A Scientific Study of Gulabi Meenakari: Handicraft from Banaras District

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Abstract. The city of Banaras located in the eastern part of state called Uttar Pradesh has several handcrafts being practiced since time immemorial. The region of eastern Uttar Pradesh has more than 22 handicrafts being practiced at present. One such hand craft is gulabi meenakari which is an art of creating surface ornamentation by using vitreous glass enamels on the surface of silver metal. In order to create designs according to latest market tendencies; technical understanding of the craft's raw materials is very much desired. Therefore, a scientific enquiry has been carried out on enamel colors, metal behavior etc. While innovations of surface ornamentations; experiments were carried out by altering purity of silver, its dimensions (length, width and height) and gauge, manner of color applications etc. by vitreous enamels. These innovative effects were used to design two set of table top accessories for corporate gifting and usage. Later these accessories were shown to set of consumers, retailers including artisans pertaining to gulabi meenakari in the district of Banaras. 76 % consumers reported visual appeal as appropriate for corporate usage. 83 % of the retailers found product prices appropriate. The craft of gulabi meenakari has enormous potential to set latest fashion trends.

Keywords: Artisan communities, Banaras, Craft clusters, Craftsmanship, Gulabi meenakari, Silver metal, Vitreous enamels.

Introduction

City of Banaras, Varanasi or Kashi located eastern Uttar Pradesh region, India has several clusters practicing handicraft since ages. Specially city of Banaras, several recent official excavations witnessed evidences of craft practices even older than 3500 years. Many of the crafts being practiced at present are also protected under geographical indication (GI) registry. Gulabi meenakari is one of the Geographical Indication(GI) registered craft from Banaras. City has thousands of years of history for practicing crafts based in several a material which were supposedly sustainable and eco-friendly. Artisans of this craft create surface ornamentation on the surface of silver, gold and copper metals. The craft has metals with specific purity and set of vitreous glass enamels and vitrified milled enamels used for ornamentation. They prepare jewelry, show pieces etc. A group of artisans of gulabi meenakari migrated to the city of Banaras around 17th century. They almost settled here and kept on practicing the craft which they were also working on at Delhi royal courts before their migration at Banaras. Meenakari is practiced in various parts of the world as well as Indian subcontinent. They differ in style and techniques. But as the name suggests meenakari at Banaras is identified by the colour "Gulabi" strokes hence gulabi meenakari has color "pink" used as predominant color. Its GI logo is also in "Gulabi" i.e. pink color. The craft got it GI Certification in the year 2015.

Review of literature

Ancient history and popular centers of meenakari

Various historians discovered through museums, archaeological studies, and books etc. that Indian subcontinent had numerous centers of meenakari handi craft but they differed in type of colors used, styles, methods and procedures. Some places having meenakari clusters are Kangra, Pratapgarh, Lucknow, Rampur, Rajputana (Bikaner, Udiapur, Jaipur), Kutch, Kashmir and Hyderabad. Centuries ago City of Delhi also had clusters of meenakari but exists no more. It appears most of artisans migrated from there to several other places including Banaras [1].

It was discovered by a research scholar that handicraft of meenakari existed during Indus valley civilization period [2].

Moreover, it was observed during research on Indian sub-continent that since the Vedic period, India has tremendously rich history of handicrafts including metal-smiths and engravers who not only practiced various handcrafts but also made abundant amount of contribution to the socio economic life of the country those times. It seems that the craftsmen were financially thriving and products made by them were consumed by all the classes of society and were meant for both decoration and utility [3].

Present-day the artisans of gulabi meenakari from Banaras district use silver, gold and copper metals and meena and powdered painting colors (varied type of enamels). But these days' silver metal is more popular amongst artisans due to cost factor etc. The metals and process of meenakari is eco-friendly and sustainable. In order to come with new product designs scientific approach to all raw material study is very much desired. Therefore, literature available on silver metal and enamel colors have been researched and studied in detail.

Scientific study of raw materials used for Gulabi meenakari

A study on" Silver: A powerful weapon against microbes" Made by Kent Nielsen has evidently demonstrated and verified that disinfectant and health properties of silver metal makes it effective to prevent growth and reproduction of bacteria and viruses and therefore can fight against 650 diseases [4].
Moreover, in Indian subcontinent, culture of feeding newborn child with silver bowl and spoon and gifting other silver ornaments is a prevalent practice. This was due to its attributes of killing micro-organisms in the surroundings. It has been observed that from the latest fashion trend study by a trend agency WGSN (worth global style network); that consumers post Covid-19 times are concerned for material's having natural hygiene and cleanliness properties. Therefore, it can be said that use of silver by craftsmen in jewelries, lifestyle products makes it more relevant especially in Covid-19 epidemic times. Even more all meena and painting colors applied onto silver base can be completely removed by the process of leaching by using solution of HCL (hydrochloric acid) and same piece of silver can be used to create new design altogether which makes it reusable and environment friendly and sustainable according to mega fashion trend of sustainability.

Another study titled" Durability of vitreous enamel coatings and their resistance to abrasion, chemicals, and corrosion: a review "made by Stefano Rossi, Francesca Russo & Massimo Calovi have very well described in a graphic representation which says that coatings of vitreous enamels applied makes it corrosion and weather resistant besides its aesthetic appearance [5]. Below figure 1 is a graphic representation of vitreous enamel properties. Such enamel coatings are used by craftsmen of gulabi meenakari.

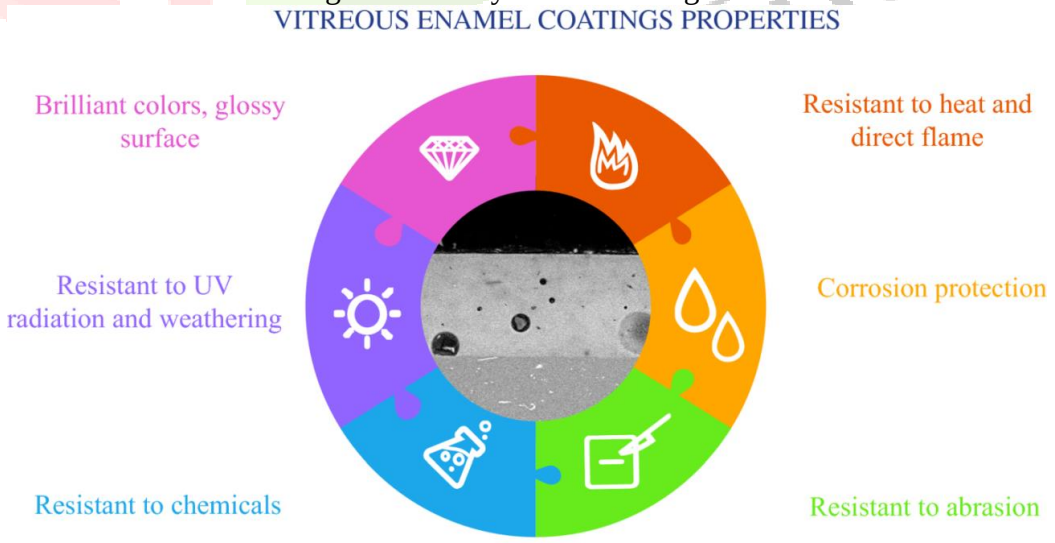


Fig. 1: Graphic representation of Vitreous enamel coating properties [6].

The Collins English Dictionary defines enamel as "a colored glassy substance, transparent or opaque, fused to the surface of articles made of metal, glass etc. for ornament or protection." Vitreous enamel is specifically on a metal base. It is thus defined as a vitreous, glass-like coating fused on to a metallic base. In American English it is usually called as Porcelain Enamel. Real vitreous enamels used for gulabi meenakari contain heat resistance, color stability and hardness.

The enamels here in gulabi meenakari are Vitreous enamels which are very different in terms of material science and behavior and the method of preparation. Vitreous enamels for meenakari applications stated here are inorganic materials and almost insoluble in water. It seems many of these enamels are amorphous in nature and give definite color tones when fired in a furnace on temperature reaching between 650°°C to 1000° °C approximately depending on its composition. Amorphous solids due to its irregular geometry do not have precise melting point, in between form semi liquid state and therefore can be blown and molded in many possible shapes [7].

Francesca Casadio, Anikó Bezur, et al have made an exhaustive scientific study about Colorant related elements from the periodic table used in the making of colored enamels. For example, Cobalt (Co) gives tones of blue, Iron (Fe) gives tone of green and yellow, Copper gives tones of red and brown Calcium gives white tone etc [8].

Application of these Powder form enamels are done by dusting (cover lightly with a powdered substance) in case of meenakari. The final glassy finish of this vitreous enamel is produced by firing in furnaces at temperatures up to approximately 1000 °C. During the process of cooling, enamel fuses and metal surface gets glass-coated. The "firing" or heating process in a furnace gives vitreous enamel its final visual appearance and color tone.

Traditional color palette and techniques

As can be seen from the images below, artisan communities of the craft make jewelry and show pieces inspired from Indian life events. Inspirations for form, shape, and surface motifs are deeply rooted in Indian culture such as peacock, elephant, Ganesha, lotus, parrot and several others. One may clearly notice the significance of flora and foliage, animals, birds etc. depicted on the products. Their goods are suitable for personal use, corporate gift, home décor, wedding, and several other life events. Study on traditional products and surface decorations has been done as shown in the figures 2 , 3, 4, 5, 6 below.

Traditional products of Gulabi meenakari. Figures Left to right:

Fig. 2. Ambari Haathi.

Fig. 3. women forehead bindi (dot) made in gold metal and painting color.

Traditional motif and style of brush strokes images: all made using silver metal. Figures left to right:

Fig. 4. Part of peacock feather made by complete fill of meena color.

Fig. 5. Stylized Floral motif with leaf and foliage made in meena color fill.

Fig. 6. Part of pendant depicting stylized swan with lotus flower made in painting color shade and strokes.

Source: Fig. 2, 3, 4, 5, 6: Workshop Kunj Bihari Singh.

Some of the existing vitreous glass enamel Colors used by meenakari artisans

All translucent (*khula* meena in Hindi) and Opaque *(Bandh* meena in Hindi) color enamels are applied on silver metal with a purity of 99.99%. All meena colors are Vitreous glass enamels as shown in figures 7 and 8. These glassy enamels have varied levels of opacity: transparent, translucent and opaque. These are glassy materials having Si(Silica) as base material which are originated from quartz in the earth layers.

Five color tones of painting color which are vitrifiable milled enamels which are found in extremely fine powder form. To apply these paint colors; silver metal must be coated with layers of white or some other meena as base as depicted in figure 9. For gulabi meenakari at Banaras, to apply painting artisans usually coat with white meena as pink or "gulabi" strokes come out better on the same.

Here color tone is referred as pure Hue. One may vary value of both meena and paintings colors and achieve more color tones by applying multiple layers on top of silver metal. Here Value is referred as degree of lightness and darkness of one specific color. Besides these there are separate meena colors for gold and copper metals.

Figures left to right:

Fig. 7: Translucent meena color tones

Fig. 8: Opaque meena color tones

Fig. 9: Painting color tones

Source: Fig. 7, 8, 9: Workshop Kunj Bihari Singh.

In order to realize product, artisans use numerous hand and electric operated tools such as Silver sheet, silver wire rolling machine, Hand-drive sheet rolling mill, electric engraving machine, tools for engraving and buffing, handmade furnace or kiln, balance to weight silver, gold etc; **Mortar and Pestle** to grind the vitreous glass into a fine paste or powder, hand painting brush in several sizes used to apply meena and painting colors. In addition to these there are hundreds of other electric and hand operated machines, hand tools and devices to achieve effective designs.

Methodology: Action research

The research objective was to make changes in existing product design (as 1st variable) and thereafter observe its market acceptability and henceforth monetary gain (2nd variable) to the artisan.

In order to meet research objective, action research with case study method was used. Such research designs are also known as applied research and are largely for problem solving. The main purpose of this type of research is to investigate the causes of a problem, assess the importance and provide an action plan to solve the difficulty. In this research design, the emphasis is on solving difficulties through adoption of alternative practices suggested by a research study. Action research method is most suitable for pilot testing.

Expert sampling procedure was used to identify a relevant and competent unit for the case study. Relevant ministry officials, local and Indian jewelry brand heads all from Banaras district; Award considerations, infrastructure availability and history of family practicing craft etc. were considered in order to select the artisans' unit for case study.

Place of study and selection of the case study

City of Banaras has quite a few micro, medium and small size units producing and selling gulabi meenakari products. Some of these cater to local and domestic clients and some export to various countries. The select family of artisan Shree Kunj Bihari Singh is the only artisan unit having authorized user number as craft practitioner mentioned on http://www.ipindia.nic.in and is National award winner in the year 2015 by Development Commissioner Handicrafts, Ministry of Textiles. The artisan family belongs to district Banaras, Tehsil Sadar, Lal ghat locality. This artisans' family have history of practicing gulabi meenakari since 17th century, earlier at Delhi royal courts, and later migrated to Banaras around 100 years back. In addition to family of Kunj Bihari Singh, roughly 50 more families are practicing gulabi meenakari at the district. In order to conduct the actions involved; a "Micro" size unit "Kunj Bihari Singh" named after artisan and registered under Udyogadhaar, Ministry of Micro Small Medium enterprise (MSME) was finalized.

The study intends to create contemporary product range which is likely to be in line with new tendencies as reported by world's leading forecast agencies, brands, magazines etc. such as WGSN(Worth global style network), Magzter as well as various local social tendencies observed at Banaras. These most conversant design details are likely to be projected to create a product identity based on local and native craft techniques and aesthetics which may prove a trend setter in its own right. It is expected that the outcome of freshly created designs and lifestyle products are likely to find new set of buyers for the artisans.

Scientific study and trial of samples:

In order to finalize on set of table top accessories, several scientific experiments were conducted to achieve visually appealing products. These products could be utilized for corporate gift, souvenir etc. and were prepared in line with autumn and winter seasons 2021-22 for fashion consumer trends.

Study and experimentation here is limited to application of meena and paint colors on silver metal with a purity of 99.99%. Traditionally craft involves fallowing main raw materials and two main categories of enamels which are vitreous glass enamels (meena colors) and Vitrifiable milled enamels (found as fine powder). Besides the surface ornamentation, Application of these enamels also provides with the protective coating which prevents surface from corrosion, scratch, oxidation etc.

To get the final color of the enamels, kiln or furnaces as shown below fig.10 are used. Firing or heating is done from few seconds to minutes, not longer than that. As the furnace used by artisan in the select case is handmade, it can't record exact temperatures but artisan has fairly good idea of temperature to be achieved. Temperature inside the kiln may be between 300-1000°C approximately which varies color to color and type and gauge of base metal used. During heating process oxygen gets mixed with flammable glassy vitreous enamel which forms semisolid formations on the surface. Sometimes it has to be heated multiple times layer after layer in order to get desired aesthetic finish. Enamels are fired in the order of hardness, so artisans apply enamels beginning with those most capable of resisting fire; usually white is applied first fallowed by pink, green, and blue and so on.

Fig.10: Handmade furnace at artisan workshop to fire meenakari products

Table 1
List of raw materials used for experimentation

Gulabi meenakari : Handicraft of Banaras	
S.No.	List of raw materials and their scientific details
1	• **Silver metal:** ○ Symbol-Ag ○ Atomic Number 47 ○ Density of pure metal: 10.49 ○ Melting point silver pure 960.5°C ○ Annealing temperature silver pure 300°C ○ Silver sheet gauge: ranges between 18-32 ○ Desired Purity of silver metal for meenakari application: 99.99%
2	• Vitreous glass enamels (meena colors)
3	• Vitrifiable milled enamels(found as fine powder)
Source for melting point, annealing temperature [9]	

Annealing temperature of metals is also dependent on factors such as gauge of metal sheet, its purity, and number of pieces used on a surface, whether silver pieces are assembled or non-assembled etc. Smaller is the gauge number of silver thicker it is. After hand grinding of the enamels in the glass like pieces, they are applied on the surface of silver metal. Silver metal has a very ductile behavior therefore could be easily hammered into desired form and shape hence requires less effort compared to gold and copper metals and therefore is most popular metal these days amongst gulabi meenakari artisans.

Experiments were carried out to create textures other than traditional ones by changing manner of color strokes, differ in color combinations and its proportions, motif, changing silver sheet gauge and dimensions. Below is the list of experiments done by the researcher. Trial of visual textures has been made with meena and painting enamel colors. All experiments are done with base metal as silver of 99.99 % purity.

Table 2
Experiment No 1: Ombre dye effect

Silver base size	**:** L 32mm X W 32mm (millimeters)
Silver gauge	**:** 28.
Meena colors used	**:** Dark blue, light blue, translucent white.

Brush sizes used for meenakari: 000, 0000.
Final observations : Silver sheets with small dimensions look visually Appealing compared to bigger sheet sizes.

Table 3
Experiment No 2: Making Variations in silver sheet gauge

Silver base size : 292 mm x 178 mm
Left figure silver sheet gauge : 32
Right figure silver sheet gauge : 22
No of paint colors : Blue, green
Painting brush sizes : 000, 00000

Final observations : While firing both sheet and meena layer become wavy and look untidy, therefore suitable sheet gauge and number of meena layers has to be used on the basis of product design and size.

Table 4
Experiment No 3: Mixing and blending two or more enamel paint colors

Silver base diameter : 32mm
Silver gauge :28
Paint colors used : Blue, green, pink
Painting brush size : 00000
Final observations : Colors can not to be mixed in the manner of basic color wheel theory. After firing no sharp lines of color strokes were achieved.

After these trials, latest fashion trends were also referred to finalize the set of designs. While studying indian cultural references and latest fashion forecast; it was found that parrots were the most popular figuerine in India since ancient times as seen in vedas, puranas, and several art forms and handicrafts as well. Parrots are considered auspicious and supposed to bring good fortune. More over india also has very rich history of precious and semi precious stone jewlleries made in geometric cuts. Study of trend forecast also emphasized on preservation, reviving handcrafts, heirloom elements, raw and organic materials, trans seasonal appeal to products, geometric cuts and most important silver metal as most popular metal replacing gold. Therefore these features were incarporated while designing products. Lately one central theme as "Preserve India" and two sub-themes namely "Parrot in the garden" as presented in figures 11 and 12, " Geometronomy" as presented in figures 13 and 14 were used to design two set of table top accessories consisting of pen stand, paper weight, institution or organisation flag stand and pair of paper pins. These accessories could be utilised for personal usage or carporate gifting.

Product design with Central theme as " Preserve India"; Sub theme: "Parrot in the garden".
Figures left to right:
Fig. 11: Paper weight, Height 3.5 Cm, Maximum width: 6 Cm.
Fig. 12: Pen stand, Maximum height 11.5 Cm, Maximum width 7 Cm.

Product design with Central theme as " Preserve India"; Sub theme as " Geometronomy".
Figures left to right:
Fig. 13: Pair of paper pin, Total height of pin including Pin head 5.5 Cm.
Fig. 14: Flag base: 18 Cm X 15 Cm, flag height 18.5 Cm.
All measurements in centimeter(Cm).

All the products displayed here in Figure 11, 12, 13, 14 are handcrafted by artisan Kunj Bihari Singh.

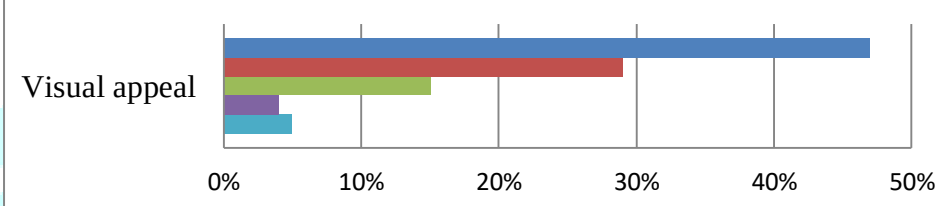
Product acceptance and salability

In order to validate the research objective, two set of respondents were considered. The first set of respondents were group of 100 probable consumers comprising of international and domestic tourists, NRIs

(Nonresident Indians), well-travelled Business communities, bureaucrats, "A" Grade central government officials etc. Second set of respondents were group of 60 retailers, artisans those selling direct, souvenir shop owners at hi-end hotels, traders etc. All respondents reflected here were contacted at Banaras district. These respondents were presented newly designed 10 products in person and then asked to answer set of questions asked.

When respondents were asked about products' features such as visual sensory appeal 47% found the same as "excellent" and 29% as very good. Here it may be inferred that total 76% respondents found product designs appealing enough to consume it.

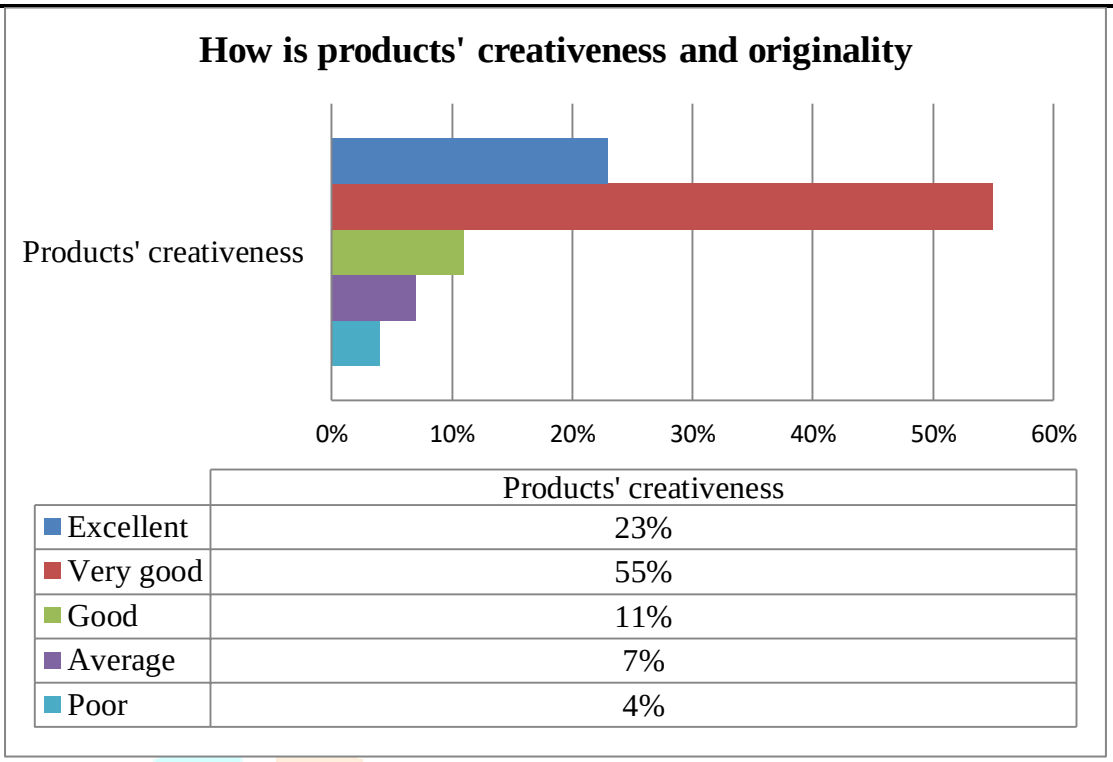
Table 5
Consumers' responses towards sensory appeal of the products



	Visual appeal
Excellent	47%
Very good	29%
Good	15%
Average	4%
Poor	5%

Similarly, when asked about Products' creativity; 23% respondents found as "excellent" and 55% as "Very good"; together total of 78% Respondents found designs creative and original.

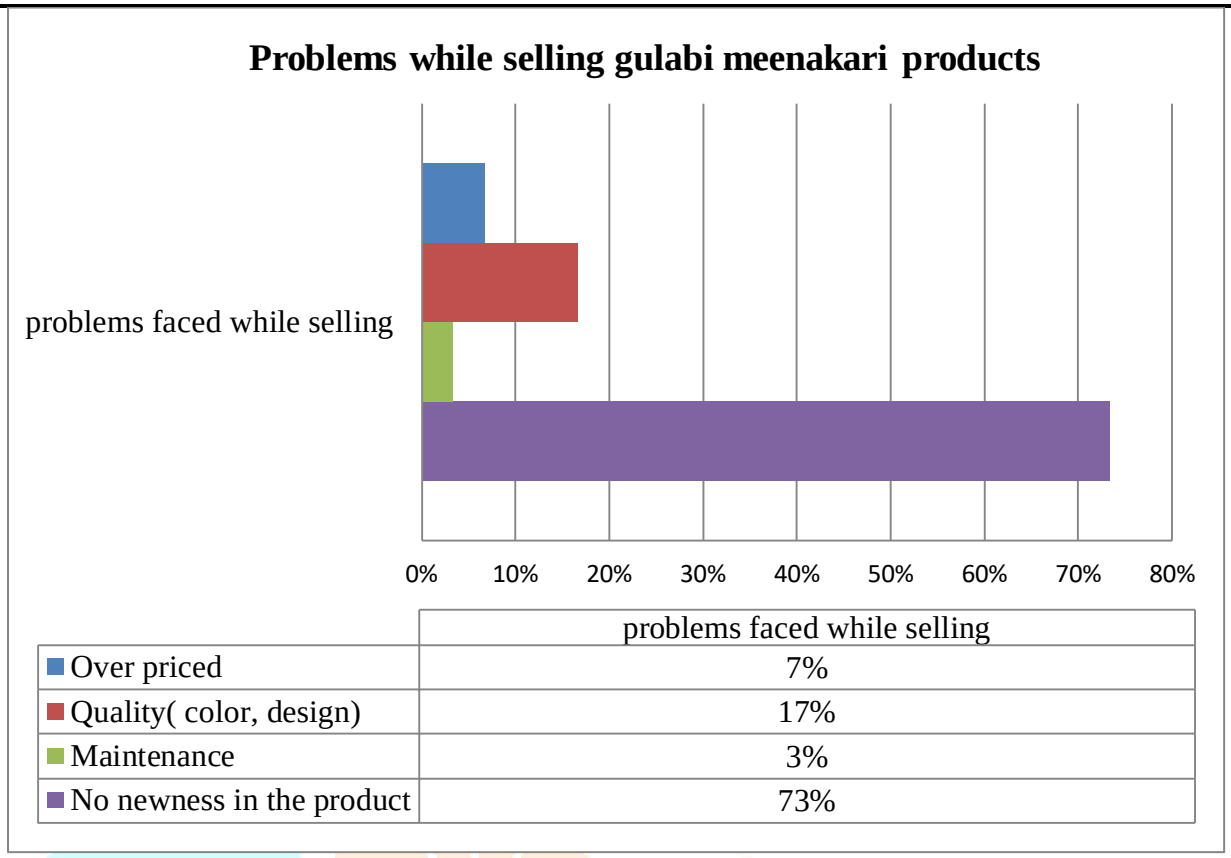
Table 6
Consumers' responses towards product originality



	Products' creativeness
Excellent	23%
Very good	55%
Good	11%
Average	7%
Poor	4%

When second set of respondents were asked about if there are any problems or concerns selling gulabi meenakari products.

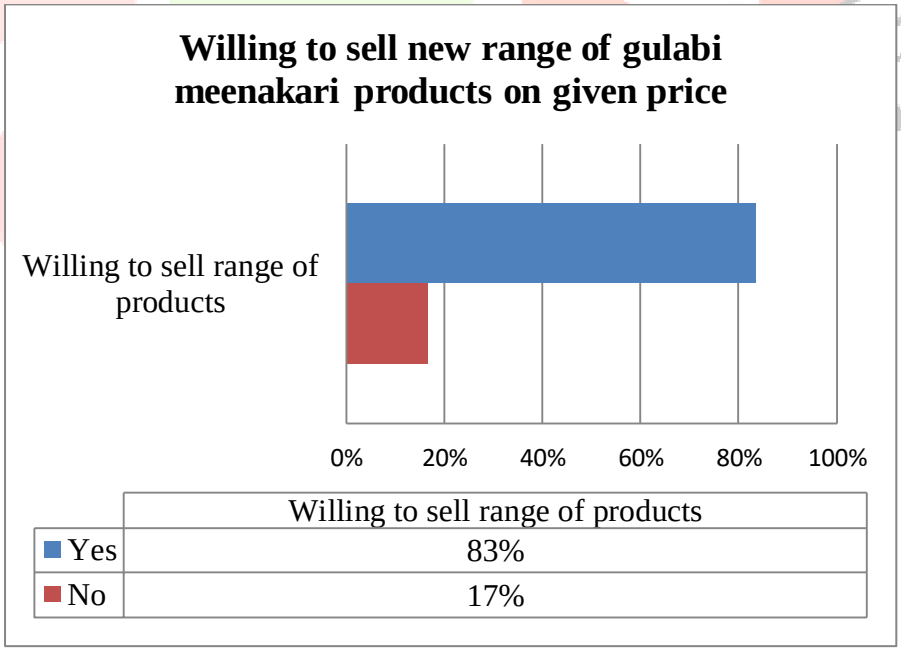
Table 7
Merchants' responses towards challenges faced while product sale



	problems faced while selling
Over priced	7%
Quality(color, design)	17%
Maintenance	3%
No newness in the product	73%

When second set of respondents were asked whether they are willing to sell the given gulabi meenakari products at given prices.

Table 8
Merchants' responses towards new products' prices



	Willing to sell range of products
Yes	83%
No	17%

When second set of respondents as traders and wholesellers were asked whether they were willing to sell products on the given prices; 83% agreed and the rest were reluctant to take the risk with new products.

Research Findings

It was observed during entire learning on case study unit and experimentations that artisans of gulabi meenakari have set of world class skills. They are very much capable of creating new type of form and textures. The type and number of enamel colors they use are available in limited tones; therefore, there is a need to conduct scientific study and develop more number of enamel colors. For this an appropriate innovation partner probably from metallurgical study is required to carry out research and development (R & D) and come up with more number of tones of vitreous enamels which are suitable for metals used in gulabi meenakari handicraft. Lately these newly developed vitreous enamel colors could be tested in artisans' workshops for its visual aesthetic appeal.

Accurate firing temperature records have to be maintained in relation to metal gauge and firing temperatures of meena and paint colors. For this digital furnace could be utilized.

Similar experiments as shown in table 2, 3, 4 could be performed on gold and copper metals as well which are also used in gulabi meenakari handcraft.

While making of totally new designs, one has to make a careful consideration towards appropriate selection of dimension and gauge of silver sheet, number of meena layers to be applied, accurate firing temperature of each color and mixing and blending of two meena and paint colors etc. to get the visually aesthetic results. Trials of prototype is must before proceeding with the final designs.

Since significant percentage of consumers and sellers preferred the products appearance and prices; therefore, one may conclude that there is a greater possibility of selling the pieces in larger quantity. More over there is a possibility of exploring many other artistic color effects to achieve different type of visual effects to create craft based fashion consumer trends.

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