reliable solar system	9.26	9.23	8.43	8.89	.29
Intensity of organizational consequences for an uneconomical air conditioning system	5.45	4.89	5.24	4.65	1.18
Intensity of organizational consequences for an unreliable air conditioning system	7.03	7.79	6.90	6.27	3.28[c]
Intensity of personal consequences for an uneconomical air conditioning system	6.87	5.50	5.33	5.27	.46
Intensity of personal consequences for an unreliable air conditioning system	7.35	7.54	6.22	6.30	2.30[b]

WILKS Λ = .235 F(18;314) = 1.74
Generalized Correlation η = .765

[a] Entries are mean importance ratings on each scale.
[b] Statistically significant at the level α = .10.
[c] Statistically significant at the level α = .05.

- the likelihood that a cost effective solar system can currently be produced
- the perceived intensity of consequences at the organizational level that would follow adoption of an unreliable system, and
- the perceived intensity of personal consequences if an unreliable system were adopted.

Independently of the statistical significance of the differences observed, it is interesting to compare patterns of risk assessment differences across decision groups. We have summarized these differences in Table 3.

It appears the Plant Personnel consider manufacturers as more likely to produce a cost effective solar system than Corporate Personnel do. On the other hand, Engineers consider it more likely that a reliable solar system can currently be produced than do Managers. Plan Personnel tend to weight heavily organizational and personal consequences of the adoption of an industrial air conditioning system that later proves uneconomical. This suggests that cost savings considerations would play an important role in the evaluation of industrial air conditioning systems by Plant Personnel.

Also, Engineers tend to be more concerned about the organizational and personal consequences of the adoption of an unreliable air conditioning system. Hence one may expect that solar systems reliability will raise a major issue for Engineers.

Preference Formation Analysis

Step D of the methodology aims at assessing the incidence of risk components on individual preferences formation. For this purpose, constant sum paired comparisons preference measures were first transformed into a ratio scale by Torgerson's method. The preference scores obtained by the new solar system were then regressed against *expected* intensity of consequences at the various levels. Several analytical forms were tested but did not lead to substantially better fit. We reproduce in Table 4 the results of a linear model of the type:

$$P_j = \alpha_0 + \alpha_1 \bar{C}_{oej} + \alpha_2 \bar{C}_{iej} + \alpha_3 \bar{C}_{opj} + \alpha_4 \bar{C}_{ipj} + \epsilon_j,$$

where $\bar{C}_{oej}$ refers to the expected intensity of organizational consequences that would follow adoption of an uneconomical air conditioning system, that is $\bar{C}_{oej} = P_{ej} C_{oej}$.

Prior to estimation, each individual's perceptual scores $C_{..j}$s were standardized to allow for meaningful comparison across decision participants.

The fit of the model, as evidenced by the R^2s, suggest that individual preferences are influenced by factors other than perceived risk, such as some of the new product characteristics, not included in our model (see [12]). However, several interesting results stem from this analysis. First, not all α coefficients are significant in all equations. Moreover, the Chow test leads to an F statis-

TABLE 3
Interpretation of the Differences in Risk Assessment Between Decision Groups

	Grouped Categories	Individual Categories
Likelihood of a cost-effective solar system	PLANT > CORP	PENG > PMGR CENG < TMGR
Likelihood of a reliable solar system	ENGS > MGRS	PENG > CENG PMGR < TMGR
Intensity of organizational consequences for an uneconomical air conditioning system	PLANT > CORP	PENG > PMGR CENG > TMGR
Intensity of organizational consequences for an unreliable air conditioning system	ENGS > MGRS	PENG < CENG PMGR > TMGR
Intensity of personal consequences for an uneconomical air conditioning system	ENGS > MGRS	PENG > CENG PMGR > TMGR
Intensity of personal consequences for an unreliable air conditioning system	ENGS < MGRS	PENG < CENG PMGR > TMGR

PENG: Production Engineers (1)
CENG: Corporate Engineers (2)
PMGR: Plant Managers (3)
TMGR: Top Managers (4)
PLANT: Plant Personnel (both 1 and 3)
CORP: Corporate Personnel (both 2 and 4)
ENGS: Engineers (both 1 and 2)
MGRS: Managers (both 3 and 4)

tics $F(4.93) = 6.237$ resulting in the rejection ($\alpha < .01$) of the null hypothesis of equality of regression coefficients. Hence, there exists substantial differences across decision groups in the way risk perceptions are related to individual preferences for the new product.

From a qualitative standpoint, it appears that Production Engineers preferences are mainly affected by their assessment of organizational consequences if the system proves uneconomical and by their assessment of personal consequences if the system is unreliable. Corporate Engineers preferences as well as Top Managers preferences are heavily influenced by their evaluation of economic consequences at the organizational level. Hence, our analysis tends to support the hypothesis that cost considerations become more important as one goes higher in a firm's hierarchy. It also underlines the potential impact of price reductions on the preferences of Corporate Personnel for the new solar system.

It is interesting to note that these differences could not have been identified had the analysis been performed at a more aggregate leel—all four decision groups combined—as evidenced by the last equation in Table 4.

DISCUSSION

Our analysis points to the existence of substantial differences across decision participants in the assessment of the risks associated with the adoption of a new industrial product. Moreover, the major components of risk appear to have a significantly different impact on the formation of individual preferences within each decision group.

TABLE 4
Preference Regressions Results

	Intercept	Expected Intensity of Organizational Consequences for an Uneconomical System	Expected Intensity of Individual Consequences for an Uneconomical System	Expected Intensity of Organizational Consequences for an Unreliable System	Expected Intensity of Individual Consequences for an Unreliable System	Coefficient of Determination
	α_0	$\alpha_1{}^a$	$\alpha_2{}^a$	$\alpha_3{}^a$	$\alpha_4{}^a$	R^2
PENG	1.84	−.43	−.26	−.02	−.40	.34
	(*t*-Stat)	(1.88)	(.77)	(.08)	(1.82)	
CENG	2.39	−.35	−.27	−.31	−.31	.32
		(1.79)	(.56)	(.57)	(.91)	
PMGR	2.28	−.20	.02	−.73	.04	.65
		(.29)	(.07)	(1.97)	(.14)	
TMGR	1.83	−.81	−.72	−.55	−.61	.38
		(2.05)	(1.83)	(1.58)	(1.81)	
All four categories included	1.92	−.49	−.30	−.27	−.46	.31
		(3.02)	(1.92)	(1.67)	(2.96)	

[a]These are standardized Beta coefficients.

These differences might be used in conjunction with the segmentation methodology proposed by Choffray and Lilien [13]—which identifies within the target market for an industrial product groupings of organizations homogeneous in the composition of their buying center—to develop differentiated industrial marketing programs aimed at reducing risk perception among major decision participant groups.

The analysis performed here, however, stands by itself. Results can be used directly by management to identify priority areas for new product improvements, e.g., cost effectiveness versus reliability dependability in the case of the new solar system. They can also be used to develop advertising copy aimed at alleviating negative perceptions of product characteristics.

CONCLUSION

This paper proposes methodology to assess risk perception differences among members of the buying center. Our empirical analysis involved the adoption of a new solar air conditioning system. Six dimensions of risk were identified. They included the likelihood that adoption of the new product would have undesirable consequences and the perceived intensity of these consequences at the individual and the organizational level.

Multivariate analysis of variance was proposed to investigate the existence and exact nature of perceived risk differences across decision groups. Preference regression was used to measure the relative influence of these various components on the formation of individual preferences.

Results of the analysis can be used to develop differentiated advertising programs or to identify major areas for product improvement. They are most powerful however, when used in parallel with an industrial segmentation methodology such as that proposed by Choffray and Lilien [13].

Last, but not least, the methodology proposed here should be viewed as an additional attempt to bring quantitative analysis, based on sound statistical criteria, to the study of industrial marketing problems.

APPENDIX 1: THE MANOVA MODEL

Consider a situation in which measurements are obtained on a n-vector variable X from a group of individuals submitted to several treatments. The MANOVA model assumes that each n observation is generated by the model:

$$x_{ij} = \mu + \gamma_j + \epsilon_{ij},$$

where the subscript $i = 1, \ldots\ldots N_j$ refers to a specific individual submitted to treatment j with $j = 1, \ldots\ldots, k$.

In this model, μ is a general level vector parameter whose h component is common to all observations obtained on response variable h, γ_j is a vector whose components represent the effect of experimental condition j on each response variable, and ϵ_{ij} is a vector of disturbances. The MANOVA model assumes that the disturbance vector ϵ_{ij} has a multinormal distribution with zero mean vector and some unknown nonsingular covariance matrix Σ common to all experimental conditions.

In terms of this notation, the null hypothesis of no treatment effect in the one-way analysis of variance design can be written

$$H_0 : \gamma_1 = \gamma_2 = \ldots = \gamma_k.$$

This hypothesis can be tested using Wilk's Lambda

$$\Lambda = |W|/|T|,$$

where

W denotes the matrix of squares and cross products of deviations of subjects from their experimental condition centroid (that is the vector of average ratings) pooled over all experimental populations, and

T denotes the matrix of sums of squares and cross products of deviations of all subjects from the grand centroid.

As $|T|$ increase relative to $|W|$, the ratio Λ decreases with an accompanying increase in the confidence with which we reject H_0. Intuitively, we reject H_0 when the proportion of the total variance in the data explained by the k experimental conditions is large.

Under H_0, Wilks' Λ has an approximate F distribution whose degrees of freedom are function of the design parameters n, k, and N_js (See Cooley and Lohnes [14]).

APPENDIX 2: THE CHOW TEST

Consider two regression models:

$$Y_1 = X_1 \lambda_1 + \epsilon_1 \quad (1)$$
$$Y_2 + X_2 \lambda_2 + \epsilon_2, \quad (2)$$

where Y_i is $(n_i \times 1)$, X_i is $(n_i \times m)$, λ_1 and λ_2 are vectors of coefficients, and ϵ_1, ϵ_2 are vectors of disturbances.

The null hypothesis, $\lambda_1 = \lambda_2$, gives rise to the reduced model:

$$Y = \left[X_1/X_2\right] \lambda + \epsilon \qquad (3)$$

If we let e_1, e_2, and e be residual vectors associated with least-squares estimation of (1), (2), and (3), respectively, it can be shown (8) that, under the null hypothesis,

$$C = \left(\frac{e'e}{e_1'e_1 + e_2'e_2} - 1\right)\frac{N-2m}{m} \qquad (4)$$

is distributed as F with m, (N-2m) d.f. (where $N = n_1 + n_2$).

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