



The Criteria of Islamic Geometric Patterns Design for the Contemporary Jewellery Making Process

Zainudin Siran^(✉) and Alaa Al-Khulaqi^(✉)

Centre for Immersive Digital Applications and Contents (CISDAC), Faculty of Creative
Multimedia, Multimedia University, 63100 Cyberjaya, Malaysia
zainudin.siran@mmu.edu.my, alaaalkhulaqi@gmail.com

Abstract. There is a scarcity of research carried out on jewellery with Islamic Geometric Patterns (IGPs) designs and their making processes, even though these patterns are widely used and researched in architecture. Recent research is limited in the jewellery making methods, lacks validated qualitative data, and lacks quantitative data. IGPs consist of a specific structure, processes, and philosophy. Since the Umayyad caliphate till the present day, IGPs' application is focused on architecture and interior decoration, featuring traditional symmetrical, colourful, and intricate designs. Despite the potential market of two billion Muslims worldwide, the use of IGPs in jewellery products is less explored. In the recent scenario, the making process of jewellery products comprises of modern machinery and traditional manual processes which produce different outcomes in quality and value. Furthermore, the success of a design-based business relies on the involvement in new product development (NPD) to produce a marketable product. Hence, this paper discusses IGPs, particularly on the characteristic of the motifs, criteria and requirements for product development, the scenario of issues, and the making process for jewellery. Comparative research was conducted on three previous scholarly papers that study IGPs to design jewellery. The research outcome will enhance the understanding of the specific methods currently practiced in the making process, as well as determine the areas that need to be explored for future research. It will aid in improving the IGPs design concept for jewellery product development.

Keywords: Islamic Geometric Patterns (IGPs) · Islamic Art · Jewellery Design · New Product Development (NPD)

1 Introduction

Islamic art is rich with messages, towards eliciting the power of God, besides representing Islamic theology [1]. The application of design motif elements into art or design is tied up with strict rules which includes prohibiting the use of life figures and permitting the use of floral elements, geometrical elements, and calligraphy [2]. One of the most common Islamic art motifs approached in design is the Islamic Geometric Patterns (IGPs). For

long decades, IGPs ornaments are widely used in architecture and interior decoration such as mosaics [2]. Despite that, recent research on its application in jewellery making is limited in processes, lacks validated qualitative data, and lacks quantitative data. The character of IGPs consist of symmetrical shapes formerly used to decorate various parts of buildings with Islamic concepts, including ceilings, walls, domes, minarets, jointing etcetera [3]. However, this pattern lacks application in modern or contemporary jewellery products. Furthermore, IGPs evolved by designers of various ethnicities through a long period of time. As the second-largest religion of 2 billion Muslims, this opens a huge potential market for business to be explored [4]. In this context, what are the appropriate specific criteria of IGPs for jewellery design to result in marketable products, fulfilling the consumer's taste, and complying with Islamic contents? For this reason, a comparative study was conducted to highlight some major techniques used for making jewellery with IGPs for the purpose of new product development (NPD). In this paper, we set out to showcase varying viewpoints about the application of Islamic Geometric Patterns in contemporary jewellery. The aim of this study is to highlight the difficulties present with using IGPs in making jewellery and the existing techniques available to overcome these challenges.

2 Literature Review

2.1 Islamic Geometric Patterns

According to [5], Islamic art is the expression of a culture that is extremely entangled with religious, legal, and theological beliefs. It is a means of embracing and celebrating ideologies that embody the Islamic communities. Islamic art intends to be a representation or a manifestation of the sacred; it pushes the viewer to use their imagination to understand the meaning of the artwork [1]. Illustrating these subjects did not come from a need to express oneself, but rather to honour the nature of its meaning [6]. According to [7], Islamic art consists of calligraphy, geometric patterns, and floral designs, and these three primary ornamental arts were historically developed in increasing refinement and complexity. Geometric patterns have existed long before Islam; however, in the Islamic age they became the centrepiece of an artwork instead of solely being a decorative element [8]. IGPs emerge from an initial shape that then forms a geometric system, and Islamic artists build this system using three different grids, and they are:

- The square grid: consists of a square repeat unit and the root 2 proportion system. This grid can be used for Kufic calligraphy.
- The triangular grid: consists of a triangular repeat unit.
- The hexagonal grid: consists of a hexagonal repeat unit with the root three proportion systems.

Islamic ornaments adhere to triadic qualities as a governing mechanism for the aesthetic expression of diverse and varying Muslim cultures, and yet they are identifiably Islamic [7]. Another fundamental method practiced in creating IGPs is using circles and straight edges that then can create different shapes of equal sizes [9] as seen in Fig. 1. It applies a geometric division of the plane, following clear mathematical laws, requiring

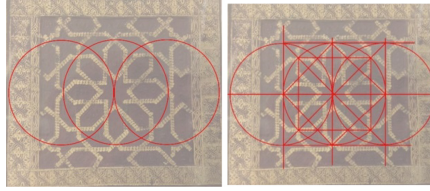


Fig. 1. Constructing a Rosette using circles and straight edges.



Fig. 2. Metal jewellery with IGPs influence [8].

only simple tool such as a ruler and a compass to construct the ornaments [2]. During the sixteenth and seventeenth centuries, Islamic geometric patterns experienced a decline in use as more floral ornamentation became preferred. The push for this shift in aesthetic is unclear how it happened. [7] speculates that the decline in IGPs materialized due to IGPs being reliant on specific methodologies and polygonal techniques to construct, and with the patronage shifting in taste, masters of this art found less work and fewer apprentices to pass on their knowledge.

As Arabs entered Egypt, they were introduced to exquisite jewellery that were made by Coptic artisans who then influenced Islamic jewellery heavily in its early development stages [8]. The early Ottoman preserved the use of geometric patterns inherited from the Seljuks though in a less grand scale [7]. By the end of the fifteenth century, the application of IGPs have been utilised to a lesser extent, to be replaced with a more floral motif (arabesque) [7]. This floral motif was incorporated into jewellery, textiles, leatherwork, stained glass, woodwork... etcetera [7].

Figure 2 features a gold bracelet that goes back to the first half of the 11th century.

2.2 Jewellery Making

Historically, jewellery referred to ornaments worn on the head and now it refers to accessories on any body part such as earrings, pins, pendants, bracelets, and others. Jewellery appeared as an instinctive physiological necessity “to beautify the body” [10]. The materials used to make jewellery underwent a series of evolution, beginning with stones, bones, and feathers in primitive societies to then shifting to metals and precious stones. The value of traditional jewellery came from the characteristic of the material, different to the contemporary jewellery which the value comes from the design concept or style [10], which is subjective among different consumers [11]. Modern jewellery is combining meanings, semantics, and technologies invented over the years [11]. While the non-traditional materials used in contemporary jewellery refers to:



Fig. 3. A 15th century brass box with silver and niello, perhaps from Egypt [13].

- Synthetic and inorganic materials that was manmade due to technological advancements.
- Alternative organic materials such as plant petals and shells.

Integrating such unconventional materials in jewellery making, opens opportunities for designers to enhance their creativity to explore new forms [11]. Nevertheless, the specific target user's taste and characteristics need to be clarified with precise concepts definition when designing the jewellery. In the context of the traditional making process, it consists of various techniques from the beginning till the finished product.

(i) Niello techniques: a black metallic alloy of sulphur with copper, lead, or silver [12]. The alloy is used to fill the engraved pattern on the surface of more precious metals such as silver. According to [8], the process begins with hammering the surface with a metal punch vertically, repeated a few times at an angle. The niello is then hammered onto the engraving of the ornament to prevent it from being raised (Fig. 3). (ii) Hand forging: is the modelling of forms on the surface of metal sheets, and it is done through hammering the metal on a surface that can hold against hits [14]. A block of Elmwood is fit for hammering metals for embossing or rising.

[14] added, to raise the design on a metal sheet it needs to be heated and then set while hot on a block of wood. Then, it can be hammered while it is hot, forming the desired shape. Modelling hammers come in various sizes, and the ball and peen of the hammer should be smooth, or the result will be rough. (iii) Hacksaw: or a jewellery saw is used to cut thin metals (aluminium, steel, brass...etcetera) and plastics (ABS, PVC, PEX...etcetera) and it is unsuitable to cut stones or wood [15]. This saw allows metalsmiths to cut holes in metal with extreme precision and detail [8]. (iv) Enamelling: This 13th century BC invention from Cyprus is one of the methods used in adding colour to metals [16]. Enamel is a colourful glass-like material that is fused to metal, and it was historically first applied onto gold, then silver, copper, bronze, and further on [16]. It's made from a mixture of materials to create different colours: lead, sodium bicarbonate, flint, potassium, and boric acid [8]. The process is through grounding the materials, mixing it by hand at a melting temperature, and then pouring it into water [17]. Various metals can be fused with enamel onto them using heat, except for nickel, brass, or zinc [17].

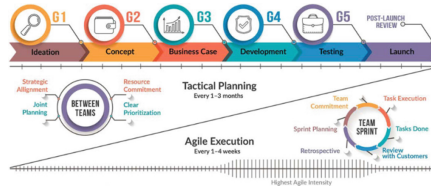


Fig. 4. The Agile-Stage-Gate hybrid model for NPD from [21].

2.3 New Product Development

The survival of a business can be supported by its venture into new product development (NPD) research in design which focuses on user needs and serves the business commitments [18];[19]. [20] underlined that successful NPD processes are firmly linked with the company's strategic development, and researchers demand for flexible, new, and iterative approaches to NPD instead of the sequential and linear approaches. For this reason, they insisted on the Agile-Stage-Gate hybrid model (Fig. 4), combining both the agile and the stage-gate aspects, where companies such as LEGO, Tetra Pak, Honeywell, and Danfoss have implemented in their NPD process [21]. Through it, the project management process becomes more agile by replacing planning, milestones, and Gantt charts with agile tools. Each stage has a sprint process of two to four weeks in real-time, rapid progress, constant yet cumulative production of designs and prototypes with instant consumer feedback [21]. Several capabilities are:

- Design agility increments.
- Enhanced focus on projects: better time management and task prioritisation.
- Expanded communication and productivity amid team members.
- Elevated the team's spirit.

Through restructuring the NPD process toward meeting the technology and market needs, businesses are resistant to unstable situations and manage to overcome the rapid technological changes [20]; [25].

While in the context of jewellery businesses, there is a need to remodel the NPD process method, so that new designs can excel in the competitive market, improve functionality, and become technology-driven [26]; [27]. Moreover, businesses that are strongly connected with the market and respond quickly are observed to perform better as they can spot trends and customer needs [20]; [22]. Jewellery businesses will need to adapt new systems and embrace new concepts to produce new-to-the-world products.

3 Discussion (Case Example)

Three previous research papers focusing on designing and producing jewellery with IGPS were reviewed and compared to understand the specific issue of design and product making processes, challenges, solutions, and the fundamental issues as shown in Table 1. [6] studied the structure and criteria of IGPs for jewellery design based on the literature references and observations method. For the design and product making process, they

Table 1. Comparison of different methods used to make IGPs jewellery.

[6]	
Design & making process	Computer-aided design (CAD). Laser cutter machine.
Challenges	Costly, suitable for a company with a machinery facility.
Solutions	Produces the exact design. Saves time.
Fundamental issues	Identifying the specific criteria for designing through ‘Personal Observation’ for the IGPs analysis.
[8]	
Design & making process	Handcraft (Sawing, hand-forging, welding, carving & Nielloing).
Challenges	Relies on the metal smith’s skills. Time-intensive, consists of various steps.
Solutions	Cheaper, does not require costly machinery.
Fundamental issues	Limited of the IGPs design sources, from the Prophet’s Holy Mosque only.
[9]	
Design & making process	Handcraft (methods/tools were not clarified). Material: ceramics
Challenges	Relies on the artisan’s skills.
Solutions	Cheaper, does not require costly machinery.
Fundamental issues	The research doesn’t clarify the methods used to create the jewellery.

utilized computer-aided design (CAD) to enhance the quality of design and to aid in the making process, adjustment, analysis, and optimization. The 3D drawings were illustrated in SolidWorks, then prepared for the machine for the model making process. They used white and yellow plated copper and pearls to make the jewellery products. The challenge with the product making process is the setup cost to facilitate such machinery features.

The fundamental issues highlighted in this paper aims to enhance the quality of the design, and to aid in the making process, adjustment, analysis, and optimization of jewellery with IGPs concept (Fig. 5).

The data on IGPs was collected through the ‘Personal Observation’ method on existing IGPs applications from different categories of media. As a result, the data findings are rough, subjective, simple and have some inaccuracies (Table 2). For example, the application of ‘architecture’ is described as only in ‘construction’ when painted tiles and painted walls are also part of the application of IGPs. As well as furniture described as only printed, when the application of IGPs is also through construction, such as wood carving. Moreover, books or the Quran is a missing category, which are ornamented with IGPs and common in the 21st century (Fig. 6). In this context the ‘personal observation’ method provides unstructured data that is broad and subjective, depending on individual interpretation, understanding and perception of ‘the language of design’ [18]; [28].

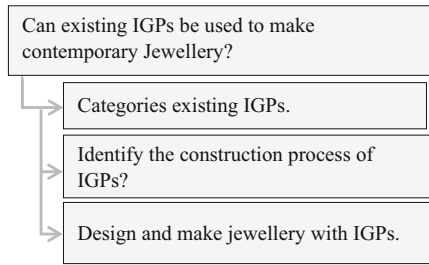






Fig. 5. The summary of research process [6]

Table 2. The data [6] collected from the personal observation method.

No.	Product	Description	Pattern	Technical	Material
1		Architecture	Structure	Construction	Stone
2		Furniture design	Surface	Printed	Wood
3		Product design	Surface	Drawing	Ceramic
4		Jewellery product	Surface	Inlay	Metal

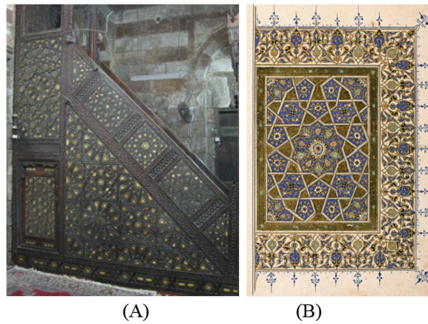


Fig. 6. (A) image of Mamluk minbar at the Amir Azbak al-Yusufi complex in Cairo, Egypt [7], (B) image of Mamluk Quran design created from fivefold system [7].

As an alternative, an interview is an appropriate method to provide such concrete and rational qualitative data required for specifying the scope and criteria of IGPs. The criteria of respondents from the professional level of expertise in Islamic art will accommodate valid and credible statements. This study has low internal validity in its means of data collection, and it would've had benefited from data validation to strengthen the validity of the data and the conclusions reached [19]. The author concluded that with digital design and machinery it results in accurate models, possible for reproduction and accuracy. However, the accuracy was not measured. In this context, the conclusion is valid for the testing stage only.

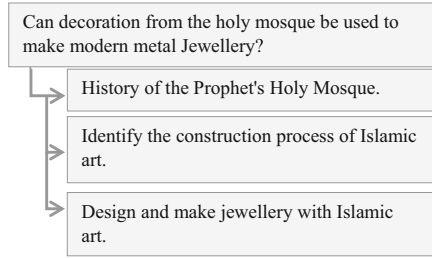


Fig. 7. The summary of research process from [8]

Table 3. Summary of [8] case studies.

Case	Process	Material
1	Sawing & carving	Red copper
2	Sawing, hand-forging, welding & Nielloing	Red & yellow copper
3	Sawing, carving & welding	Red & yellow copper
4	Sawing, carving & welding	Red & yellow copper

While for the second case example of research from [8] used a manual handcraft method to make the jewellery instead of a machinery process resulting in the process being low cost but instead time-consuming due to the several steps required. The results are also inconsistent since it depends on the skills of the handcrafters. The research framework is like [6] but the design pattern inspiration was limited to ornamentation at the Prophet’s Holy Mosque only (Fig. 7). This study experiments in designing and making modern jewellery inspired by the decoration of the Prophet’s Holy Mosque. It aims to introduce the history of the Prophet’s Holy Mosque, discuss the evolution of Islamic art, and to highlight its beauty and worth.

A total of four experiments were conducted that took motifs from the mosque and then innovated them for jewellery products. Table 3 summarises the different processes and materials used. Unfortunately, the research does not clarify the difficulties or the pros of the methods. Despite having created multiple jewellery pieces with IGPs successfully, the results cannot be used to debunk the research finding from [6] which insisted on the need for machinery to achieve the accuracy for IGPs jewellery. Nevertheless, both scholars agreed that IGPs can be used to create marketable modern jewellery.

The third case example of research from [9] did not use metals for its materials instead used ceramics. The research framework (Fig. 8) follows a similar structure as [6] and [8]. This study experiments in designing and making modern jewellery using ceramics. It aims to link between civilisations by using IGPs for modern jewellery, highlight the aesthetics of IGPs, and to provide design solutions for IGPs.

The researcher provided eight different concepts of how IGPs can be incorporated into modern ceramic jewellery. Unfortunately, the research does not delve into the making process, but only showcases prototypes of the concepts. Proposal 1, 2, 4, & 7 applies

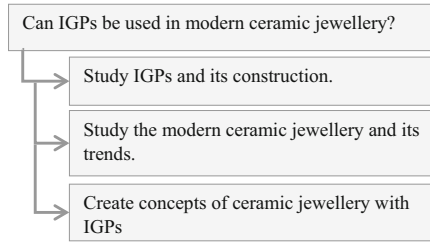


Fig. 8. The summary of research process from [9].



Fig. 9. Concept proposal 2 and 5 of ceramic jewellery designs with IGPs motif [9].

IGPs as they are into jewellery. Proposal 3, 5, 6, & 8 are abstract designs that modernise IGPs. [9] noted that IGPs share characteristics that keep up with modern fashion trends like geometrical lines and shapes and minimalism, making IGPs a suitable motif to incorporate into modern ceramic jewellery (Fig. 9).

4 Recommendations

There is a scarcity of research carried out on jewellery design and the making processes with IGPs concept, even though these patterns are widely used and researched in architecture design. Recent research is limited in the jewellery making methods, lacks validated qualitative data, and lacks quantitative data. In fact, encouraging the use of IGPs for jewellery needs knowledge expansion from all contexts that benefit to NPD process, which influences business survival, aligns with trends changes, and meets customers' demand [20]; [22]. [23] states that emerging economies will encounter challenging hurdles due to the speedy changes in the market. Hence, the jewellery industry critically needs to explore new concepts, invest in NPD activity, and embrace new technologies and innovative ideas. Future researchers should be more proactive in exploring different jewellery making processes and delve into new technologies, such as rapid prototyping. As well as in the context of colouring; explore adding colour to the prototypes, and this can be done using enamelling for metal jewellery or resin and paint for unconventional jewellery (Fig. 10).

[8] recommend for future research to be a comparative study between traditional making processes and new technological processes. Moreover, they recommend studying the technical side of jewellery making, to discover unconventional uses for metal

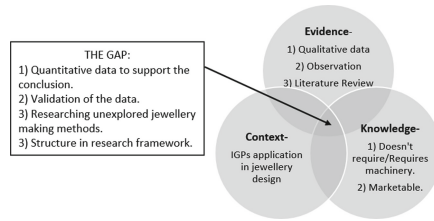


Fig. 10. The research gap to explore for future researchers

jewellery. [6] suggest that IGPs are not only suitable for making jewellery, but they can be used to ornament an array of household items.

5 Conclusion

In this paper, we conclude that IGPs are complex and require symmetry and accuracy in design since it is constructed through geometry. Historically, different methods existed to composite IGPs, and each method produces different results. Constructing jewellery with IGPs demands experienced artisans that can recreate the same design or the aid of machinery to ensure accuracy. The three papers discussed reached the same conclusion, that it is possible to create modern jewellery with IGPs that is also marketable. They differ in that [6] stated that it is needed to use machinery to achieve the accuracy needed for IGPs jewellery, while [8] was able to successfully produce four different designs using handcrafting methods only, and [9] used ceramics instead of metals. The research gap found is in the lack of quantitative data (time, cost, and accuracy etcetera), the lack of data validation, and limited in the jewellery making methods.

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