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Attitudes of Gemstone Distributors to Value Adding Strategies of Ruby Production

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Abstract—Over the centuries gemstones have at times played a key role in the international trade. To date, they still play a significant role in economies of many countries, especially Thailand. Ruby, the red gemstone, one of the best known gemstones to ordinary people, is the focus of this study. Previous studies have shed the light on examinations of the characteristics and production methods of ruby. However, none has studied the attitudes of gemstone distributors toward several treatment strategies, which aiming to add value to ruby and maximize the return from the limited ruby supplies. The prime purpose of this study is to identify the value adding strategies deemed acceptable to gemstone distributors, by comparing their levels of satisfaction toward each treatment strategy. The findings reveal gemstone distributors accept that other methods in addition to normal cutting and polishing can also add value to rubies. Analyses of sample t-test and one-way repeated measures ANOVA suggest two treatment strategies of ruby production are deemed acceptable to gemstone distributors, and that the satisfaction levels of gemstone distributors toward each of the five treatment strategies are significantly different. Gemstone distributors consider heat treatment strategy as the most satisfactory strategy in adding value to rubies.

Keywords—Value adding strategies, ruby production, supply chain management.

I. INTRODUCTION

Gemstones have always held a special place in the minds of individuals. Over the centuries they have at times played a key role in the international trade. In today's global trade they still play a significant role in economies of many countries. It should not be surprising that there is a significant interest in optimizing the financial results of the overall production process. Traditionally, many gemstone producers have applied various treatment strategies available for them aiming to increase the value of their product and to maximize the returns from the limited gemstone supplies. It is commonly held view that other methods in addition to normal cutting and polishing can add value to gemstones. What is not well known to public is how gemstone distributors react to the utilization of available treatment strategies aiming to improve the qualities of gemstones in production processes. This is particularly important as utilizing inappropriate methods can result gemstones which are likely to be considered fakes, resulting in zero market-value.

Ruby, the red gemstone, one of the best known gemstones to ordinary people, is the focus of this study. Previous studies involving rubies have shed light on ruby's characteristics and qualities, mining, cutting, or treatment procedure. However, the attitudes and acceptance of gemstone distributors towards different treatment procedures applied to ruby have not been examined. The types of treatment processes and their acceptable degrees in Thailand gemstone trading circle tend to be acknowledged in practice. Nevertheless, there is limited formal research and publications available to quantify these views.

The study aims to rectify this deficiency by clarifying how gemstone distributors react to the utilization of several treatment strategies involving rubies. The strategies and processes investigated include heat treatment, surface diffusion, surface repair, irradiation, and the use of dyes and oils. The knowledge and understanding acquired in this research assist in reducing the risk of mispurchasing confronting gemstone purchasers. In so doing, the study helps to broaden the extent of existing literature in relation to value adding of ruby production and, as a preliminary for relevant future studies involving other gemstones.

The study was conducted in Thailand, a world gemstone market place. Gem and jewelry industry is one of the top 10 export earners for Thailand. However, gem and jewelry export figures have diminished each consecutive year from 1996 to 1998 [3],[4]. The two most likely reasons are the Thailand and Asian economic crisis during that time [5] and the fluctuation in rough ruby supply both from local and foreign localities [6]. The latter issue arouses questions for this study. Given the gradually diminishing amount of rough rubies, how have gem manufacturers and distributors reacted to this situation? Some suggest that an alternative answer is to improve the quality of gemstones - rubies in the production processes [7],[8],[9]. Thus, two prime relevant constructs will be investigated here.

Value Adding—three main areas evidently emerge when considering definitions of value adding. Firstly, in monetary terms, it can be summarized as the difference between total revenue and the cost of purchase [9],[10]. Secondly, in marketing terms, the value can be added through several marketing strategies - promotion strategies, pricing strategies [11]. Thirdly, in operational terms, the value can be added through manufacturing process such as by transforming the rough gems [12],[13] improving or upgrading product value - features or qualities [11],[14]. Although some see value adding as the balance of those three perspectives, the study focuses on the operational terms, in other words, concentrates on enhancing the qualities of rubies by several value adding strategies in the production process.

In the production process the value is commonly added to rubies through three main processes - mining,
cutting, and treatments (enhancements). This study will focus on the methods or strategies of such the treatment process, consisting of heat treatment, surface diffusion, surface repair, irradiation, and dyes and oils [15],[16],[17].

Satisfaction toward the utilization of each ruby production strategy i.e., treatment strategies—Wood [10] suggests that value adding needs to be determined by the satisfaction of customers rather than manufacturers. In a similar vein, this study utilized gemstone distributors as a substitute of customers. The rationale is that, such gemstone distributors are more accustomed to these value adding strategies than customers, either in terms of production or distribution. Moreover, the gemstone distributors act as intermediaries to balance the satisfaction between manufacturers and customers.

Thus, the explicit hypotheses underlying two main questions are:

1) Are all value adding strategies of ruby production acceptable to gemstone distributors?
   
   H1: More than one strategy is acceptable to gemstone distributors.

2) Does each value adding strategy provide equal satisfaction levels to gemstone distributors?
   
   H2: The satisfaction levels of gemstone distributors toward five treatment strategies are not the same.

II. METHODOLOGY

A. Sample

Within the major constraints in relation to a very short time frame (i.e., 16 weeks), lack of budget allowances and unavailability of elements, this study is limited to population samples rather than census. The sampling units are selected based on recommendations of the experienced gemstone distributors who have traded in Thailand's gem trade circle for approximately 20 years (i.e., [18],[19],[20]). In other words, nonprobability sampling — judgment sampling [21] was employed. The two-stage sampling of this research is selected from the gemstone distributors who exhibit at Bangkok Gem & Jewelry Fair 2002. The 40 gemstone distributors, officers or managers of marketing or production department, are the sample units.

B. Data Collection

The data were gathered using a survey research using question-and-answer formats. The questionnaires were dropped with the respondents, gemstone distributors exhibiting at the Bangkok Gems and Jewelry Fair 2002 on the first day of the exhibition and collected on the last day of the exhibition. The uncompleted questionnaires were rectified by telephone and interview method. In sum, the data collection was completed within the end of March, 2002, that was, approximately 6 weeks period.

The questionnaire contains three parts — general information to obtain general knowledge in relation to ruby production, specific information to obtain attitudinal data, levels of satisfactions toward value adding treatment strategies, and company information to ensure the qualifications of the respondents. It contains 12 items within four-page length (A4 size) and takes only 10-15 minutes to complete. Most of the questions are close-ended type — dichotomous questions, multiple-choice questions and scaling questions [22].

C. Measurement

To seek statistically significant answers, each treatment strategy will be measured on the basis of several dimensions (quality attributes) of treated rubies — color, clarity, cost, permanence of outcomes, and market value [12],[16],[23],[24].

The five scale descriptors of Likert Scale and Semantic Differential Scale were utilised in this research. However, some open-ended questions were utilized to obtain the answers other than the predetermined choices and some explanations in relation to treatment strategies.

D. Pilot Study

A pilot study was conducted to test the acceptability of the questionnaire — words, phrases, instructions, question flow and other confusing with the 20% of sampling units (i.e., 8 gemstone distributors) by means of in-depth interview in Bangkok, Thailand at respondents' venues during 5-15 January, 2002.

E. Statistical Design

Based on the hypotheses of this study, the satisfaction level of gemstone distributors is stipulated dependent variable whereas the independent variable is five treatment strategies; and within the assumption that each respondent has been randomly exposed to each of the five strategies (from their experiences). Therefore, the One-Way Repeated Measures ANOVA [25] is used to determine any statistically significant difference amongst the satisfaction levels of gemstone distributors toward each treatment strategy (i.e., treatment condition). The existence of a treatment effect is determined by comparing mean scores measuring satisfaction toward each of the treatment condition [26]. The descriptive statistics is also utilized in analyzing the general and company information as well.

III. RESULTS

A. Analyses

With the well-designed procedure of data collection and some background relationship within the Thai gemstone industry, the corporation has been overwhelmingly succeeded. Completed questionnaires were received from all 40 respondents, that is, 100% of response rate was achieved.

The significant level = .05, that is, a 95% level of confidence is utilized as criterion value in this research. The central limit theorem (CLT) was adopted to rectify deficiency in relation to the distribution of some variables.
The alpha = .5107 of the reliability analysis using Cronbach’s statistic indicates that items contained in the questionnaire are statistically accepted, signified employing this questionnaire as data collection tool is moderately reasonable.

Hypothesis 1 was assessed using two-set of statistics. The first set aims to find out what are the acceptance levels for a number of treatment strategies by gemstone distributors using Npar and Friedman tests. The majority of responses (56.3%) have perceived heat treatment, 23.9% have perceived surface repair treatment, 8.5% have perceived surface diffusion treatment, and 2.8% have perceived irradiation treatment acceptable. Most importantly, in terms of the percentage of all cases, 100% of them have perceived heat treatment followed by surface repair treatment (42%) acceptable. Table I reports the p-value (.000) < .05 obtained from Friedman rank test suggests that those five means (i.e., ranks) are significantly different. The results suggest that the value adding methods other than cutting and polishing, heat treatment was the most frequently perceived value adding ranked first with a mean of 4.61, followed by surface repair treatment with a mean of 3.17, surface diffusion treatment and dyes and oils with a mean of 2.49, and irradiation with a mean of 2.24 respectively. Such the findings simultaneously reveal implications of value adding methods in ruby production.

<table>
<thead>
<tr>
<th>Treatment Methods</th>
<th>Mean</th>
<th>Rank</th>
<th>Friedman Test</th>
</tr>
</thead>
<tbody>
<tr>
<td>Heat treatment</td>
<td>4.61</td>
<td>N = 40, df = 4</td>
<td></td>
</tr>
<tr>
<td>Surface repair</td>
<td>3.17</td>
<td>Chi-Square = 98.639</td>
<td></td>
</tr>
<tr>
<td>Surface diffusion</td>
<td>2.49</td>
<td>Asymp. Sig. = .000</td>
<td></td>
</tr>
<tr>
<td>Dyeing &amp; oiling</td>
<td>2.49</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Irradiation</td>
<td>2.24</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The second set aims to test the number of acceptable treatment strategies using one sample T-test. The data derived from summation of the number of treatment methods perceived by respondents. The Sig.(2-tailed) = .000 < .05 in Table II suggests more than one strategy (i.e., treatment method) is significantly acceptable to gemstone distributors at the mean = 1.78 (i.e., 2 treatment methods). Therefore, the hypothesis 1 is supported.

Hypothesis 2 was tested using the repeated-measures ANOVA. The respondents were asked to rate their attitudes toward five treatment strategies based on a set of attributes (i.e., color, clarity, cutting, permanence, origin) from 1: being Strongly Dissatisfied to 5: being Strongly Satisfied. In Table III, the result from Tests of Between-Subjects Effects, Sig. (p-value) = .000 < .05 indicates the average of the means of the populations represented by all five treatment strategies are not equal to zero. Such result allowed us to proceed on the Mauchly’s Test of Sphericity. The result, Sig. (p-value) = .477 > .05 suggests a univariate test of the data is appropriate for the one-way repeated measures ANOVA rather than a multivariate F test. The result of univariate test, Sig. (p-value) = .000 < .05 reveals that the means of the populations represented by five conditions (treatment strategies) are significantly different. Therefore, these findings support the hypothesis 2 of the study, that is, the satisfaction level of gemstone distributors toward five treatment strategies are not the same.

The additional Paired Samples Test of ten possible comparisons of five conditions (treatments) was performed to test which treatment differs significantly from one another. To rectify the problem arising as the probability of making an alpha error (i.e., Type I error), additive across all ten possible comparisons, the criterion alpha level .05 is divided by the number of possible comparisons (i.e., 10), resulting in a new criterion value of α = .005 (α = .05 ÷ 10). Subsequently, One-tailed t tests were then utilized to make decision against the hypothesis, which states that the means of each comparison are equal. The results of such ten comparisons reveal:

1) Gemstone distributors are significantly more satisfied with the heat treatment (mean = 19.62) than with surface repair treatment (mean = 14.87) at the Sig. (p-value) = .000 < .005; than with surface diffusion treatment (mean = 13.33) at the Sig. (p-value) = .000 < .005; than with dyes and oils treatment (mean = 13.31) at the Sig. (p-value) = .000 < .005; than with irradiation treatment (mean = 11.44) at the Sig. (p-value) = .000 < .005.

2) Gemstone distributors are significantly more satisfied with surface diffusion treatment (mean = 13.33) than with irradiation treatment (mean = 11.44) at the Sig. (p-value) = .0035 (Sig. = .007 < 2) < .005.

3) Gemstone distributors are significantly more satisfied with surface repair treatment (mean = 14.87) than with irradiation treatment (mean = 11.44) at the Sig. (p-value) = .000 < .005.

4) None of the statistical differences exist between the level of satisfaction expressed by the respondents towards surface diffusion treatment (mean = 13.33) and surface repair treatment (mean = 14.87) at the Sig. (p-value) = .039 (Sig. = .078 < 2) > .005; between the level of satisfaction expressed by the respondents towards surface diffusion treatment (mean = 13.33) and dye and oil treatment (mean = 13.31) at the Sig. (p-value) = .4245 (Sig. = .499 < 2) > .005; between the level of satisfaction expressed by the respondents towards surface repair treatment (mean = 14.87) and dye and oil treatment (mean = 13.31) at the Sig. (p-value) = .0125 (Sig. = .025 < 2) > .005.; and between the level of satisfaction expressed by the respondents towards irradiation treatment (mean = 11.44) and dye and oil treatment (mean = 13.31) at the Sig. (p-value) = .009 (Sig. = .018 < 2) > .005.
were also provided. With regard to the value adding, the
4.62) respectively, in determination of the qualities of rubies. The p-value (.000) < .05 obtained from Friedman rank test suggests that the mean of these six attributes are significantly different. Furthermore, the majority of respondents considered those six attributes (i.e., color, clarity, cutting, carat weight, price, and origin) are sufficient to determine the quality of rubies. In dyad of satisfaction, the Sig. (p-value) = .000 < .05 from Friedman rank test suggests heat treatment is the most likely strategy to satisfy customers (mean = 1.08) followed by surface repair treatment (mean = 2.58), surface diffusion treatment (mean = 3.21), dye and oil treatment (mean = 3.86), and irradiation treatment (mean = 4.28) respectively.

The assumption adopted in this study, that gemstone distributors should be experienced in selling treated rubies is met as only 5% of respondents have never sold treated rubies, that is, the majority of respondents (95%) have done so. Moreover, the majority of gemstone distributors (60%) simultaneously operate as manufacturers and distributors. This supplementary experience in manufacturing helps to strengthen the results of this research.

Although the majority of respondents (87.5%) were categorized into the small and medium enterprises (SMEs) [27], employing less than 50 employees and holding capital investment of less than 20 million Baht (i.e. approximately AUD$830,000) rather than the large and public companies, the industry experiences of the respondents should help rectify this dependency as 65% of respondents have been operating in the industry for more than 11 years.

IV. DISCUSSION

The administration of current research is limited by several constraints, influencing the generalization of the results to larger target population (i.e., gemstone distributors). Firstly, this study was conducted within a small sample size (i.e., 40 gemstone distributors). Secondly, it is relatively difficult to conduct a real experiment where these five treatment strategies would be systematically exposed to each gemstone distributors as gemstone trading circle is quite closed to outsiders and such treatment processes have been kept secret [18],[19],[20].

Therefore, the sampling units of this research are selected based on recommendations of the practitioners, experienced gemstone distributors who have traded in Thailand’s gemstone trading circle for approximately 20 years. This resulted in the adoption of judgmental sampling rather than probability sampling. Subsequently, incorporated inherent sampling bias has lead to a failure to achieve some of the considerations for conducting quantitative research in which some variables did not form a normal distribution. However, the central limit theorem (CLT) was adopted to rectify such deficiency.

Many implications of relevant parties have been emerged. In light of manufacturers, the level of satisfaction expressed by gemstone distributors toward the
five treatment strategies might be counted as an alternative guideline of the most appropriate approaches to increase value adding to ruby production in addition to normal cutting and polishing. Rubies treated by the more accepted strategies (e.g., heat treatment) could be sold to gemstone distributors at the higher price than the less accepted strategies (e.g., surface diffusion). Such results simultaneously imply the satisfaction of their customers with these treatments. The finding supports the use of gemstone distributors as a substitution of customers because they act as intermediaries to balance the satisfaction between manufacturers and customers.

For the implications of purchasers (e.g., gemstone brokers, companies, end-users) of rubies, the results can help to bolster ruby purchasers' knowledge and understanding of ruby production processes, especially the treatment strategies deemed acceptable for the enhancement of the quality of rubies. In reality, rubies treated by the less acceptable methods are likely to obtain lower market prices in gemstone trading circle. In the worst scenarios, rubies treated by either the least acceptable or unacceptable treatment methods may be mistaken as fakes, resulting in zero market price. Therefore, the knowledge and understanding acquired from this research may help reduce the risk of mispurchasing.

There are implications in terms of academy and industry. The attitudes of gemstone distributors, levels of satisfactions, toward several treatment strategies manufacturers utilized to rubies, have been rarely published. This study will help to broaden the extent of existing literature in relation to such questions. It also serves as a preliminary for future studies such as re-examinations of the current research with the larger numbers of the Thai Gem and Jewelry Traders Association’s members, examinations of the new constructs, risk perception and trust, of gemstone selling using the Internet channel.

V. CONCLUSION

The findings of this study help to clarify gemstone distributor’s attitudes towards the value adding strategies utilized in production process aimed to improving the quality of rubies. Applying appropriate treatment strategies to natural rubies can increase the perceived value of the product down the supply chain. It is also evident that the gemstone distributors are not equally satisfied with each of the treatment strategies, that is, variation exists in terms of applications and acceptability of various treatments. Overall, the findings of this study reflect the common practices in industry in relation to treatment strategies utilized with ruby.

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