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RESEARCH ARTICLE

Art and technology interactions in Islamic and Christian context: Historical approach to architectural globalization

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Abstract
Efficient interaction between art and technology enabled Islamic architecture to actively experience early globalization, but today's separation between these domains and technological hegemony have presented challenges to Islamic architecture. Accordingly, this research was aimed at illuminating art and technology interactions in Islamic architecture during early globalization when it flourished along with Christian architecture. To this end, logical reasoning and qualitative data analysis were performed in parallel on 12 chains of mostly worship-oriented artworks, such as mosques and churches. The results indicated that art and technology interactions in Islamic and Christian architecture were underlain by the same nature and sequential pattern of beginning from primitive technology and ending with innovative technology (art). The cultural and technological value of these architectural styles eventually crossed geographical boundaries. Therefore, the beneficial interactions between art and technology enabled Islamic and Christian architecture to participate in globalization through the conveyance of their value to other regions even as differences existed in the measures implemented for such transmission.

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1. Introduction

Despite the widespread and complexity of the globalization phenomenon in the present era, some sociologists believe in the historical origins of this phenomenon. Based on a

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categorization, globalization is divided into four periods: ancient globalization, initial globalization, modern globalization and the globalization of communications (Mc Clure, 2016). Ancient globalization refers to the period of the emergence of main religions, such as Islam and Christianity (Luke, 2010). Ancient globalization refers to a multipolar global phenomenon through inter-regional and even intercontinental small scale communications formed by rulers, traders and pilgrims, with each group pursuing political, economic and religious goals, respectively (Encyclopedia of Global Studies, 2012). One of the characteristics of ancient globalization is the constructive interaction between art and technology which has entailed the dominance of technology in late globalization as well as threats referred to by philosophers such as Nasr and Heidegger. Despite the importance of the historic roots of globalization considered by skeptical theorists, quantitative research in this field, namely its religious aspect and its relation with architecture is scarce.

Current studies on ancient globalization, especially its religious identity have drawn less attention from Western Europe (Castells, 2006); but the Islamic world has examined potential approaches and solutions for globalization as well as the formation of specific hypotheses regarding the globalization phenomenon (Fazeli, 2006). Given the challenge of confronting globalization for areas with an ancient cultural background, such as Muslim communities, the importance of learning from globalization in the past is of particular importance in terms of cultural and technological aspects. The lack of detailed studies and structured assessment methods for the interpretation of ancient globalization in relation to religious architecture in eastern and western studies has provided the grounds for writing this paper(Sassen, 2003; Nasr et al., 2009).

According to hyperglobalist views, today, paying attention to the issue of globalization is a vital, especially in the Eastern bloc due to the threat of Western cultural dominance. Such importance is further intensified due to the dominance of technology and the abatement of religion, spirituality and art as well as the danger of loss of religious and cultural identity for the Eastern bloc. According to skeptics, the globalization phenomenon is not a new concept and its history and eras are conceivable. According to some scholars such as Hopkins (2002) and Bayly (2004), the emergence of religions such as Islam and Christianity is a type of ancient globalization and their difference with late globalization is their attention to art in serving religion whilst being in equilibrium to science and technology. This paper aims to analyze the ancient globalization model from the perspective of religious architecture based on the optimistic views of transformationalists. According to the views of transformationalists, globalization has reengineered local power, and it seems that identifying signs of successful ancient globalization in the Islamic religion and its comparison with a similar religion, namely in terms of art and technology interactions, paves the way for such powers to face the pervasive contemporary globalization phenomenon with more potency.

Therefore, the second part of this paper assesses the relationship between architecture and globalization in cultural and technological aspects. In the third section, ancient globalization of Islamic and Christian architecture is discussed with respect to interactions between art and technology. In the fourth section, the research methodology is dedicated to data collection and coding methods for globalization signs, which include the four phases of identification of studies, extraction of globalization signs, assessment of interactions between technology and art within such signs and a comparative analysis between Islamic and Christian architectural contexts. In the fifth section, the findings and discussions of the research analysis on the axes of globalization and interactions between technology and art are used to identify the hidden pattern between these axes as well as to compare the similarities and differences of the identified patterns in the aforementioned domains.

1.1. The relationship between architecture and globalization based on cultural and technological dimensions

There is a two-way relationship between what is deemed architecture and the vast scope of social, political, and economic changes under the subset of globalization. Adam (2008) states in reference to the relationship between architecture with globalization: Architecture is a natural reflection of what is occurring in various contexts in society. Although architecture has an insignificant role in human life, it brings together everything that is important to a community. Therefore, architecture can be a mirror for society and society can, it turn, be a mirror for architecture. Thus, globalization, as an influential phenomenon on all aspects of societies' life is directly involved in the architecture of nations. On the other hand, one way of linking these two (architecture and globalization) is in regard to the globalization aspect. As presented in Figure 1, globalization involves various dimensions, i.e. political, economic, social and cultural. Architecture is more relevant to two globalization dimensions, as a combination of art and technology.

There are different approaches concerning the origin and history of globalization. In one of these approaches, globalization is considered as a series of periods or historical waves, each course covering a certain level of human communications and exchange. The cultural and technological dimensions of globalization have experienced profound developments in each of these periods. From a cultural dimension, zeitgeist is the essence of architecture and movement through zeitgeist provides the means of the fourth dimension of time. Zeitgeist and time were location dependent in the past but late globalization is responsible for changing the order of traditional time and zeitgeist

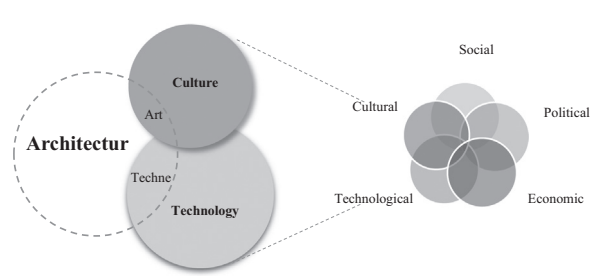

Figure 1 Dimensions of globalization in relation to art-technology interactions.

(Giddens, 1994) whilst in pre-modern societies, zeitgeist and time were linked by location. In the stages prior to the transformation of nationalism into dominant discourse, the dominant pattern of social zeitgeist order was a local pattern and all relations, interactions and social institutions originated from location dependent local social zeitgeist (Hall, 1995). Therefore, culture and identity are closely associated with homeland and in spite of foreign cultures and organizations such as the world's main religions and great empires, humans generally gain their identity from the history and culture of their homeland. The process of globalization has transformed this state of affairs and culture, as the most important and rich source of identity has lost its power in traditionally creating identity (Ghol Mohammadi, 2007).

From a technological aspect, Heidegger explains in the "Question from Technology" paper with the help of Aristotle and Plato's ideas that technology originates from the Greek work "techne" which is accurately linked to find arts (posis) and knowledge (episteme) (Dias, 2003). Techne is a fundamental method of revealing the truth, a definition that represents the role of mediating technology that distinguishes it from art (Parry, 2014); the definition of mediation is similar to a sense emanated by the "bring forth" expression (Christians, 2011). There is a contradictory concept of technology in relation to art in the eastern perspective. According to Islamic philosophy, technique (technology) and art are the same originating from the Farsi word "San" (San'a in Arabic and industry in English) and belongs to any of God's creations as a "great industrialist" (al-sana'a) which is implemented by humans as rulers on earth (Nasr, 2012; Nasr et al., 2009; Bakar, 1999). Despite this difference of perspectives by Heidegger and Nasr, both experts confirmed globalization against technology (Ramos, 2003). Both were aware of the negative impacts of modern technology which results from its superiority over humanity in multiple aspects and its inability to reveal or "bring forth" the posis (art) idea (Joronen, 2008). Modern technology has also reduced the connection between humans and the production process (Nasr et al., 2009). The serious consequences of modern technology may be appeased if a human is allowed to create artistic works that modifies vapid content resulting from technology. Considering the remarkable dominance of technology and its disconnection from art amidst the late globalization era (Asefi, 2012), the recent challenges facing architecture, namely traditional architecture confirms that scholars and experts should reinterpret traditional art and technology previously supported by ancient globalization.

1.2. Archaic globalization in Islamic and Christian architecture through technology-art interactions

In regard to ancient globalization between the years 500–1500 CE, dominant tendencies were of significant spiritual backing due to the advent of Islam (Singer et al., 1954), such that there were no differences between science, art and technology and all had a single meaning (Ranney, 2007). In the field of artistic productions, there was a continuous chain that ended in God; during this period, there was talk of holy science that revealed the inner world and art was a suitable platform to spread spirituality and the transfer of knowledge (Asefi and Salkhi Khasraghi, 2017). Moreover, architectural technologies were not separated from other leading technologies such as building dams, routes and irrigation networks etc. whilst taking its values from the religion of Islam in complete harmony with the aforementioned technologies (Hill and Al-Hassan, 1992). For example, various branches of Islamic art such as architecture, gilding, pottery, and metal industries were created as a result from the strong link between knowledge, technology and art with the goal of linking buildings and objects across the world (Grube and Michell, 1995).

In prevalent religions before Islam (such as Christianity), the connection between art and technology was used to represent the glory of God and the kings as representatives of God on earth (Barber, 2010). The two factors of art and technology were increasingly integrated because religious and political rulers were required to meet both the physical and spiritual needs of their societies (Elbelkasy and Mohammed, 2016). On the other hand, according to the Christian worldview based on Aristotle's Greek philosophy, art and technology, alongside science were a method of discovering the truth: episteme (theoretical knowledge), praxis (distinct from theory; techne, a means of practical knowledge) and poiesis (production or art). According to Aristotle, "Praxis and poiesis are closely linked and their composition is intended" (Ranney, 2007).

However, the integration of faith and technology shows the capability of religions, such as the transformation of cultural values (Whiting, 2011). This unity represents the significant differences in various religious communities. An example of such difference is evident in Christian context where technology was used to describe the domain of "useful art" originating from science whereas in the Islamic domain, technology is characterized by a mental model based on moderation that leads to the unification of all forms of art without the presentation of a useful or useless classification (Bakar, 2016; Bruce, 2006). In terms of similarity, both the context of Islam and Christianity praise the importance of "holy art" (Nasr, 2006; Schuurman, 2011)and the necessity of "decisive factors" for the technological realm whilst both agree to the statement "we all love creation for the sake of the creator" (Foltz et al., 2003). Further research is required to address the gap in explaining ancient globalization in both Islamic and Christian context, especially from an architectural perspective. It is evident that focusing on the interaction between art and technology and its relevance to ancient globalization is a favorable basis for filling this research gap.

2. Methodology

In this research, a three stage methodology based on the qualitative method of systematic literature review is used to extract the signs of ancient globalization pertaining to Islamic and Christian architecture. This is a standard method to combine the findings from numerous studies on similar topics. Furthermore, a systematic review presents reasoned answers containing useful information in regard to the research question (Boland et al., 2017). The three research stages are: 1) definition of the question (how have Islamic and Christian architecture experienced ancient

globalization?); 2) identification and evaluation of accessible documents (extract signs of globalization from documents); and 3) combining the findings and extracting related results (assessing the interactions between technology and art from the extracted signs).

2.1. Selection of studies related to early globalization

Original source books on Islamic and Christian architecture from the archive library of Tabriz Islamic Art University were reviewed, after which data (i.e., codes) were collected on the basis of the following criteria: (1) The codes should provide information covering specific historical eras, that is, the Abbasid, Seljuk, Mongol, and Safavid eras (600–1700 AC) for Islamic architecture and the Early Christian, Byzantium, Romanesque, and Gothic eras (300–1400 AC) for Christian architecture. Such codes were chosen to represent the aspect of universalism in archaic globalization and focus as much as possible on art–technology definitions, relationships, classifications, and differentiations as exemplified in structural or ornamental architectural elements; (2) The codes should, as broadly as possible, cover the cultural and technological dimensions of globalization in temporal and spatial domains through a specific consideration of religious functions, for which information is more accessible than that on other uses (Islamic: towers, mosques, and tombs; Christian: churches, monasteries and chapels); (3) Both holistic and atomistic approaches from orientalists and Western scholars were selected to cover aspects of globalization not only in a particular historical period but also across different epochs; and (4) The codes should reflect cultural and technological exchange, aside from effects, either with respect to art–technology interactions or globalization themes.

2.2. Selection of globalization codes

The codes derived from the studies, wherein technology or art terms and the effects of these disciplines on other regions were mentioned, were organized in tables and evaluated on the basis of reference type (e.g., included all eras in analysis, focused on one special era, considered the relationship between eras). The data were pre-coded by classifying each code as art (cover layer, i.e., decoration) or technology (structural layer). Post-coding was implemented on the globalization dimensions (i.e., cultural and technological) extracted from the studies and the researchers' opinions and logical reasoning based on evidence. The codes were investigated in line with the progression of artworks from a simple technique to a masterpiece and how they were temporally and spatially incorporated in archaic globalization. Because the terms "art," "technology," and "globalization" have many interpretations, these terms were defined in accordance with the aims of this research. Correspondingly, technology refers to the science and technique (know-how) that underlie building construction. It has a source of origin and gradually develops and differs from land to land in terms of types of material, structure, or process of construction. From the perspective espoused in this work, technologies can be divided into two classes, namely, structural and cover technologies. Art pertains to a building technology that demonstrates and flourishes beyond functional requirements and is characterized by innovative, complicated, and stylish features. In other words, art is the rise of a single technology, regardless of origin from a foreign land, not only achieving a new regional identity but also affecting other lands because of its development and extension. Globalization is an indication of a process wherein art (rich technology) constitutes a standard everywhere over a long period of time because of inspiration from and prevalence in other lands. Given its inherent capabilities, such artistic nature can transcend the geographical boundaries of its native land and become accepted by other nations.

2.3. Analysis of art and technology interactions

Interactions linked to art and technology were organized as the holistic or atomistic perspectives of referenced authors and analyzed in relation to the researchers' ideas about the union, separation, or procedural clustering of art and technology, the various naming and classification systems ascribed to these disciplines, and their coverage of globalization dimensions. Procedural clustering was prioritized in the analysis because of its higher relevance compared with the other indications. With respect to art and technology interactions, therefore, the post-coded items reflect four phases: proto technology, developed technology, art (innovated technology), and influential art. Post-coding was then applied to the connections between the interactions and the different phases of archaic globalization. Specifically, an origin code indicates an art/technology source, common place signifies that art/technology became popular around its region of origin, perfection indicates whether art/technology transformed from its simple form into a masterpiece or was repeated as a standard pattern, and prevalence pertains to the influence of art/technology on other worlds. For the classifications in terms of globalization dimensions, logical reasoning of valid evidence was conducted separately for the Islamic and Christian contexts. The meanings of the classes of art and technology and, if possible, the evidence behind their connections to the globalization dimension were described.

2.4. Comparative analysis of Islamic and Christian architecture

The Islamic and Christian codes were compared in terms of their similarities and differences in art–technology interactions during archaic globalization. First, the comparison focused on the following aspects: classifications of art and technology, interactions between art and technology, and different phases of archaic globalization. Second, 12 sample artistic/technological works were compared, and their archaic globalization post-coding patterns were presented according to origin, common place, perfection, and prevalence. Among these samples, two were selected each from Islamic and Christian architecture for a comprehensive analysis of how a technology transforms into an artform and then exerts a global impact.

3. Results and discussion

3.1. Examination of chosen studies

A total of seven studies were selected (four Islamic and three Christian) (see Table 1). Some of the studies focused on art and architectural features in a specific historical period and descriptions of certain remarkable buildings. The others inquired into all golden periods, beginning from the advent of Islam/Christianity to their eras of glory, and the linkage between various styles and their differences and similarities. A few of the chosen studies highlighted the concepts and causes/effects of successful religious architecture in relation to the exchange of cultural and technological values.

3.2. Trends of art-technology interactions in the Islamic and Christian architecture studies

The analysis of the selected resources, which explained universal thoughts regarding Islamic and Christian architecture, revealed three main perspectives regarding art and technology interactions (see Figure 2). The first is an atomic point of view regarding art and technology, wherein each of the disciplines is allocated a special role in a building. For example, art functions as a decoration, and technology functions as a structure. The second perspective highlights the union of art and technology at the conceptual level, with one of them regarded as more important than the other. In Islamic architecture, for instance, priority is accorded to art because of its nearly non-Islamic technological roots. The final perspective, which seems more thoughtful and realistic than the first two, offers a place for either art or technology in a temporal spectrum so that progression begins from a simple technique based on knowledge (literally means technology or know-how, including physical matters) and ends with a final or perfect position (called art or masterpiece, including both physical and spiritual aspects). In such development, functional goals probably transform or are incorporated into cover goals or vice versa. The conclusion section presents a correlative analysis of the scope of archaic globalization dimensions in Islamic and Christian architecture on the basis of the three perspectives.

3.3. Axis one: indications of archaic globalization in the studies

From a religious point of view, universalism (subjective and objective) has been tackled in three major disputes. The first declares the ruling political power as a representative of God on earth in Islam or the coexistence of monarchy with religion in Christianity. The second is related to the immigration of courts and artists and creation in other lands (aside from pilgrimage and the exchange of commodities) in Islam and the implementation of the same patterns and principles by artists who were the church's servants in Christianity. The third revolves around the continuity of the traditions of early

Table 1 List of analyzed Islamic and Christian architecture studies.

context	Type of studies	Reference and author	Aim and focus
Islamic	Included all eras (holistic)	1. Islamic art and architecture, 650–1250 (Ettinghausen et al., 2003)	Presented unifying elements among the Ummah of Islam in terms of Islamic art and architecture
Islamic		2. Art ancient Middle East (Allam, 1988)	Provided an overview of different Islamic styles in art and architecture
Islamic		3. Architecture of the Islamic world: Its history and social meaning (Grube and Michell, 1995)	Focused on the pre-Islamic origin of most of the techniques in Islamic architecture and pointed out the central role of decorating
Islamic	Focused on one special era (atomistic)	4. The art and architecture of Islam 1250–1800 (Blair et al., 1994)	Examine the features of Islamic Ilkhanid and Timurid era through case studies
Christian		5. Art of the Byzantine era (Rice, 1962)	Highlighted the characteristics of the Byzantine era as an entry to Gothic and Renaissance art
Christian	Considered the relationship between eras (holistic and atomistic, i.e., hybrid)	6. Western architecture (roots and concepts) (Banimasoud, 2010)	Discussed the very early origin of Western architecture, including early Christian, Byzantine, and medieval eras from Mesopotamia up to postmodern times
Christian		7. History of art (the Middle Ages) (Crandell, 1991)	Discussed the evolutionary chain of artworks in Romanesque and Gothic periods

Figure 2 Three views on art and technology interactions (separation, unity, and procedural clustering).

epochs and their evolution and development in both Islam and Christianity. In the first and third contexts, globalization aspects are strongly connected to technological and political developments, whereas the second context—the most important one—is related to the considerable influence of religion and its principles on society. These debates are further explained in Part d.

3.4. Analysis of indications in Islamic and Christian architecture

With reference to religion as the driving force in the development and blossoming of Islamic and Christian art and architecture, almost all the reviewed studies pointed to the universality of archaic globalization dimensions, such as the political, economic, and social. Hence, the treatment of globalization indications in Islamic and Christian architecture was classified into three categories: the consideration of all eras in general (geopolitical), the focus on one special era (socioreligious), and the consideration of the relationship between eras (technocultural) in direct association with three globalization dimensions. The first category of studies emphasized the integration of geopolitical aims with religious ones. The union between Islamic kingship and religion was reflected mainly in capital cities, which were assumed to be the cultural and symbolic center for the demonstration of the glory of the current monarch (Ettinghausen et al., 2003). The Islamic empire adopted architecture as a tool that represents the power of the nominated caliph; it therefore summoned artists and artisans from distant areas to set up metropolitan planning as splendidly and as gloriously as possible (Blair et al., 1994). Such linkage between power and faith was also apparent in Christian architecture, as evidenced by Emperor Constantine's exploitation of all resources to promote faith in Christ. Later, Justinian, similar to his predecessor, was concerned about the coexistence between crown power and church leadership (immortal monarch supported by the immortal divine); such concern was mirrored in art and architecture through the application of majestic materials, symbolic iconography, and magnificent structures (Banimasoud, 2010). In addition, clerics, aristocrats, merchants, and artists competed in producing artworks during medieval times (Rice, 1962).

The second category of studies identified globalization indications in special periods, particularly the Ilkhanid and Timurid dynasties (Mongol) in Islamic architecture and the Byzantine empires in Christian architecture. Despite the brutal presence of foreign nomadic Mongol ethics and their negligence of buildings, the Mongolian style was eventually influenced by Muslims' noble sociocultural features, thereby enabling the prevalence of a global style, whose universalism was followed by succeeding monarchs. Previous traditions in building mosques and their complexes of surrounding buildings, tombs, and ornaments were adapted and developed, ultimately leading to the application of new arrangements. Likewise, knowledge on innovation in other art fields was applied. For example, manuscript illumination served as a potent initiative for involvement in Timurid architecture. The studies on Christian architecture indicated a noticeable global style that began from a slight change in Roman basilicas to function as churches and ending with great extensions to Christian or Islamic styles called Constantine art. Such outcomes were also derived in *Caucasus* (present-day *Georgia* and Armenia) outside of the city of Constantinople, where focus was directed toward monastic patterns (pilgrimage route). These patterns were sustained in the Romanesque and Gothic periods and used to create splendid cathedrals across the whole European continent. Another example is the development plan for the Yazd Jami Mosque (1334–1325 AC) in Iran. The plan adhered to the common practice of constructing in the capital city of Tabriz, and the construction of succeeding mosques in this region targeted the connection of surrounding *shabestans* (columned halls) to the space beneath domes through the addition of some connected halls. This new style later became a standard beginning in the Ilkhanid period. Blair et al. (1994) assumed that the designer of the Imam Mosque in Mashhad (1500 AC) previously designed the plan for the Tabriz Blue Mosque and was familiar with the builder of the Yashil Jami Mosque in Bursa (Turkey). In the Christian context, the combination of basilica plans with the Greek Cross in Hagia Sophia was referenced not only as evidence of the progress of Constantine art but was also regarded as a key standard style for the additional domed churches constructed in the Byzantium period (Rice, 1962). The origins of the plans for the Byzantium Dome and Roman Cross was recognized through the promotion of techniques such as those evident in the Etchmiadzin Cathedral (-483 AC), in Armenia. These techniques were developed through the addition of continuous corridors to fulfill the tradition of catering to the pilgrims of Romanesque monasteries.

The third category of studies distinguished the importance of globalization indications across different eras and represented ethics as the exchange of cultural and technological assets. The contributions of Islamic and Christian architecture to these indications were attributed primarily to their historical and cultural differentiations resulting from the evolution of religious architecture. An example is the compositional style of Islamic with Turkish and Persian architecture, which transformed to encompass new symbolic ornamental patterns called Arabesque patterns; these patterns became popular in Egypt (the Tulunids), Iran (the Buyids), Khorasan and Transoxania (the Samanid), and Afghanistan and Panjab (the Ghaznavids) (Allam, 1988). The Islamic world considered the embellishment and decoration of buildings, but their Christian counterparts were concerned about technical and structural issues. Roman Cross monasteries initiated the rib vault techniques that developed in the early Gothic period with the invention of flying buttresses, which later became a prevalent pattern in France, Germany, Italy, England, and Spain. Eventually, the pattern evolved into fascinating net vaults and fan-vaulted roofs, which were influenced by the Islamic stellar vault (Crandell, 1991). Sometimes, vernacular forms led to some partial deviations from standard patterns.

3.5. Axis two: art-technology interactions reflected in globalization indications

The interactions between art and technology as depicted by the globalization indications discussed in the Islamic and

Christian studies (i.e., separation, unity, and procedural clustering) have resulted in a variety of interconnected sets of artworks called case study chains and excellent examples that reflect signs of archaic globalization in religious architecture. From the seven analyzed studies, 12 case study chains (see Tables 2 and 3) were identified: brick works, vaults, domed square tombs, mosaic works, stucco and plaster works, and Arabesque works in Islamic architecture and Constantinople Church style, vaults, Cappadocia Church style (monastic), Armenian Church style, Byzantine Dome, and iconography in Christian architecture. In most of the cases, the focus of the scholars was mainly spread throughout other regions. In line with the earliest globalization indications, every case study chain was classified on the basis of its origin, common place, perfection, and prevalence codes. For example, the Hagia Sophia from the hybrid plan of Christian architecture and the Samanid Tomb from the brick works of Islamic architecture were placed in the perfection class. Two leading types of items were identified: decorative and structural technologies. These are explained in more detail in the next section.

3.6. Analysis of art-technology interactions in Islamic and Christian Architecture

In analyzing Islamic cases, many orientalists separate art from technology. Lewcock (1995), for instance, specified the structural and ornamental scopes of Islamic architecture, and Jones (1995) identified two techniques, namely, structural and cover approaches (Grube and Michell, 1995). This detachment was refuted by a small group of Islamic scholars. Despite the non-Islamic nature of most of the technologies in Islamic regions, art and technology are seen as intensely interweaved in a way that prevents the easy perception of one without the other (Ettinghausen et al., 2003). To date, few studies have proposed an advanced perspective that acknowledges art and technology as occupying a continuum rather than operating in consolidation or separation (Blair et al., 1994). The *Moqarnas* (type of corbel) in the Mausoleum of Khawaja Ahmed Yasawi (Turkistan) is an example of how structural items were used in deviation from its original function in the early Timurid empire, during which these subsidiary items were installed in the main networks of dome vaults. In the late Timurid epoch, their use departed from their constructional function, and they were jointed to a set of roof decorations. This case highlighted the transformation of structural aims into ornamental ones in Islamic architecture and the Muslims' desire to cover the unsightly features of buildings to render an entire space integrated.

The second trend of examining art and technology identified contradictory types of art and technology interactions on the basis of the globalization indications in Christian architecture. The integrity of art and technology is rarely implied in studies on Christian architecture, but a few scholars, such as Rice (1962), articulated the unification of iconographies, sculptures, and paintings with structural elements in Byzantine and Medieval architecture. The separation of art and technology were asserted by Western researchers when they described these disciplines as two classes of essential and ornamental components aimed at demonstrating the increasing exposition of building skeletons through decorative elements, such as rib vaults, pointed arches, flying buttresses, and sculptured columns (Crandell, 1991). Recent studies assumed that art and technology interactions operate in a continuum (Banimasoud, 2010), in which structural technology achieves its perfected form (art) and establishes a reputation in other lands. This approach is coherent in potential technologies, from the emergence of barrel vaults in Romanesque architecture to the rise of rib vaults and flying buttresses (art) in Gothic architecture, and in its considerable propagation in the European continent. In contrast to Islamic cases, this example highlighted the significant role of structural elements while providing a lateral place for decoration in Christian architecture.

3.7. The cumulative effect of the two axes: latent pattern of globalization-based art-technology interactions

A latent pattern resulting from the interplay of axes one (globalization indications) and two (art-technology interactions) was observed in the 12 case study chains discussed in the Islamic and Christian studies (see Tables 2 and 3). As previously stated, out of the 12 cases, two that are relevant to the aforementioned axes were analyzed. These two artworks progressed from simple techniques to masterpieces, thereby enhancing their chances to influence other regions; they were also located in the cumulative Tables 2 and 3. The first case study chain, which centers on Islamic architecture, reflects the transformation of structural aims into decorative ones and vice versa (e.g., brick artworks) (Grube and Michell, 1995). The second case study chain, which revolves around Christian architecture, indicates the promotion of structural technologies from plain techniques to magnificent artworks (e.g., rib vaulting and cross-in-square plans). The characteristics of these two distinct archaic globalization sample sets were further assessed in accordance with the principle of art-technology interactions in each context.

3.8. Analysis of Islamic and Christian case study chains on the basis of the latent pattern underlying art-technology interaction vis-a-vis globalization indications

The case study chains that reflect procedural interactions between art and technology were assessed, with four sample artworks from each set post-coded as proto technology, developed technology, art (innovated technology), and influential art. An adapted or emerging technology starts to develop through the incorporation of changes provided that a great innovate shift—art—takes place and begins to impress other regions as a leading global style (Blair et al., 1994). These items within art-technology interactions exhibited strong relevant conformity with the post-codes of the globalization indications (i.e., origin, common place, perfection, and prevalence) and laid the groundwork for logical reasoning on the existence of an underlying pattern between the two axes (art-technology interaction vs. globalization indication). That is, proto technology in archaic globalization occupies an origin phase and is elevated to the common place stage upon sufficient

Table 2 Sample case study chains that reflect archaic globalization in Islamic architecture and their art and technology interactions.

Sources	Case study chains	Axis 2: Procedural interaction between art and technology				Reference	Globalization dimension
		Proto technology	Developed technology	Innovative technology (art)	Influential art		
Jones (1995), Grube and Michell (1995)	Brick works	Brick + baked clay	D Mix plaster	D In 3D form, Moqarnas	D Mix with mosaic	Direct Direct Direct	Cultural Technological
		Mesopotamia, Akhizadeh Castle, Euphrates, Abbasid, 7 AC	Iran, Jameh Mosque of Isfahan Seljuk era, 8–10 AC	Uzbekistan, Samanid Mausoleum, Bukhara, Seljuk,10–12 A.C	Tunisia, Qirovan Mosque Mongol, Safavid,12–14 A.C		
Lewcock (1995)	Vaults	Diaphragm arches and barrel vaults	D Rib dome (vaults)	I Squinch, Karbandi early Moqarnas	D Moqarnas	Direct Indirect Direct	Cultural Technological
		Syria, Mosque of Damascus, Umayvad, 8 AC (originated from Sassanid and Byzantine)	Spain, Mosque–Cathedral of Cordoba, Moorish, 10 A.C	Iran Jameh Mosque of Isfahan 11 AC	Cairo, Mosque-Madrassa of Sultan Barquq, Mamluk, 14 AC		
(Blair, Bloom and Ettinghaus 1994)	Domed square tomb	Mongolian fluted tent	D Fluted cylindrical body	I Fluted dome	D Fluted dome	Direct Indirect Direct	Cultural Technological
		Transoxiana, Mongol tribes' tents, Seljuk, 9 AC (originated from Iranian Chartaqi)	Iran, Radkan Tower, Khorasan, Saljuk,11 AC	Uzbekistan, Mausoleum of Timur, Samargqand, Timurid, 15 AC	Turkey, Zeynel Bey Mausoleum, Hasankeyf, Aq Qoyunlu, 16 AC		
Allam (1988)	Mosaic works	Glazed mosaic	D Moaghali combination with brick	I Moaraq through floral and geometric patterns	I Seven-colored mosaics	Direct Indirect Indirect	Cultural
		Iraq, Great Mosque of Samarra, Abbasid, 6–10 AC	Iran, Jame Mosque Qazvin Seljuk, 10–12 AC	Uzbekistan, Sher-Dor Madrasah, Registan, Samarqand, Timurid, 13 AC	Iran, Shah-Abdol-Azim Shrine, Rey and Kashan, Ilkhanid, 14 AC		
Allam (1988)	Stucco and plaster works	Figurative scenes	D Oblique carving and floral patterns	D Mixture of Turkish, Persian, Arabic patterns	D Floral patterns	Direct Direct Direct	Cultural
		Mesopotamia, Susanid Stucco, Ctesiphon, Susanid, 5–6 AC	Iraq, Great Mosque of Samarra, Abbasid, 9 AC	Iran, Heidariyeh Mosque of Qazvin, Saljuk, 12 AC	Eygpt, Darih Shajarat al-Durr, Cairo, Mamluk, 13 AC		
Allam (1988)	Arabesque	Oblique carving	D Combined with Turkish and Persian elements	D Symbolic geometric ornaments	D Arabesque	Direct Direct Direct	Cultural
		Iraq, Stucco decoration in Mosque of Samarra Berlin Museum, Abbasid, 6–10 AC	Eygpt, Ibn Tulun Mosque, Cairo, Tulunids, 10 AC	Iran, Samanid Mausoleum, Bukhara, Buyid, Samanid, 9–11 AC	Afghanistan, Ghazni Minarets, Ghaznavid, 10–12 AC		
		Origin	Common place	Perfection	Prevalence		
		Axis 1: Globalization process					

development; through evident transformation, it can ascend to the perfection phase, after which it acquires the potential to enter the prevalence phase and inspire other territories as influential art.

One of the two case study chains for further analysis was chosen from the brick works identified by Jones (1995) (Figure 3). The first two works in this chain centered on early Mesopotamian brick and backed clay work and their

Table 3 Sample case study chains that reflect archaic globalization in Christian architecture and their art and technology interactions.

Sources	Case study chains	Axis 2: Procedural interaction between art and technology				Reference	Globalization dimension
		Proto technology	Developed technology	Innovative technology (art)	Influential art		
Rice (1962), Banimasoud (2010)	Constantinople Church style	Greek cross plan	I Cross in square	I Synthesis with triple-naved Basilica plan (linear)	I Combined plan	Indirect Indirect Indirect	Technological
		Italy, Old St. Peter's Basilica, Rome, Roman, 4 AC	Armenia, Church of Saint John, Mastara, Byzantine, 5 AC	Turkey, Hagia Sophia, Istanbul, Byzantine, 6 AC	Serbia (Kosovo), Pec Monastery, Peć, Medieval, 13–14 AC		
Crandell (1991), Banimasoud (2010)	Vaults	Barrel vault	D Groin vault	D Rib vaults with flying buttresses	D Net vaults and fan-vaulted roofs	Direct Direct Direct	Technological
		Switzerland, Abbey of Saint Gall, city of St. Gallen, Romanesque, 9 AC	Germany, Speyer Cathedral, Speyer, Romanesque, Gothic,10–11 AC	France, Charter Cathedral, Paris, Gothic, 12 A.C	England Gloucester Cathedral, Gloucester, late Gothic,13–14 AC		
Rice (1962)	Cappadocia Church style (monastic)	Cave-like church	D Linear, high with conical dome	I Cruciform plan with central dome	D Various cruciform-domed plans	Direct Indirect Direct	Technological
		Turkey, Çanlı Kilise, Aksaray, Saljuk, 1 AC	Turkey, Tokalı Kilise, Cappadocia, Göreme, Byzantine, 4 AC	Armenia, Saint Gayane Church, Etchmiadzin, Byzantine, 7 AC	Georgia, **Tsromi Church,** Tsromi, Byzantine, 7 AC		
Rice (1962)	Armenian Church style	Domed cross in square	I Complicated geometrical four-apsed square	D Cruciform plan, extra domes	I Domed eight-apsed square	Indirect Direct Indirect	Technological
		Armenia, Etchmiadzin Cathedral, Vagharshapat (Etchmiadzin) Byzantine, 4 AC	Georgia, Jvari Monastery, Mtskheta, Byzantine, 6 AC	Turkey, Basilica of St. John, Ephesus, Byzantine, 6 AC	Turkey, Church of the Holy Redeemer, Ani, early Medieval, 11 AC		
Rice (1962)	Byzantine Dome	Domed square	D Separation of dome from walls and location in columns	I Private sanctuaries as buttresses	I Cross-in-square with central dome	Direct Indirect Indirect	Technological
		Armenia, Hagia Sophia, Istanbul, Byzantine, 6 AC	Armenia, Saint Theodore Church of Bagaran, Bagaran, Byzantine, 7 AC	Armenia, Cathedral of the Holy Cross, Aghtamr, Byzantine, 10 AC	Serbia, Gračanica Monastery, Kosovo, Serbo-Byzantine, 14 AC		
(Rice (1962), Banimasoud (2010)	Iconography	Wall painting (fresco)	D Iconoclastic art, mosaics, and frescoes	I Post-iconoclastic period (painting and mosaics)	D Mosaics	Direct Indirect Direct	Cultural
		Italy, Catacombs of Domitilla, Rome, Early Christian, 2 AC	Turkey, Hagia Irene, Istanbul, Byzantine, 9 AC	Turkey, Hagia Sophia, Istanbul, Byzantine, 9 A.C	Syria, Umayyad Mosque, Damascus, Umayyad, 19 AC		
		Origin	Commonplace	Perfection	Prevalence		
		Axis 1: Globalization process					

enrichment and compositional improvement through their combination with plaster and mosaic works, which were transformed into special stalactite forms, such as the *Moqarnas*. These forms were replicated frequently in later Islamic eras and over broad distances. In globalization terms, this Islamic brick work with Iranian archaic roots originated from Euphrates (Abbasid era, 6 AC) and entered the common place stage in Iran, Afghanistan, and Turkestan (Seljuk era, 8–10 AC). It evolved into its perfected form in Bochara (Uzbekistan) and Torbat-e Jam (Iran) (Seljuk era, 10–12 AC), and its prevalence occurred in outland regions, such as Africa (Mongol, Timurid, and Safavid eras, 12–14 AC). This

chain not only confirmed the solid correlation between art-technology interactions and globalization but also validated the particular characteristics of Islamic architecture in archaic globalization, that is, the ambition and effort devoted to the application of ornamental elements to cover structural harshness while defining the space as a whole.

The second case study chain chosen for further examination was that on Christian vaulting technology, starting from Roman semi-circular vaults to complicated Gothic net-vaulting (Figure 4). This chain demonstrated the emergence of barrel vaults as a proto technology for covering the churches and monasteries of the pilgrimage route; they progressed in compound form into groin vaults as perpendicular vaults were added to it (Banimasoud, 2010; Crandell, 1991; Rice, 1962). The invention of rib vaults supported by flying buttresses by Christian artists evolved into an innovative technology called Gothic art and served as strong inspiration for later masterpieces, such as fan vaults. Similar to the Islamic chain, the Christian chain exhibited an apparent relationship between progression from technology to art and archaic globalization. Before Gothic vaulting art earned a reputation, barrel vaults were incorporated into Romanesque art (9 AC)—a technique that was pursued by the ancient Romans; soon after, France became the host of succeeding developments called groin vaults (Gothic, 12 AC). With influence from Islamic decoration, this evolution was disseminated as a standard in the entirety of Europe (Gothic, 13–14 AC) through the creation of magnificent net vaults (or fan vaults). Tables 2 and 3 present the Islamic and Christian case study chains, their archaic globalization indications, and their art and technology interactions. Most of the implications drawn in the studies were satisfactorily verified, and some inferences and indirect indications were found to complete the case study chains. The Islamic architecture studies concentrated principally on cultural globalization, which covered the largest extent (67%) among globalization processes and prepared an avenue for the broader interrelationship between cover technology and globalization. In the Christian architecture studies, technological globalization presented the greatest value (83.5%) among globalization processes and confirmed the adequate relationship between structural technology and globalization.

3.9. Comparative analysis of the case study chains on the basis of art-technology interactions/ globalization patterns

We examined the two axes to exhibit the internal conformity between the four phases of globalization (i.e., origin, common place, perfection, and prevalence) and the four

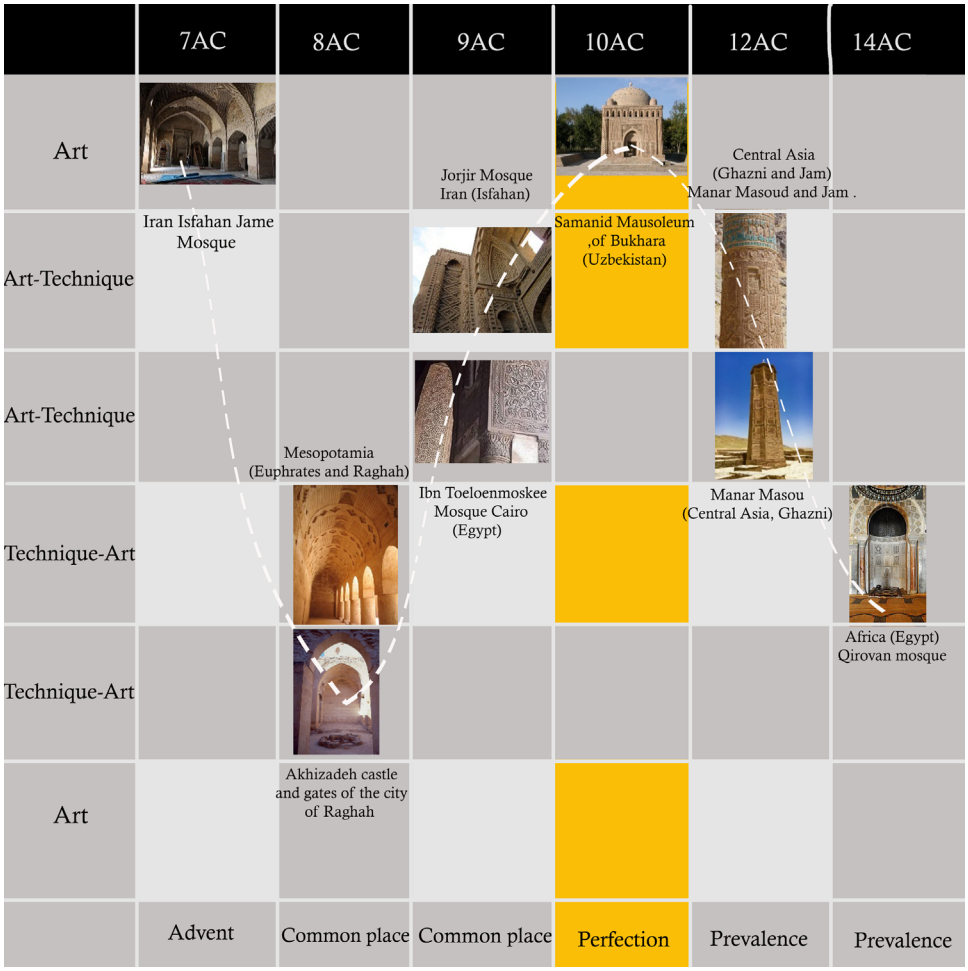

Figure 3 Islamic Brick works. Sample case study chain. Art and technique interactions in Islamic Archaic Globalization Process. Art (covering technique) converts Technique (Structural Art).

stages of art and technology interactions (i.e., proto technology, developed technology, innovative technology, and influential art) found in the Islamic and Christian architecture studies. The comparison showed that from 18 chains on the Islamic case studies, four implicitly referred to the relationship between globalization and art-technology interactions, and 16 indicated explicit or direct reference to such relationships between each of the two case studies selected for all the chains (Table 2). The number of direct and indirect studies to the relationship was mostly equally distributed in the Christian architecture studies (see Table 3). As previously explained, the type of globalization dimension addressed in the studies reflected the interactions between art and technology in the two religious styles of architecture, including the discussion of whether initial technology exhibited more structural aspects or cover factors. The studies on the Christian chains focused on the technological dimension of globalization to emphasize structural technologies, whereas the studies on the Islamic chains concentrated on the cultural dimension to underscore cover technologies.

The comparison of the case study chains showed the following similarities between the patterns of art-technology/globalization in Islamic and Christian architecture (Figure 5): (1) the adaptation of forerunner technologies and efforts to develop these technologies; (2) the application of innovative and new compositions in adapted technologies to create various art styles, thereby enabling such styles to influence not only the domains where they have gained a reputation but also in other territories; (3) the simulation of outstanding and advanced artworks as part of architectural policy; and (4) the flourishing and prevalence of technologies supported by religious domination, aside from the propagation of global attitudes and attributes. In both Islamic and Christian context, attention to previous traditions and constant efforts in continuing and evolving such traditions, given the prominent presence of religion has always existed. It seems that religion is the foundation

Figure 4 Christian church plan (Basilican +Greek cross plan). Sample case study chain. Analysis of art and technique interactions in Christian Archaic Globalization in Archaic Globalization Process. Technique(Structural Art) converts Art (covering technique).

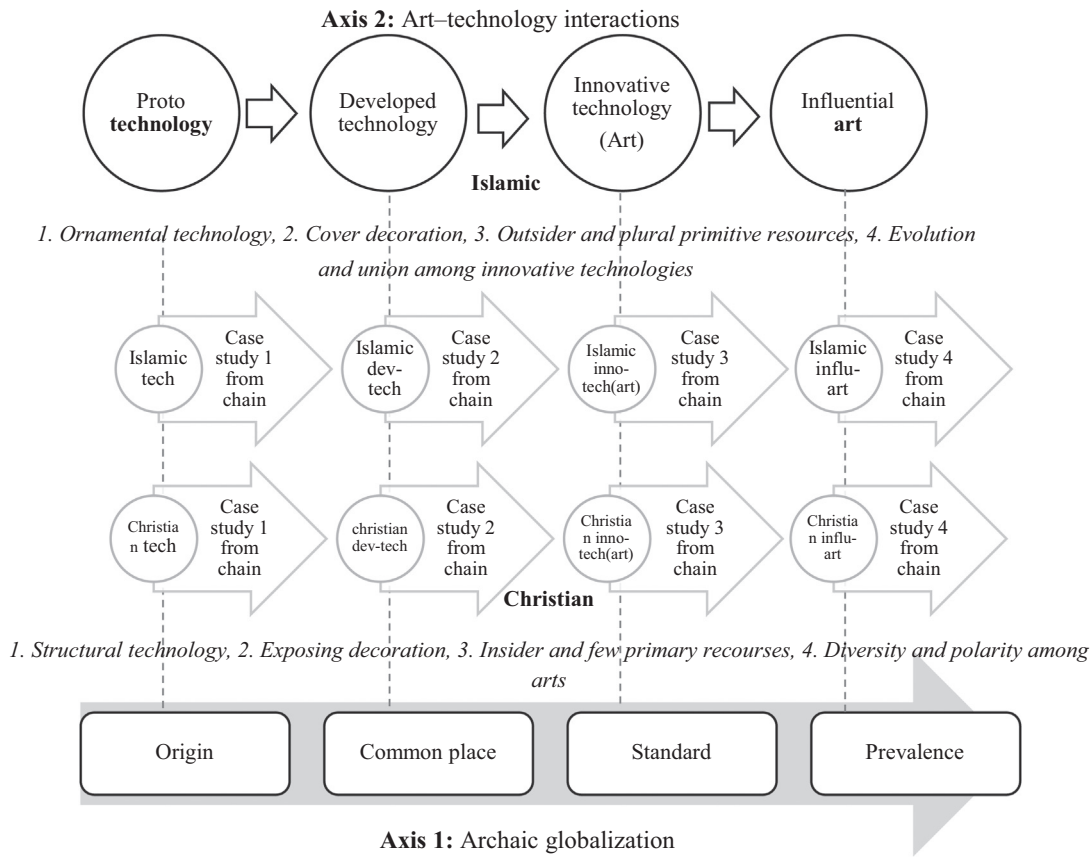

Figure 5 Diagram of similarities and differences between Islamic and Christian globalization patterns according to the two axes.

that generated thoughts, beliefs and traditions which must be the basis of any evolutionary trend.

The comparison revealed the following points of contrast: (1) The origins of almost all the Christian technologies were limited to Roman or Greek influences, whereas the origins of the majority of the Islamic technologies extended to numerous influences, such as Byzantine, Sassanid, and Mesopotamia. Note that the Islamic ornaments are originally Mesopotamian; (2) A distinct separation existed between structure and decoration in Christian architecture, wherein ornamental elements were frequently used to make structural elements even more prominent. By contrast, Islamic ornamental elements were considerably unified with structural ones as the former were used to conceal the harshness of underlying structures. The conversion of structural functions into ornamental ones was a conventional facet of Islamic architectural elements; (3) Continuity and union with maintained variety and plurality were evident in different Islamic architectural styles, whereas rivalry and competition characterized the Christian architectural styles; and (4) Although both the Islamic and Christian chains reflected global thoughts and attributes, the former exhibited a broader influence of globalization in the geographical and temporal domains than did the latter. The main source of differences lies in the context of beliefs pertaining to both religions. For example, in Christianity, despite technologies and arts having the same responsibility, there is a dual categorization where one category is deemed useful (technology) and the other is considered decorative and subservient (art), whilst the latter should be utilized for the benefit of the former. In the Islamic context, there are no significant differences between the two, and decorations were used to cover structural deficiencies whilst being complementary to technology and may swap roles in their applications.

The comparison of the patterns of art and technology interactions in the two architectural styles (see Figures. 3 and 4) showed that the evolution of both structural and ornamental technologies were aligned with architectural globalization streams. Although the process of interactions from proto technology to innovative technology (art) sometimes spanned decades before the artworks transcended their origin regions, successful case study chains never stopped evolving until globalization was accomplished. The comparison of Tables 2 and 3 also indicated that the peak in art and technology interactions—that is, innovative technology (art)—was the turning point in architectural globalization and that it revealed the importance of the procreative nature of art and technology interactions in leading globalization currents in the past.

4. Conclusion

This study affirmed the identification of art and technology interactions as an important factor in historical globalization from a religious architectural viewpoint. The research described three types of treatment in examining the indications of archaic globalization in Islamic and Christian architecture: the inclusion of all eras in analysis, the focus

on one special era, and the consideration of the relationship between eras. These categories were essentially matched with three approaches to historical globalization: holistic, atomistic, and hybrid. The most significant approach (hybrid) comprehends archaic globalization by means of the cultural and technological dimensions in which effective interactions between art and technology provided great contributions to the exchange of cultural and technological values. This approach illuminated that Islamic and Christian heritage properties demonstrated many examples of pro-creative interactions. The comparison of the indications of art-technology interactions in the Islamic and Christian contexts provided information on the globalization patterns of these architectural styles and how cultural and technological assets were disseminated. Note, however, that these architectural contexts represented distinct types of art-technology interactions in accordance with their specific cultural religious doctrines. For instance, Islamic architecture was directed toward the development of cover and decorative technologies, whereas Christian architecture was devoted to the extension of structural technologies. The holistic and atomistic approaches identified indirect aspects of architectural globalization with reference to the geopolitical and socioreligious dimensions of archaic globalization. In this regard, a transition of global thoughts from one ruling monarch to the next was observed. The hybrid approach appeared to be strengthened by geopolitical and socioreligious approaches, but it presented different views regarding art-technology interactions (i.e., separation, union, and procedural clustering). These views were applied in the current research because of their compatibility with globalization dimensions. The role of these classifications in understanding the nature of art and technology interactions has been highlighted as an essential factor in globalization indications.

With regard to the encounter between historical globalization and art-technology interactions, many of the reviewed studies (directly and indirectly) expressed the regional and transregional effects of innovation in technology, but a relevant and classified analysis of archaic globalization in Islamic and Christian architecture was lacking. The axis of art-technology interactions indicated a remaining embedded diversity and plurality of technologies and arts, thus relating the structural aspects of Christian and Islamic architecture to their cover or ornamental technologies. Although variances in remaining rare indirect indications gives rise to a new issue in the analysis of the relationship between art-technology interactions and historical globalization, the comparison of these indications is challenged by the lack of similar and in-depth studies, especially those devoted to the Islamic architectural heritage.

The recognition of Islamic and Christian patterns of archaic globalization enabled us to elucidate the role of art and technology interactions in the advantageous globalization of an architectural style. The examination of the cultural and technological dimensions of the two globalized religious architectural styles highlighted the need for reconciliation between art and technology to ensure the active role of architecture in both the local and global arenas. With consideration for the indirect influence of geopolitical and socioreligious dimensions on architecture, this research confirmed that a more thorough theorization and a deeper understanding of the correlation between art-technology interactions and globalization in the past are needed to more effectively address the later stages of globalization. In the context of previous globalization waves —archaic, proto, modern, and contemporary—further analysis of successful architectural samples is expected to broaden the appreciation of previous globalization currents and thereby provide insights that will enable a resolution of today's challenges. The identification of historical globalization patterns in the field of architecture can also help researchers and practitioners manage ongoing challenges, especially in Islamic countries; set priorities; and provide baseline knowledge for the optimization of responses to the contemporary wave of globalization.

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