ISTANBUL TECHNICAL UNIVERSITY ★ GRADUATE SCHOOL

CORRELATIONS BETWEEN COMPOSITION ATTRIBUTES OF ARCHITECTURE AND MUSIC

Ph.D. THESIS

Seyed Farhad TAYYEBI

Department of Architecture

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FEBRUARY 2021

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ISTANBUL TEKNİK ÜNİVERSİTESİ ★ LİSANSÜSTÜ EĞİTİM ENSTİTÜSÜ

MİMARİ VE MÜZİĞİN KOMPOZİSYON ÖZELLİKLERİ ARASINDAKİ KORELASYONLAR

DOKTORA LİSANS TEZİ

Seyed Farhad TAYYEBI
(502132007)

Mimarlık Anabilim Dalı

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Tez Danışmanı: Prof. Dr. Yüksel DEMIR

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Seyed Farhad TAYYEBI, a Ph.D. student of ITU Graduate School student ID 502132007, successfully defended the dissertation entitled "CORRELATIONS BETWEEN COMPOSITION ATTRIBUTES OF ARCHITECTURE AND MUSIC", which he prepared after fulfilling the requirements specified in the associated legislations, before the jury whose signatures are below.

Thesis Advisor : **Prof. Dr. Yüksel DEMIR** ....
Istanbul Technical University

Jury Members : **Prof. Dr. Sinan Mert ŞENER** ....
Istanbul Technical University

Prof. Dr. Can KARADOĞAN ....
Istanbul Technical University

Prof. Mehmet NEMUTLU ....
Mimar Sinan Fine Arts University

Prof. Dr. Pınar DINÇ KALAYCI ....
Gazi University

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To my spouse and children,

FOREWORD

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February 2021

Seyed Farhad TAYYEBI
Architect - Researcher

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ABBREVIATIONS

PPA	**:** Perceived Psychological Attributes
FFM	**:** Five-Factor of Music
SD	**:** Standard Deviations
LWC	**:** Light Warm Colors
DWC	**:** Dark Warm Colors

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CORRELATIONS BETWEEN COMPOSITION ATTRIBUTES OF ARCHITECTURE AND MUSIC

SUMMARY

“I call architecture frozen music” by Johann Wolfgang von Goethe vividly expresses the great linkage between architecture and music. The architects applying music in building design are increasing in numbers, and interrelated projects are getting progressively widespread. Interestingly, most of the interrelation between architecture and music, in various scales, are formed by some assumed correlated parameters regardless of the feeling arousal of the attribute to the listeners and observers, which are mostly based on the subjective artists’ opinion or rooted in more-objective scientific issues. For instance, ‘interval’ in music has been arguably understood as ‘proportion’ in architecture; accordingly, the harmonic musical interval applied in architectural ratio with the hope of acquiring pleasant architectural proportion. But is there any correlation between the preferences of satisfactory musical intervals and their transformation into architectural proportions?

From this perspective, this research aims to explore the correlations between the preferences of architectural and musical attributes from the subjective people’s point of view rather than the artist’s opinion or merely through an objective perspective. Thus, this study aims to answer the following questions.

- Is there any correlation between the preferred architectural and musical attributes of people? What are the most frequently correlated attributes?
- More specifically, on a small scale, which musical instruments preferences correlate with architectural material preferences? On a large scale, which musical attribute preferences correlate with architectural attributes preferences in general?

At first, a pilot study has been conducted to examine the methodology through exploring the correlation between architectural attributes and musical attributes across limited demographic classes (S. F. Tayyebi & Demir, 2020). By learning from it, two other studies find an answer to the questions. The first study, as a small-scale investigation, has explored the preference correlations between the attributes related to architecture material and musical instruments. Another study, as a large-scale investigation, has scrutinized the correlation between the general attribute preferences of architecture and music across a wide range of demographic classes.

Despite some tiny differences, the methodologies of the three papers have an identical structure. The methodology has three phases presented in Figure 4.1. The first phase provides a clear list of the considered attributes, based on two studies conducted during the dissertation progress (S. F. Tayyebi & Demir, 2019) (S. F. Tayyebi et al., 2020), though they can also be seen as part of the limitations of the dissertation. After examining eight different methods and discovering the most reliable method to extract the personal preferences of architectural attributes (Tayyebi & Demir, 2020), a survey is then prepared and distributed worldwide on the QuestionPro platform to collect the

individual's demographic information, the musical attribute preferences, and architectural attribute satisfaction. In the second phase, the participants' responses were analyzed, and the unreliable responses were filtered to provide a complete set of attribute preferences of valid participants. Finally, in the third phase, Pearson's correlation coefficient analysis examined the correlations between every single attribute within different demographic categories. The outcomes of the analysis were then filtered by the correlation p-value, to skip the statistically invalid correlations. The second and third studies also integrated with Bonferroni correction, as a second filtering technique, to skim off the utmost reliable correlations. Clustering method has also applied to the third study to summarize the correlated attributes provide a holistic understanding of the correlation trends.

As the first outcome, all the studies confirm the importance of demographic classes in the correlations exploration between the preferences of architectural and musical attributes. Not only the trace of age and gender apparently exists in the discovered correlations, the large-scale study considering the participants' education shows that even education more than age and gender impacts on the discovered correlations. It reinforces the importance of the three demographics.

Along the same line, some demographic classes, attribute categories, and the attributes themselves reflect higher number of correlations. For example, females more than males, material color and material qualities more than material reflection and texture, symmetry more than indentation and stress, and genre more than psychological attributes of music show correlation. Furthermore, within genre category, rap and jazz, and within the psychological attributes of music, sophisticated and poetic/deep have higher number of correlation and thus may reflect better the preferences of some attributes in another field.

Regarding the aim of the paper, Pearson's analysis results of the two main studies in small and large scale are indeed the outcome of the study, and thus presented in appendices. For example, the first study, concerning architectural material and musical instrument correlations, shows that preferences of cello for mature females reflect higher satisfaction for brick, full of texture materials, aluminum, reflective, and light-colored material. The results of the large-scale study show male musicians, mature musicians, and even architect-musicians who are interested in sophisticated music tend to prefer sophisticated architectural forms. Rock follower musicians are less satisfied with complicated architectural forms. Preferences for sad music for female architects tend to have a preference for horizontality in building forms.

The outcomes of the large-scale study, exploring a large number of correlations, are also clustered to provide a holistic understanding of the correlations. On its basis, those who prefer Complicated music seems to have more positive opinions about Complicated architectural forms. There are strong correlations, albeit very few in number, that shows those who like Dance music seem to prefer Rhythmic and complicated buildings. Among the Mellow music followers, in general, Simple architectural forms were found more satisfactory. Joyful music followers seem to tend towards regular patterns in architecture. Those who enjoy Rap have a preference for either regular or irregular patterns that exude a sense of repetition in the formal structure.

Finally, this explorative study confirms the existence of numerous correlations between architectural and musical attributes, thereby proving the potentials of applying the resulting insights into future building design and further investigations.

MİMARİ VE MÜZİĞİN KOMPOZİSYON ÖZELLİKLERİ ARASINDAKİ KORELASYONLAR

ÖZET

"Ben mimariye donmuş müzik derim"; Johann Wolfgang von Goethe'nin bu sözü mimari ile müzik arasındaki büyük bağı oldukça canlı şekilde ifade ediyor. Bina tasarımlarına müzik uygulayan mimarların sayısı git gide artıyor. İlginç şekilde, muhtelif ölçeklerde mimari ile müzik arasındaki karşılıklı ilişkinin büyük bölümü, farklı ölçülerde sanatçıların sübjektif görüşlerine dayanan ya da daha objektif bilimsel hususlardan kaynaklanıp, dinleyici veya gözlemcinin özelliğe ilişkin hislerinin uyarılmasına görmezden gelip ilişkili parametreler ile teşkil olmaktadır. Örneğin, müzikte 'Aralık' kavramı, tartışmaya açık şekilde mimaride 'orantı' olarak anlaşılmaktadır; bu doğrultuda, müzikteki konsonan aralıklar güzel mimari orantı elde etmek amacıyla mimari orantıya uygulanmaktadır. Fakat tatmin edici müzikal aralık tercihleri ile bunların mimari orantılara dönüşümü arasında bir korelasyon var mıdır?

Bu bakış açısıyla, bu çalışmanın amacı mimari ve müzikal özellik tercihleri arasındaki korelasyonları, sanatçının görüşü veya yalnızca objektif bir bakış açısından ziyade, kişilerin sübjektif bakış açısı üzerinden incelemektir. Dolayısıyla, bu çalışma aşağıdaki sorulara yanıt vermeyi amaçlamaktadır:

- Bir kişinin tercih ettiği mimari ve müzikal özellikler arasında herhangi bir korelasyon var mıdır?
- Daha spesifik olarak, küçük ölçekte, hangi müzik enstrümanı tercihleri mimari malzeme tercihleri ile korelasyon göstermektedir? Büyük ölçekte, hangi müzikal nitelik tercihleri genel olarak mimari özellik tercihleri ile korelasyon göstermektedir?

Genel anlamda, bu sorulara yanıt vermeyi amaçlayan iki çalışma mevcuttur. Yayınlanan ön çalışma dışında (S. F. Tayyebi & Demir, 2020), ilk çalışma mimari malzemeler ve müzik enstrümanları arasındaki tercih korelasyonlarını sorgulamaktadır. Son olarak, ana araştırmada daha geniş demografik sınıflarda mimari ve müzikal özellik tercihleri arasındaki korelasyon irdelenmektedir. Bazı ufak farklılıklara rağmen, bu çalışmanın metodolojisi özdeş yapıdadır. Metodolojide üç aşama bulunmaktadır (ŞekilFigure 4.1). İlk aşamada işlenmemiş veri sağlanmaktadır; öncelikle dikkate alınan özelliklerin listesi tanımlanmakta, ardından işlenmemiş veriyi toplayacak bir anket hazırlanmakta ve dağıtılmaktadır. İkinci aşamada, katılımcıların yanıtları analiz edilerek güvenilir yanıtlardan özellik tercihleri için tam bir küme sağlanmaktadır. Son olarak üçüncü aşamada, Pearson korelasyon katsayısı analizi ile farklı demografik kategoriler içerisinde her bir özellik arasındaki korelasyonlar incelenmektedir; ardından analiz çıktılarından en güvenilir korelasyonlar elde edilmektedir.

Mimari Özellikler. Mimari özellikler tez aşamasında mimari yapılarda en yaygın görsel özellikleri sağlayan bir çalışma temelinde tanımlanmaktadır (S. F. Tayyebi & Demir, 2019), fakat aynı zamanda tez çalışmasının kısıtlamaları olarak da

görülebilirler. Bu çalışma temelinde, büyük çaplı özellikler Simetri, Karmaşıklık, Ritim, Desen, Vurgu ve bina cephelerinin Girintileri iken, yaygın malzeme özellikleri mimari malzemelerin Kalitesi, Rengi, Dokusu ve Yansıması ile ilişkilidir. Bu iki çalışmada değerlendirilen özellik setleri TabloTable 4.1Table 4.2'ye verilmiştir. Özelliklere ilişkin bireysel tercihleri elde etmek amacıyla, başka bir çalışmada sekiz farklı yöntem incelenmiştir (Tayyebi & Demir, 2020). En güvenilir sonuçların katılımcıların bazı bina görüntülerini derecelendirmesi ve özellik tercihlerinin bu doğrultuda elde edilmesi şeklinde sağlandığı görülmüştür. Bir başka deyişle, katılımcıların yalnızca bina görüntülerinin bazılarını derecelendirmesi gerekmiştir. Ardından binaların tüm görünür özelliklerine dereceler atanmıştır; son olarak, her özellik derecesinin ortalaması bu özelliğin memnuniyet derecesi olduğu varsayılmıştır. Bu yöntem, büyük bir örneklem ve bilhassa sıradan (uzmanlığı olmayan) kişilerle yapılan bir çalışmada tercihlerin belirlenmesi için en güvenilir yöntemdir. Son olarak, bu yöntem mimari özellik tercihlerinin elde edilmesinde uygulanmıştır. Bina görüntüleri ve bunlara atfedilen özellikler Eklerde verilmiştir.

Müzikal Özellik. Müzikal özelliklerin net bir listesini tanımlamak amacıyla, tez süreci boyunca kapsamlı bir literatür taraması yürütülmüştür (S. F. Tayyebi et al., 2020). Bunlar başlıca dört müzikal özellik kategorisini temsil etmektedir. Müzik zevkinin ilk tanımlayıcısı olarak tür, müzik beğenisini en iyi yansıtan özellik olarak görülmektedir. Bir başka özellik kategorisi Beş-faktörlü model (FFM: Five-factor model) olup, buna Yumuşak Başlılık (M-Tipi), Mütevazılık (U-Tipi), Bilgililik (S-Tipi), Çarpıcılık (I-Tipi), ve Modernlik (C-Tipi). Algılanan Psikolojik Özellikler (PPA: Perceived Psychological Attributes) müziğin kavranabilir özelliklerini ve bir müzik eserinin nasıl hissettirdiğini, yani mutlu, hüzünlü, çarpıcı (etkileyici), yumuşak, agresif, güçlü v.b ifade eder. FFM'ler üç boyutta özetlenmiş olup, 3-faktör kategorisi olarak özetlenmiştir. Bunlar: Uyarma (müziğin enerji düzeyi), Valens (müzikteki hüzünlü ile mutlu arası duygular), ve Derinlik'tir (müzikal tercih ayırıcılarının ne derece ileri olduğu). FFM ve 3-faktörlü kategorilerdeki ön tanımlı özelliklerin aksine, Tür ve PPA çok sayıda özelliği kapsamaktadır. Değerlendirilen türü ve PPA'ya tanımlamak amacıyla, özellikleri elde etme yöntemi dikkate alınmalıdır. Tür, FFM ve de PPA'ler ile 3-faktörlü etmende özelliklere ilişkin bireysel tercihler arasında incelenen korelasyonlar temelinde, FFM kategori 2'de yaygın (etkili) kategori 2 yüksek derecede korelasyonlu tür, 3-faktörlü özelliklerin her bir pozitif değeri için üç güçlü şekilde korelasyonu olan PPA ve her bir negatif değer için iki PPA üzerine odaklanılmıştır. Son olarak, hem katılımcıların özelliklere ilişkin görüşlerini göstermek hem de FFM ve 3-faktörlü kategorilerdeki özelliklere ilişkin görüşlerini yansıtmak amacıyla 10 tür ve 15 PPA seçilmiştir. Benzer şekilde, birinci çalışmada da, küçük ölçekte, muhtelif müzik enstrümanı ailelerini kapsayacak şekilde, katılımcıların müzik enstrümanına ilişkin memnuniyet derecesinden müzik enstrümanı ailesi tercihlerini elde etme imkânı sağlamak amacıyla en yaygın şekilde kullanılan on iki müzik enstrümanı seçilmiştir.

İşlenmemiş Verinin Toplanması. İşlenmemiş veri toplamak için en iyi yöntem, daha yüksek sayıda katılımcı elde etmek, incelemenin geçerliliğini ve sonuçların doğruluğunu artırmak amacıyla anket yapılmasıdır. Bu nedenle üç bölümlü bir anket hazırlanmıştır. İlk bölümde, katılımcıların demografik bilgilerinin yansıtılması amacıyla yaş, cinsiyet ve eğitim düzeyi sorulmaktadır. İkinci bölüm, mimariye ilişkin bireysel tercihlerin elde edilmesi amacıyla tasarlanmıştır; katılımcılar rastgele bina görüntülerini bir'den yediye kadar derecelendirmektedir. Son olarak, üçüncü bölümde müzikal özelliklere ilişkin 10 Tür, 15 PPA ve 12 müzik enstrümanı tercihleri sorulmuştur. Anket QuestionPro platformu üzerinden yapılmış ve dünya çapındaki gönüllü katılımcılara dağıtılmış, katılımcıların yanıtları gizli ve anonim tutulmuştur. Toplamda ankete 1,000'in üzerinde kişi katılmış olup, bunların çoğu ABD'den, ayrıca İran, Türkiye, Almanya, Danimarka, Kanada, Fransa ve Hollanda'dandır.

Bireysel Özellik Tercihleri. Toplanan işlenmemiş verilerden tüm özelliklere ilişkin bireysel tercihleri elde etmek için basit bir hesaplama yapılması gerekmektedir. Özellik tercihlerine ilişkin net bir liste oluşturulduktan sonra, güvenilir olmayan yanıtların çıkarılması gerekmiştir. İlk aşamada, sonuçların dikkate alınması için anketi tamamlamak için harcanan sürenin beş dakikadan fazla olması gereklidir. Katılımcıların geniş bir tercih ölçeğinde en az belirli bir sayıda bina görüntüsünü bir'den beş'e kadar derecelendirmiş olması gereklidir. Buna ek olarak, mimari bölümüne uygulanan yarıya bölme yöntemi, birinci ve ikinci görüntü setleri arasındaki tutarsızlığın ortalaması ve standart sapması gibi güvenilir yanıtların ayrılmasına yönelik bazı ölçütler sağlamıştır. Müzik bölümü için, en az belirli sayıda müzikal özelliğe yanıt verilmiş olması ve kabul edilebilir bir tercih aralığı olması gereklidir. Bu ölçütlerin karşılanmaması halinde yanıt güvenilir sayılmamış ve çalışmadan çıkarılmıştır. Sonuç olarak, belirtilen eleme ölçütleri ile güvenilir yanıtlar elde edilmiştir. Son olarak, özellik tercihleri toplamı elde edilmiş ve birinci ve ikinci çalışmalar için sırasıyla 450 ve 500 üzeri güvenilir yanıt elde edilmiştir. Veri tabanına uygulanan tüm eleme ölçütleri Microsoft Excel Developer üzerinde yazılan bir kod ile otomatik olarak hazırlanmıştır.

Korelasyon Analizi ve Eleme. Özellik tercihleri için net setler oluşturduktan ve güvenilir olmayan yanıtları eledikten sonra, Pearson Korelasyon Katsayısı kullanılarak korelasyonlar analiz edilmiştir. Yaş ve cinsiyet demografik özellikleri ilk ve ikinci çalışmaların korelasyon analizine uygulanmış, böylece katılımcı kategorileri arasındaki olası korelasyonlar bulunmuştur. Ana çalışmada eğitim de dikkate alınmakta ve bir dizi demografik kategori arasındaki korelasyonlar incelenmektedir. Pearson katsayı analizi, korelasyonun istatistiksel geçerliliğini gösteren bir p-değeri ve korelasyon gücünü yansıtan bir r-değeri üzerinden korelasyonları göstermektedir. Korelasyon analizinin tüm sonuçları istatistiksel açıdan geçerli ve belirgin değildir. İlk olarak, çıktılardan p-değeri temelinde 0.05'ten düşük olanlar bir kez elenmiştir. İkinci ve üçüncü çalışmalarda istatistiksel açıdan en geçerli korelasyonları ayırmak amacıyla en katı Çoklu Test Korelasyonları olarak Bonferroni yöntemiyle entegre edilmiştir. Tüm istatistiksel açıdan geçerli korelasyonlar çalışmanın çıktılarıdır ve eklerde sunulmuştur; bunun dışında, daha yüksek r-değeri olan güçlü korelasyonlar tezin çıktılarında irdelenmiştir. Ana çalışmada çok yüksek sayıda korelasyon incelendiğinden, sonuçlar kategorize edilmek ve K-ortalama kümeleme yöntemi suretiyle özetlenmiş, böylece çıktılara ilişkin kümülatif bir bakış açısı sağlanmış ve korelasyon bulunan mimari ve müzikal özelliklere ilişkin daha bütüncül bir anlayış sağlanmıştır.

Çıktılar. İlk çıktı olarak, tüm çalışmalar mimari ve müzikal özellik tercihleri arasındaki korelasyonda demografik sınıfların önemini teyit etmektedir. Bulunan korelasyonlarda yalnızca yaş ve cinsiyet izi bulunmakla kalmamış, hatta bazı durumlar farklı demografik sınıflar arasında tersi eğilimler sergilemiştir. Örneğin, viyolonseli tercih eden genç kadınlar bina cephesinde ahşap veya taş için daha yüksek memnuniyeti yansıtırken, olgun kadınlar için tuğla ve alüminyumda daha yüksek memnuniyeti yansıtmaktadır. Katılımcıların eğitim düzeyini de dikkate alan ikinci çalışma, büyük ölçekte, eğitimin bulunan korelasyonlar üzerinde yaş ve cinsiyetten daha yüksek etkisi olduğunu göstermektedir. Bu üç demografik özelliğin önemini desteklemektedir.

Çıktılar. Bu üç çalışma demografik sınıfların, özellik kategorilerinin ve özelliklerin daha yüksek sayıda korelasyonu yansıttığını göstermektedir. Örneğin kadınlar için mimari ve müzikal özellik tercihleri arasında erkeklerden daha fazla korelasyon görülmektedir. Birinci çalışma malzeme rengi ve malzeme özelliğinin müzik enstrümanları ile en çok sayıda korelasyon gösteren kategoriler olduğunu ortaya koymuştur. Benzer şekilde, üçüncü çalışmada kümülatif bakış açısı ile müzikal özellikler sınıflandırmasından Tür, Müzik Türü (FFM) ve mimari özellik sınıflandırmasından Girinti, Kompleksklik ve Simetri daha yüksek sayıda korelasyon yansıtmakta, bu kategorilerin farklı bir alanda bireyin zevklerini daha iyi yansıttığına işaret etmektedir. Ayrıca rap ve jazz tür kategorisi, FFM kategorisi M-tipi ve C-tipi, PPA'lerde gelişmiş ve şiirsel/derin ile 3-faktölerde derinlik daha yüksek sayıda korelasyona sahiptir; dolayısıyla farklı bir alanda bazı özelliklere ilişkin tercihleri daha iyi yansıtabilir.

Pearson Analizi Çıktıları. Pearson analizinin sonuçları ilk çalışmada, viyolonseli daha çok tercih eden olgun kadınların tercihi tuğla, deseni vurgulu malzemeler, alüminyum, yansıtıcı ve açık renkli malzeme için daha yüksek memnuniyet değerini temsil etmektedir. Orta yaşlı erkekler arasında flüt tercihi tuğla ve siyah renkli malzemelerde daha yüksek memnuniyet oranı göstermektedir. Ikinci çalışmanın sonuçları, büyük ölçekte, Amerikan Folk Müziği ilgi duyan erkek müzisyenlerin, olgun müzisyenlerin ve hatta mimar-müzisyenlerin gelişmiş mimari yapıları tercih etme eğiliminde olduğunu göstermektedir. Pop müziğe ilgi duyan kadın mimarlar ile mutlu ve neşeli müziğe ilgi duyan erkekler tamamen simetrik mimari yapıları cazip bulmaya daha yatkındır. Rock takipçisi müzisyenler karmaşık mimari yapılardan daha az memnuniyet duymaktadır. 65 yaşın üzerindeki kişiler yumuşak müziklere ilgi duyuyorlarsa simetri tercihleri daha yüksek olmaktadır, 45 yaşın üzerindeki kadın mimarlar ise Soul müziğe ilgi duyuyor olmaları halinde basit bina yapılarını tercih etmektedir. Kadın mimarlarda hüzünlü müzik tercihi bina yapılarında yataylık tercihi eğilimini yansıtmaktadır.

Pearson Analizi Çıktıları. Üçüncü çalışmanın küme bazlı çıktıları korelasyonlara ilişkin bütüncül bir anlayış sağlamaktadır. Karmaşık müzik tercih eden kişilerin Karmaşık mimari yapılarla ilgili daha olumlu görüşleri olduğunu teyit ettiği görülmektedir. Sayıca az olmakla birlikte, Dans müziği seven kişilerin Ritmik ve karmaşık binaları tercih ettiğine işaret eden güçlü korelasyonlar bulunmaktadır. Yumuşak müzik takipçileri arasında, genel olarak Basit mimari yapılara ilgi duyan kişiler bulma ihtimali daha yüksek olmakla birlikte, çok karmaşık bina yapılarını tercih eden nadir durumlar da görülmektedir. Rap takipçileri genel anlamda bina tercihlerine daha yüksek dereceler veriyor gibi görünse de, sonuçlar bu grubun Karmaşık bina yapılarına eğilimli olduğunu ortaya koymaktadır. Neşeli müzik takipçileri mimaride düzenli desenlere eğilim göstermektedir. Rap müzik sevenler formal yapıda tekrar hissi veren düzenli veya düzensiz desenleri tercih etmektedir.

Toplamda çok sayıda korelasyon keşfedilmiş olması, mimari ve müzikal özellik tercihleri arasında uyumlu bir ilişki olduğunu teyit etmektedir. Özellikler arasında sağlanan köprü, müzik zevkini kullanma imkanı sağlamakta, genel anlamda mimari özellik tercihlerinin bir yansıtıcısı olarak müzik tercihine ilişkin sayısız çalışma ile örtüşmektedir. Son olarak, çalışmada mimari ve müzikal özellikler arasında çok sayıda korelasyon bulunduğu teyit edilmekte, bundan doğan içgörülerin gelecekte bina tasarımlarına uygulanması için bir potansiyel teşkil edilmektedir.

1. INTRODUCTION

“I call architecture frozen music” by Johann Wolfgang von Goethe (Barnstone, 2015) and “music is architecture in movement” by Iannis Xenakis (Xenakis, 2008) show the existence of robust interrelation between architecture and music. The two mentioned statements, from architect’s and composer’s points of view, vividly express the great linkage between architecture and music, to the extent of considering them as one unified essence. Michael Ostwald separated the relationship into ‘utility’ which focuses on acoustic science and ‘analogy’ which refers to the term “frozen music” of Goethe (Benedikt, 2014). Focusing on the analogical interrelations, despite various points of view, many philosophers and specialists discussed the interrelations between architecture and music like Arthur Schopenhauer, Steven Holl, Leon Battista Alberti, Louis Kahn, and Charles-Edouard Jeanneret, known as Le Corbusier.

There are many theoretical interrelations and shared discursive terms between the two disciplines. The notions of shape, form, space, and time, as well as smaller-scaled terms including transitional space (Mahjouri, 2000), modularity, rhythm, sequence, proportion, distance, height, balance, weight, interval, and proportion exist in both architecture and music. Despite some differences in the terms explanations, many theoreticians encouraged to use the similarities in interrelated projects. For example, Vitruvius and Xenakis have evidently advocated the use of structural elements from music to organize architectural composition (Barnstone, 2015) and Alberti vividly expressed the importance of borrowing rules of harmonic music for applying into architecture (Alberti, 1955; Kong et al., 2017). In practice, the musical proportion, rhythm, and musical orders of polyphonic music of the time is illustrated in the modification and development of the Saint Ivo church by Borromini, the architect of Sapienza (Benedikt, 2014); and the musical sequence and modularity are visible in undulating pans of La Tourette by Le Corbusier (Xenakis, 2008). From another point of view, architectural proportions influx into the musical realm; “Warren (1973) and Trachtenberg (2001) identify Guillaume Dufay’s 1436 motet Nuper Rostrum Flores as containing an elegant manifestation of the proportions of the newly completed Florence Cathedral dome of Filippo Brunelleschi” (Fowler, 2011).

Apart from the influxes of shared terms in the interrelated projects, the whole structure of architectural composition can be affected and even derived from either small-scale music characteristics and its large-scale internal structure of music. For example, Iannis Xenakis translated the small-scale musical concept of Metastasis into hyperbolic parabola shapes as the structural composition of Phillips Pavilion of the Brussels World Fair in 1958 (Xenakis, 2008). From another stance, composer Claudio Monteverdi "makes extensive use of the balconies at St Mark's Basilica for floating brass choir effects" that articulate spatial perception of the early Baroque masterpiece: Vespro della Beata Vergine 1610 (Fowler, 2011).

As large-scale formation samples, Steven Holl takes advantage of Bela Bartok's Music in the design of Stretto House projects in both large scale composition of the whole building (based on the composition of heavy percussion and light violin in music), and small-scale proportion, numerical orders, and textural combinations (Fowler, 2011). Similarly, whether being assumed as a superficial compositional imitation or deep methodological compositional characteristics, the illustrated collage-like composition of a grid, curved lines, random points, and straight line of Fontana Mix music piece by John Cage can be similarly and analogically seen in the superimposition of three autonomous systems of points, lines, and planes in Parc de la Villette in Paris by Tschumi (Benedikt, 2014). In landscape architecture, Toronto Music Garden by Yo-Yo Ma and Julie Moir Messervey is designed based on Bach's Cello Suit #1 in G Major and, according to Brenda J.Brown, can be assumed as its spatial translation of the music piece (B. J. Brown, 2014).

Apart from the aforementioned technical interrelation, architecture and music have always been as an inspiration source (F. Tayyebi, 2013). For example, Michael E. Veal analogically compared the whole structure of Miles Davis's jazz and architectural artwork of F. Gehry, Z. Hadid, P. Eisenmen, and P. Shumacher (Veal, 2014). He analogically compared the warping system of Gehry and architectural Ribbons of Zaha Hadid, curving back upon and across each other in architectural form, with "the Lost Quintet" by Miles Davis departing from tonality and metered time. Finally, he declares Eisenman and Schumacher "destabilize solid elements by blending them with more fluid processes," and Davis "seeks to ground a fluid element by blending it with a more stable, repetitive form." He believed them as a mirror image of each other "capable of implying motion and stasis simultaneously" (Veal, 2014, p. 40). As a music piece can inspire architects to embody some aspect of the musical comprehension, architectural space or the composition of architectural elements can inspire musicians. As an instance of this internal influence, Whittington argues that “the aesthetics of traditional Japanese gardens can provide insights into Cage’s work as a whole” like the internal influence of traditional Japanese gardens like garden Ryoanji (1983-1985) on Cage’s work (Whittington, 2013).

Interestingly, most of the interrelations between architecture and music, in various scales, are formed by some assumed interrelated parameters that are mostly based on the subjective artists’ opinion or rooted in more-objective technical issues. Whether the parameters being about the same feeling arousal or not, they are assumed as peer parameters and transformed into each other. For instance, ‘interval’ in music has been arguably understood as ‘proportion’ in architecture; accordingly, the harmonic musical applied in architectural proportion with the hope of acquiring a pleasant architectural ratio. Otherwise, a few scholars concern if the attributes arise similar perception and feeling; do transforming audible harmonic intervals result in pleasing visual proportions in architecture? Is there any relationship between the satisfactory visual attributes of architecture and audible attributes of music?

From another perspective, extracting the aesthetically-preferred architectural attributes is critical in architectural design and always be the central core of many studies in architectural aesthetics. Since the aesthetic assessments of building forms are, whether or not, under the influence of the physical attributes of the building elements (Gifford et al., 2000), it is significant to discover the existence of what attributes can increase the positive response or higher appraisals to architectural forms. For example, people tend to rate higher to larger buildings (Silvera et al., 2002), objects and buildings with curvature (Bar & Neta, 2006; Silvia & Barona, 2009), the interior spaces containging visible windows (Kaye & Murray, 1982), and buildings with visible entrances (Herzog & Shier, 2000). Among them, there are some common attributes which are found influential; for example, complexity was found influential on residential building façade preferences (Akalin et al., 2009), appraisals of storefronts (Çakırlar, 2010), and building preferences in general (Herzog & Shier, 2000) (Tinio & Leder, 2009) (Imamoglu, 2000). More specifically, another study showed that the existences of some attributes can increase the satisfaction rates of police station façade, including being foursquare, having well-defined entrance, possessing massive-transparent, being legible and elaborated, and etcetera (Dinç Kalaycı & Bilir, 2016).

But, several studies have addressed the aesthetic judgment differences between designers and non-designers. As an earlier empirical evidence reflecting the difference between architects, pre-architects, and laypersons, Hershberger found that the architects differed significantly from the other two groups in the perceived physical settings and building ratings (Hershberger, 1969). In addition, Robert Gifford in several studies replicated the difference between architects and laypeople. By focuding on office buildings, he and his colleagues showed that except fancincess, other 11 considered physical attributes were interrelated differently to arousal and pleasantness as emotional impact of the attributes by architect and non-architect (Gifford et al., 2000). Groat shows generally laypeople sort buildings on the basis of preference and type, whereas architects used categories such as design quality, form, style, and historic significance (Groat, 1982). Architects were more driven by building materials whereas laypeople were more driven by building form; even they often disagree about the aesthetics of contemporary buildings (Gifford et al., 2002).

Architecture education impacts in individuals' value sets, and aesthstic judgements, even more than cultural factors (Dinç et al., 2013) (Dinç & Yüksel, 2010). It is shown that freshmen architectural students acknowledge the objective qualities of the architectural projects, while pre-architects were more evaluative, reliant on concepts, connotative values. (Erdogan et al., 2010); similarly, as confirmed by another study, non-architects tended to provide descriptive evaluations whereas architects provided evaluations that were more abstract and conceptual (Devlin, 1990). As Wilson explains, during the course of architectural education, students develop increasingly abstract and more differentiated concepts, which become more complex with increasing length of education. (Wilson, 1996); during their years of education, young designers tend to shift their memorable imagery from concrete, physical to more complex, abstract imagery (Downing, 1992).

Not having a congruent perspectives toward the pleasing physical attributes in building appearance not only provide incongruent opinion about building appereance, but also prevent architects to predict the public's aesthetic evaluations of architecture (Nasar, 1988). Thus, architects still need to know more, from a lay viewpoint, about the physical values of building facades and a delightful building appearance, in order to provide an appreciated building forms from people's point of view. In our contemporary era, when personal values and subjective interests are getting increasingly significant, it is a great curiosity to know more about different mediums which can reflect the satisfactory architectural attributes of laypeople. Furthermore, under the influence of technological advancement, the professions are getting more and more interrelated, interdisciplinary research progressively becomes significant. Consequently, it is the right time to explore the correlation between the satisfactory attributes of architecture and music to discover which attributes are more interrelated to be applied in interrelated projects, and to examine if musical taste of laypeople can reflect their architectural attribute satisfactions. Thereby, provide a foundation for having more robust interrelated projects and consciously utilize music as a reflector of architectural attribute satisfaction from the laypeople.

After this brief introduction, the next following parts of this chapter clarify the main issues related to the thesis. The problems which this study aims to tackle, the dissertation hypothesis, and the aim of the study will be discussed in the subsequent parts of this chapter. This study is not the only research about the relationship between architecture and music, but it has two main unique aspects, which are discussed afterward. Regarding the fact that this study is architectural research in the field of architectural design, the relationship between the expected outcomes and architectural design process is discussed subsequently. In the end, after having a general understanding of the study, the structure of the methodology framework and the structure of the booklet are briefly mentioned.

1.1 Problem Statement

Generally, this study aims to tackle two problems. The first problem pertains to the feeling arousal of the considered interrelated attributes. Some attributes being considered as peers merely based on the artist's opinion, without concerning the feeling provocation and pleasantness effect from the observer's perspective. For instance, 'interval' in music is assumed as 'proportion' in architecture, though the feeling raised from the two attributes is discerned. Does a satisfactory musical interval reflect a pleasant architectural proportion? Is there any correlation between the preferences of satisfactory musical intervals and their transformation into architectural proportions? Similarly, Thomas Baker vividly introduces the significant compositional parameter of “time” in music as “span” in architectural discipline (Ostwald, 2014); Does anyone who likes a long span in architectural space prefer lengthier musical notes and sections? Although various aspects of music are transformed into architectural features in the interrelated projects, the individual opinion and the provoked senses are the missing parts. Thus, as the main problem, this study tries to consider the individual’s opinion on the architectural and musical attributes.

Some attempts have been emanated to concern the user/clients’ opinions during the architectural design process, like user participation in design. Although Users’ comments over the meetings during the design process of architecture significantly altered the design decisions and brought more satisfaction for the clients, new researches show that user participation has more substantial effects on usability and functional matters than the aesthetic aspects (Farel et al., 2013). That is to say, meetings with the clients could not significantly improve the aesthetic aspects and the satisfaction of the physical appearances of buildings.

In addition, as briefly discussed earlier, the difference between architects and laypersons resulted in architects to be unable to predict how laypersons would assess buildings, even when they were explicitly asked to do so (Nasar, 1988). As examined by another study, architects’ prediction on laypersons' responses to large contemporary building were poorly correlated with ratings by laypersons; though some architects were better in rating predictions, architects were generally could not meaningfully predict the satisfaction of building appearance, and preferred architectural attributes in building facades (G. Brown & Gifford, 2001). Despite many efforts for considering the personal values, not every architectural design reaches a satisfactory aesthetic level. This research, as another endeavor to tackle this problem, aims to find the relationship between the individuals’ subjective opinion of architectural and musical attributes, thereby provide an opportunity to utilize the musical taste of clients as a reflector for the architectural aesthetic preferences.

1.2 Research Hypothesis

Considering music as a reflector of architectural taste can somehow be assumed as the thesis hypothesis. Many researchers discuss and believe that people’s musical taste among various alternatives and several modes can reveal their tastes and personal interests. As writing style and selected words in a text can be an indicator of the writer's personality (Short, 2005), music as "another kind of language" reflects personal interest (Wu et al., 2010). From this perspective, music is not merely a kind of entertainment or enjoyable artwork; instead, it is another kind of language that represents the human mind. Architectural facades, make stimuli, and being perceived by the viewers' sensations, and interpreted in the viewer's mind; thus, like any artwork can transfer meaning and judged by observers. Architectural facades can transmit impressions and certain messages, through visual communication (Gibson, 1950) (Dinç Kalaycı & Bilir, 2016). Thus, it is possible to consider architectural attributes as texts reflecting the architectural tastes of the viewers. Regarding the robust interrelation between architecture and music, people's favorite musical attribute may reflect their architectural taste and desired visual attributes, and vice-versa. In this case, this study examines if music as an indicative of personal tastes can reflect the pleasant architectural attributes.

1.3 Research Questions

To tackle the discussed problems by considering music as a reflector of personal preferences, the purpose of this research is to investigate the relationship between the preferred architectural and musical attributes. In other words, this research explores if there is any relationship between the preferences of visual architectural attributes and audible musical attributes. By concerning the individual's preferences of the architectural and musical attributes, this research deductively aims to discover the most frequently correlated attributes. Accordingly, the musical taste can reflect the preferred architectural attributes, and the correlations enable architects to consider the preferred attributes in building design and approach the buildings to the clients' preferred features. In brief, as the graph below shows, this research aims to disclose the correlation between the preferences of architectural and musical attributes to find answers for the following questions.

Figure 1.1 : Aim of the study.

- Is there any correlation between the preferred architectural and musical attributes of people? What are the most frequently correlated attributes?
- More specifically, on a small scale, which musical instruments preferences correlate with architectural material satisfactions? On a large scale, which musical attribute preferences correlate with architectural attributes satisfaction?

1.4 Unique Aspects

This study has two related unique aspects. The previous studies on art preferences mostly concern one art form for its own sake, or finding relationships between one art form and an external factor, like exploring the relationship between music and personality or gender. In contrast, this study directly investigates the relationship between the preferences of two arts, the preferences of architectural and musical attributes. In addition, the previous studies mostly concern classifications, like western and non-western music classes, or five types of personality. Since art classifications have an ever-changing unstable essence and is like the accumulative of several qualities, there is inconsistency in the study outcomes. As a brief instance of controversial results, Langmeyer et al. (Langmeyer et al., 2012) found that individuals with O-type personality prefer Complex and Intense music, while Bodner and Bensimon point their desires toward Intense and Energetic (Bodner & Bensimon, 2014). This study, instead of concerning classification as the mold of accumulated characteristics, focuses on smaller-scaled more-rudimentary primary attributes, despite the trace of the basic classification in the music section. Consequently, as the two unique aspects, this study investigates the correlations between architecture and music in a direct manner and via the most rudimentary attributes, without involving the traditional classifications.

1.5 Expected Outcomes and Architectural Design

As an investigation in the field of architectural design, the outcomes of the thesis should be related to architecture. Regarding the aim of the study, by discovering the interrelations between the preferred architectural and musical attributes, the musical taste of a client or a group of users can reflect their preferred visual attributes in a building; this makes architects capable of considering the users' or clients' taste in the design process of a building and make the building appearance more satisfactory. In other words, making a bridge between the preferred architectural and musical attributes enables us to discover the architectural preferences with the easily discoverable musical taste. For instance, if the preference of violin positively correlates with the preferences of whiteness in architectural facade, which it means preferences of violin shows higher satisfaction for white material, then architects might consider the white material preferences of violin-followers in the architectural design process of the building, and hopefully, make the buildings features more satisfactory. Thus, in brief, this research makes a platform for utilizing music as an indicator of the client's preferences.

Using music as a reflector of architectural taste has two main advantages. First, the musical preferences of some project users are more accessible than their architectural taste; and second, the uncountable number of studies on musical taste can then be utilized in the field of architecture. As an example, the long background of children's or elderly's musical taste can reflect their satisfactory musical attributes; accordingly, the study outcomes can reflect their architectural taste, and thus potentially enable architects to apply them in the design process of kindergartens to make them more pleasant from children's perspective and elderly houses to or make them a real retirement home at least from an aesthetical point of view. For designing a building for a particular region with a special taste, the main characteristics of favorable music of the area can make the building more pleasant for the local people. Consequently, this paper opens a new way of understanding people's desire to reach more pleasant architectural forms. Worth mentioning, concerning the individual's desire, should not lead to ignoring the internal architectural principles or closing our eyes on other architectural aesthetic actions. Rather, the expected outcomes will reflect the satisfactory attributes as another set of considerable issues in the design process of a building, with the hope of acquiring more pleasant architectural forms.

1.6 Methodology Framework

A three-phased methodology is designed to find answers to the dissertation questions. The first phase provides the raw data; a list of the considered attributes is defined, and then a survey gathering the raw data is prepared and distributed. In the second phase, the participants' responses are analyzed to provide a complete set of attribute preferences. The responses are then filtered out to distinguish the reliable ones. In short, this phase provides a set of architectural and musical attribute preferences of reliable responses. Finally, in the third phase, Pearson's correlation coefficient analysis examines the correlations between every single attribute within different demographic categories. The outcomes of the analysis are then filtered once by the correlation p-value to ignore the statistically invalid correlations; then, Bonferroni correction, as a second filtering technique, is applied to skim off the utmost reliable correlations. Although the discovered correlations are indeed the thesis outcomes, categorizing and clustering methods have also applied to the correlated attributes to provide a meaningful summary of the results. The above steps are illustrated in Figure 4.1 on page 44 and explained more in the subsequent sections.

1.7 Structure of the thesis

After having a general understanding of the research in this introductory section, the subsequent chapters go into the study in detail. The next two chapters discuss the architectural and musical attributes. They provide the prerequisite information on the considered attributes and discuss how the individual satisfaction of the attributes are discoverable. Please consider, these sections are more like the pre-requisite information supporting the methodology of the dissertation. Chapter four, entitled RESEARCH DESIGN AND PROCEDURE, discusses the methodology procedure and reflects the applied methods in detail to discover the preference correlations between architectural and musical attributes. Chapter 5 reflects the outcomes and discusses the methodology results. Finally, the conclusion in Chapter 6 sums up the findings and makes a general understanding of the discovered correlated attributes. Please consider the first paragraph of each chapter providing a summary of the section, to increase the legibility of the booklet.

2. ARCHITECTURAL ATTRIBUTES

This section discusses on how to define a clear set of visible architectural attributes and how to extract the personal preferences of the attributes. Two studies are conducted to define a comprehensive list of visual attributes and to introduce a reliable method to extract personal preferences. The first study proposes a systematic method to define a list of visual attributes of building facades (S. F. Tayyebi & Demir, 2019), and the second paper, after examining various techniques, discusses on how to extract the individual preferences of building attributes (Tayyebi & Demir, 2020). On their basis, at first, a systematic method is proposed to define a clear list of visible attributes in building forms. After applying the method to 200 different building forms, the second section accordingly makes a list of the most common attributes. Lastly, the third section discusses on various techniques for extracting the individual preferences of the attributes, and reflect the most reliable method to extract the personal preferences of the attributes.

2.1 Defining Architectural Attributes Procedure

The procedure aims to introduce a systematic method for defining the visual attributes of a building. Based on the composition definition and by concentrating on building façades, a composition graph for a building is prepared; then, the attributes extracted accordingly. Despite experiencing many definitions, the term ‘composition’ is generally defined as “variety in unity”; or as “containing differences within a unified whole.” (Li, 2010). In brief, various elements, as ‘composition elements,’ are connected together to form a composed element, knows as ‘unified object.’ Thus, the notion of composition concerns with the unification of various elements. In other words, a unified object contains various interconnected elements; the unified object and the elements can be allocated to a different layer of composition. From the scale point of view, the elements belong to a smaller scale, and the unified object is located in a larger scale. Thus, each composition has 2 main layers, the layer of the elements in a smaller scale and the layer of the unified object on a larger scale. Accordingly, a composition layer refers to a specific scale in which the composition elements or the unified object of composition exist within. Figure 2.1 illustrates the definition of composition and its assigned composition layers.

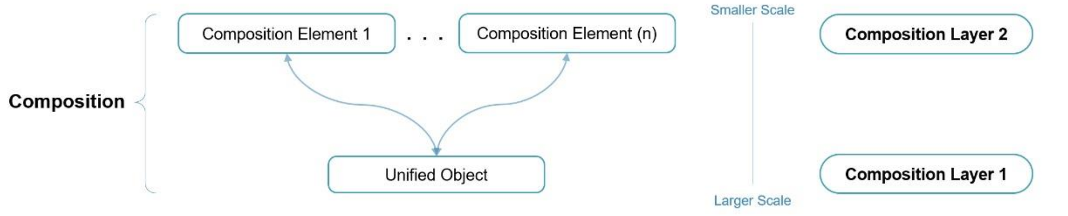

Figure 2.1 : Graphical composition definition & scale-based composition layers.

Each composition element might be considered as a unified object of other smaller-scaled elements. Likewise, a unified object can also be a component of another larger-scaled composition. Composition has chain-like composition elements and unified object, possessing a fractal essence (Figure 2.2, right). From this perspective, any architecture element is composed by some material, which is constitute by some ingredients. In a larger scale, Durand discusses, "Buildings are the elements of which cities are composed" (Durand, 2000, p. 143); Blondel similarly believes on "no discontinuity between architectural and urban design" (Lucan, 2012, p. 17). Thus, the chain of composition can exceed the architectural realm, from material science to urban studies. To provide a composition graph and provide a list of architectural composition attributes, the fractal nature of composition needs a proper limitation for both the smallest and the largest scales (Figure 2.2, left).

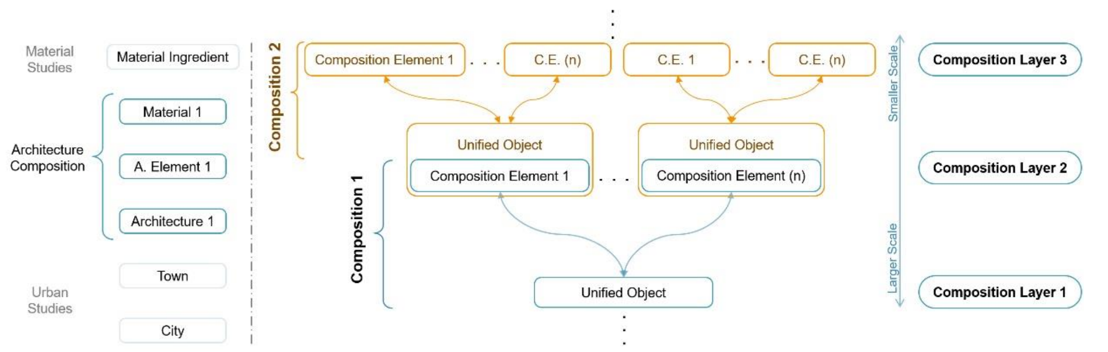

Figure 2.2 : The chain of composition layers.

Among the concentrated scale range, there might be a various number of intermediate layers. For instance, defining a building as the composition of some materials makes no intermediate layer between material and building, as the smallest and the largest composition layers, respectively. Instead, by considering a building as a composition of walls, roofs, and windows, one intermediate layer as *building elements* is introduced to the composition graph. Similarly, French architect J.N. Huyot proposes the order of building composition as architectural elements (like shaft), architectural type (column with capital), a simple subject (like vestibule), and complex subjects (like building), regarded here as four composition layers (Lucan, 2012, p. 88). Alternatively, the graph below illustrates six composition layers from the architectural material to the building (Figure 2.3). Worth mentioning, although the number of layers correlates in defining composition attributes, a higher number of layers does not necessarily lead to more comprehensive composition attributes. Instead, to have a well-organized list of attributes, instead of an exhaustive number of layers with little difference in scale, distinctive composition layers are required. Hence, the redundant intermediate layers should be discerned, as supposedly the three intermediate layers are eliminated in the graph below.

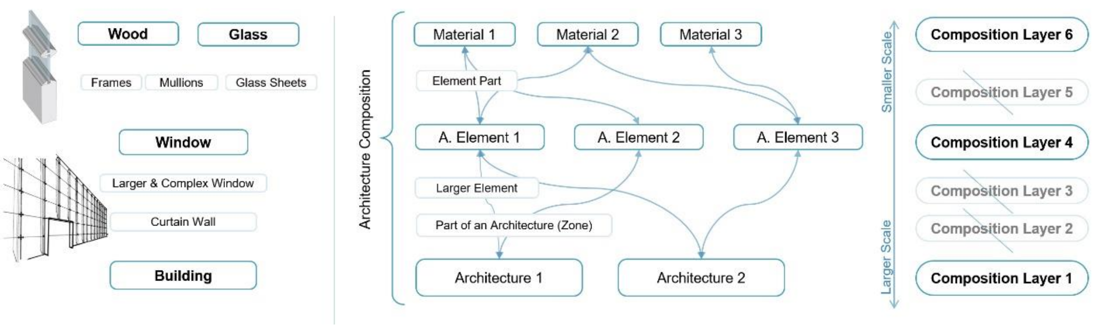

Figure 2.3 : Various intermediate layers for a composition graph.

The considered scale-range and the number of intermediate layers are under the influence of various issues. The object, either a building, a building section, or a wall component, is mainly the ultimate unified object in the composition graph. The profound influence of material in the newly constructed buildings leaves no place to discern it as the smallest influential layer of the composition. After defining the smallest and the largest scale of the composition layer, the intermediate layers are defined, which are under the influence of various issues related to both observer and building properties, including observer’s standpoint, its distance to the buildings, the accuracy of the perception, building details, overall building form, the number of elements, etc. Although various issues influence the number of the identified layers, the quantity of the layers is not a significant matter; instead, as far as the layers are distinctive and entirely understandable, regardless of their quantity, they will lead to a proper list of composition attributes. The number of intermediate layers is adjustable to our needs, which will be clarified after having a general insight into the whole procedure.

After having the composition layers defined, it is time to clarify the components of the composition layers referred to here as families. *Each distinctive component of a layer* is called a family. For instance, if brick, stone, and wood are the material of a considered unified object, the families of the material layer would be *brick, stone,* and *wood.* Noteworthy, each family must be independent of another family in the same layer; otherwise, the family belongs to another layer of composition, and the layers or the families need revision. For instance, a combination of wood and brick is not a material family; instead, it belongs to a larger-scale layer of the composition. Having the chain-like nature of the composition in mind, each family is formed by the assemblage of some other families in the smaller-scaled layer. For example, a distinctive *wall* as a family of *element layer* is formed by one or some families in the *material layer, like brick or wood*. Therefore, the relationship between the families is gradually being revealed. As an example, figure 4 shows a composition graph with 3 composition layers and five composition families.

Following the procedure, each family has some properties presented below each family in figure 2.4. For instance, color, texture, reflectivity, and so forth are the features of a material, as a family member; and shape, direction, and contour properties can be the properties of a plate as a family in the architectural element layer. A proper list of the family properties, can be obtained with the aid of theoretical discourses, personal experience, even comparing the families, as well as the software simulating realistic images. For example, 3ds Max lists various properties of a material in a user-friendly order; it can make an assistive list of properties such as quality, color, texture, pattern, pattern size, transparency, translucency, reflection, self-illumination, edge-properties, index of refraction, roughness, and so on. Since this study focuses on the visible composition attributes in building images, the very distinguishable properties need to be identified, rather than a vast number of properties hard to specify. Finally, after defining the composition layers, families, and their properties, a composition graph is provided to reflect a list of visual building attributes.

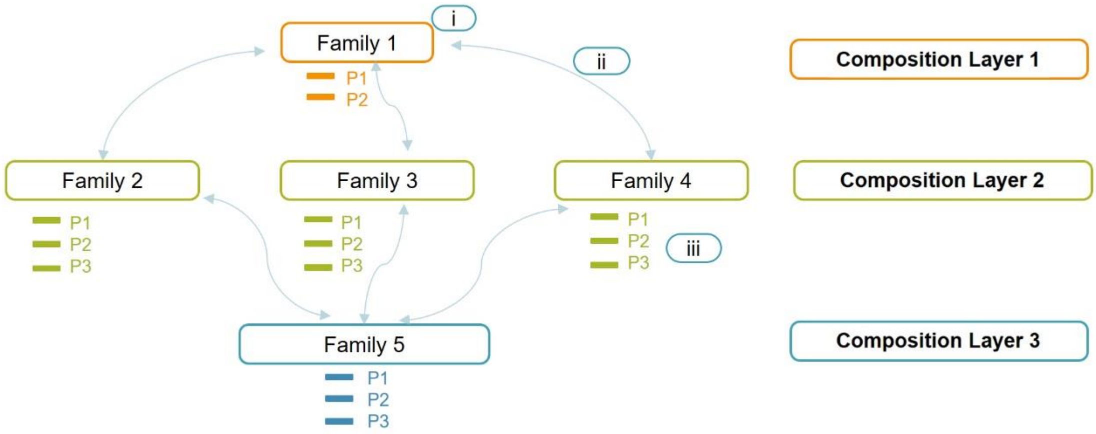

Figure 2.4 : An abstract sample of a composition graph.

Arising from the composition graph, Figure 2.8, there are three main roots for the composition attributes: (i) The overview on the family (rectangular shapes in the graph), (ii) the relationship between the families (lines in the graph), and (iii) the family properties (the features under each family). The first two roots are the general overview of the composition graph, and the last one focuses on the properties.

(i) The families' overview leads to some composition attributes and their allocated values. For example, the existence of just one family in the material layer will lead to the *number of material (single material)*, as a composition attributes and its value in parentheses; in case of existing five family members in the architectural element layer, then an attribute would be the *number of elements (five or many)*. Worth mentioning, the number of layers can also reflect a composition attribute.

(ii) The lines showing the relationship between the families reflect another set of composition attributes. For example, if all building elements had been formed by just one material, the *number of material in each element (one)* would be a composition attribute.

(iii) In most cases, family properties are the primary source of the composition attributes. Each property mostly reflects the value of composition attributes. For instance, plain white as a property of a family in material scale, the right-angle cube as a property of an element family, and symmetry as a property of the unified object are the value for the *material color (white), material texture (no texture/plain), element geometry (right-angle cube), and building symmetricity (symmetry).*

While providing a list of the attribute, please consider, if there was just one family in a composition layer, then all of its properties can reflect some attributes. In the case of existing more than one family in a composition layer, the relationship between them may lead to a more meaningful list of attributes. For instance, if black and white materials are utilized in a building form, the relationship between their colors, which is *in-contrast*, would be the value of an attribute: *material color (in-contrast)*. Noteworthy, a highly detailed graph may lead to a huge number of attributes which are not really influential on our building preferences. Thus, the most significant ones may need to be filtered out. In case of focusing on some particular issues, the attributes need selection accordingly. Finally, the attributes need refinements to have the most remarkable composition attributes.

While applying the method for a set of buildings, the attributes and their values should be harmonized since it makes more sense to have a proper list of attributes covering them all. After gathering the significant composition attributes of each building, a set of attributes and their quantified values can be prepared, and each composition attributes and their values should be accordingly revised and adapted. For example, despite the existence of color spectrum, six values with a clear border can be defined, and the attributes can be valued accordingly, like (white, grey, black, light warm color, dark warm color, and cold color). That is, every color attributes have one of these six values, though it may add an ignorable 'aboutness' to the values. This adaptation makes the measurement, comparison, finding similarities, and discovering the differences much easier; in brief, this harmonization makes the method more applicable for many further architectural investigations.

The introduced method is applied to two buildings to reflect the methodology in practice: Stamisol Fa building and Ronchamp Church, respectively designed by Serge Ferrari and Le Corbusier. The samples have very distinctive parts, which comprise one intermediate layer in their composition graph. Thus their graphs have three composition layers (Figure 2.5). The families and very few properties are also provided to attain their composition graph. Providing one graph suffices for clarifying the composition attributes of the images since they have identical composition graphs.

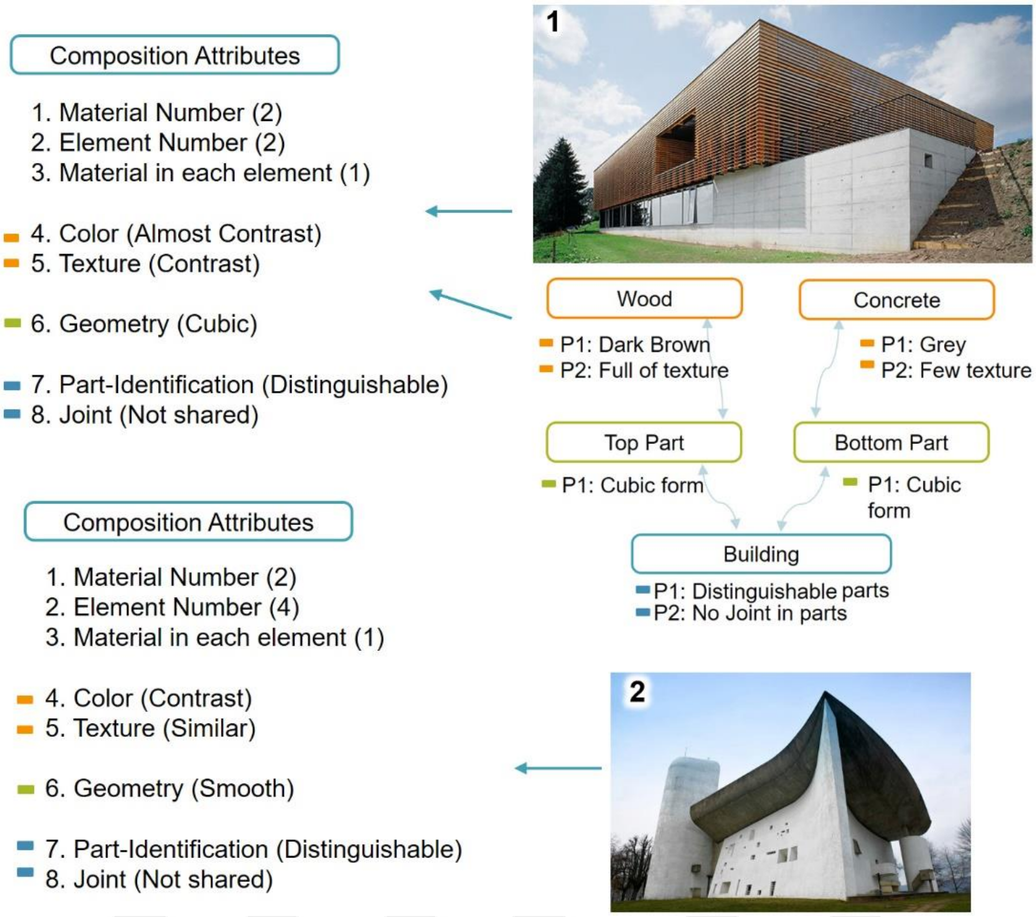

Figure 2.5 : Sample of a composition graph and its attributes.

Figure 2.9 reveals the composition graph and attributes of the first two samples. The graph overview, the families, and their relationship show the existence of three attributes: both buildings have 2 materials with a few elements (Attributes 1&2), and in both buildings, just one material forms each distinctive part (3). The family properties, as another source of composition parameters, reflect some other attributes. Regarding the existence of two families in a composition layer, rather than each property, the relationship between the properties echoes more considerable attributes; both buildings use materials with contrast colors (4). In the first sample, one with a very dense texture, and another has almost no texture; their material textures are *in contrast* (5). While in the second sample, both materials similarly have few textures (5). Having geometry as a property of both elements in the two buildings results in accepting geometry as a composition attribute with the value of *cubic right-angular Pythagorean* for the first and Smooth non-Pythagorean Sculptural-like for the second samples (6). There is no shared area/volume among the distinctive elements of the buildings; parts are distinguishable while there is no joint except their contours (7, and 8). Consequently, this procedure can provide a systematic method to define a list of visual attributes. The most common attributes among the building forms are discussed in the next section.

2.2 A Set of Architectural Attributes

Applying this method for a number of buildings can result in attaining a comprehensive list of visual building attributes. After analyzing over 200 diverse building forms provided a clear list of shared building attributes. Each attribute can possess a large number of values; for instance, architectural material as an attribute can be large number of qualities including stone, brick, wood, concrete, aluminum, cement plaster, mirror, glass, ceramic, Cor-Ten, copper, brass, porcelain tiles, and various composite panels. To make a clear set of attributes, the values are limited to the most common easily-distinguishable features, like limiting material qualities to the first six values, as the most commonly-used ones. Similarly, the spectrum-like diverse values of some parameters are quantified into some analyzable and meaningful value groups, like the six values for the material colors, including white, grey, black, dark warm colors, light warm colors, and cold colors. Finally, since the attributes are limited to the properties visible in the building images, the undistinguishable ones are simply discerned like material durability, stiffness, index of refractions, glossiness, and so on. On its basis, a set of building attributes, which are applied in the studies during the dissertation process, are presented below.

Material Quality:

Material Quality reflects the material each building is made by. There are six values for this parameter: Stone, Brick, Wood, Exposed Concrete, Cement Plaster, and Aluminum. Aluminum refers to the aluminum composite panels, generally sold in sheets for cladding. Samples of each value are illustrated below.

Stone Brick Wood

Cement Plaster Concrete Aluminum

Figure 2.6 : Samples of the attributes of material qualities.

Material Color:

In our time, there is no limitation for material color; thus, material color is among a broad spectrum of color. The continuous essence of the material spectrum needs categorizations to provide a clear set of color ranges; thus, the color ranges are divided into 6 color ranges: three colorless range: white, grey, and black, and three colorful ranges: Light Warm Colors (LWC), Dark Warm Colors (DWC), and Cold Colors (CC).

White Grey Black

Light Warm Color Dark Warm Color Cold Color

Figure 2.7 : Samples of the attributes of material color.

Material Texture:

Texture in a material mostly refers to the natural veins and lines in a material, generally having texture in a material contrast being simply plain color. Please consider, pattern concerns the gap between the material parts, mostly produced in the execution process, like a brick thread. In building photographs, generally taken from a far distance, both texture and pattern are commonly inseparable; both are observed as a line confronting pure color and plainness of the material. The texture spectrum is divided into three parts, from pure flat color to full of texture.

Without Texture/Plain with Some Tecture Full of Texture

Figure 2.8 : Samples of the attributes of material texture.

Material Reflectivity:

The color of the reflective material is more dependent to the environmental condition. On the basis, the range of reflectivity is divided into three levels: Matt (the material color is fully independent of the environment), Reflective: (reflects a pale color of its environment or the surrounding area tints the material color), and Very reflective (the material color is fully dependent of the environment). In this image-based study, the index of refraction is disregarded, though it plays a significant role in real-world perception.

Matt Reflective Very Reflective

Matt Reflective Very Reflective

Figure 2.9 : Samples of the attributes of material reflectivity.

Building Symmetry:

The symmetry is divided into four values: Symmetrical (fully symmetrical building facades), Partially Symmetrical (an almost symmetrical building forms with some small-scale asymmetrical objects), Sense of Symmetry/Balanced (an almost symmetrical building forms, with some small-scale asymmetrical elements), and Asymmetrical (no symmetry in either formal structure or its components).

Symmetrical | Partially Symmetrical | Sence of Symmetry | Asymmetrical

Symmetrical | Partially Symmetrical | Sence of Symmetry | Asymmetrical

Figure 2.10 : Samples of the attributes of building symmetricity.

Building Rhythm:

As the word shows, it refers to repeated architectural components in a building. This parameter is divided into three values of Rhythmic (existence of the repeated elements- mostly in structured elements), Partially Rhythmic (possessing some repeating elements- mostly in small-scale elements), and No Rhythm (with no repeating parts).

Rhythmic | Partially Rhythmic | No Rhythm

Figure 2.11 : Samples of the attributes of building rhythm.

Building Pattern:

In contrast to rhythm, generally referring to the repeating elements in one direction, a pattern is like having a matrix-like rhythm in two directions simultaneously. This parameter has three different values of Regular Pattern (with a clear order of repeated elements in a building façade), Irregular Pattern (with repeated elements spread randomly in a building façade), and No Pattern (which refers to buildings with no pattern in their facades).

Regular Pattern Irregular Pattern No Pattern

Figure 2.12 : Samples of the attributes of building patterns.

Building Stress:

Building stress refers to the accented direction in building forms, with their formal structure or elements. Regarding the value spectrum and diverse emphasis from excessive horizontality to exaggerated verticality, this parameter is divided into 3 values: Horizontality (horizontally stressed building façade), Neutrality (no stress in building forms), and Verticality (vertically stressed building façade).

Horizontality Neutrallity Verticallity

Figure 2.13 : Samples of the attributes of building stress.

Building Indentation:

Indentation as building manipulation is generally related to the back and force in the arrangement of the building components. It produces negative spaces or depth in building façade, creating shadow and shaded components. Despite its continuous essence, this parameter is divided into three ranges: No Indent (nearly flat building surface), Almost Indented (with some indentation and depth in building façade), and Fully Indented (possessing deep indentations and shades).

No Indentation Almost Indented Fully Indented

No Indentation Almost Indented Fully Indented

Figure 2.14 : Samples of the attributes of building stress.

Building Complexity:

Complexity mostly refers to the complexity level of the building forms, which is mainly under the influence of component quantity, order, and method of composition. It has three levels: Simple, Moderately Complicated, and Fully Complicated.

Simple Moderately Complicated Fully Complicated

Simple Moderately Complicated Fully Complicated

Figure 2.15 : Samples of the attributes of building complexity.

2.3 Methods of Extracting the Architecture Attributes Preferences

As part of the thesis investigation, we have examined various methods of extracting the architectural attribute preferences. Exploration of several questioning strategies results in distinguishing two main methods of extracting individual preferences: Directly Questioning Methods and Indirectly Questioning Methods. As the title shows, directly questioning methods inquires participants about their satisfaction with each building attributes in a straghtforwrd manner. While, in the indirectly questioning methods, participants rate some building forms, and the attribute preferences are extracted accordingly. In other words, the rates of the building images indirectly reflect the satisfaction of the attributes within the building form.

The first strategy requires a straightforward analysis to extract personal opinion about each attribute. Otherwise, as pilot studies reveal, participants may not be able to distinguish the attributes accurately, they possibly can misunderstand the values, or they even may find themselves uncertain about an attribute satisfaction. For the second strategy, since it is not entirely distinguishable that what formal attributes affected the participants' rate, thus for each attribute, a set of questions needs to be prepared; therefore, it needs more number of questions. Although the second method acquires more reliable raw data faster and easier, it requires more sophisticated analysis. Thus, concerning the positive and negative aspects of each method, both attribute extraction strategies are explored in an investigation; this section mainly summarizes the published paper reporting the examination, to provides a clear method of extracting the architectural attribute preferences (Tayyebi & Demir, 2020).

To sum up, the study examined 4 directly and 4 indirectly questioning methods. At first, the preferences of a set of building attribute are extracted by the eight mrthods. Later on, the eight acquired set of preference values are analyzed via another set of building preference prediction to disclose the most reliable method of attribute preference extraction. The eight data-generating methods are explained below.

Directly Questioning Methods

Method 1: Text-based **Questions**

As the word text-based may conjure, no building image is illustrated in this method. Participants judge the attribute values explained by descriptive words. Understood via a pilot-based survey, a very limited number of attributes might be unperceivable for laypeople; accordingly, a simulated abstract image accompanied some text-based questions to facilitate the attribute perception. Participants select their preference range out of 7 values.

***Method 2: Image-based* Questions**

In this method, each question is accompanied by a set of 3-5 building images sharing the questioned attribute value; participants observe the samples of the attribute value, then rate the attribute value. For instance, while participants are asked to rate black material, some buildings images with black material on their façade are presented as samples, then they rate black material on the building façade. In this method, samples are selected from different building forms to reduce the influence of the formal structure of the buildings on participants' opinions.

***Method 3: Building-based* Questions**

In this method of questioning, a building image is presented, and its formal attributes are askes. Compared to method 2, rather than having a group of building images sharing the same attribute value, just one building image is illustrated, and participants rate its attributes directly. In methods 2 and 3, the illustrated buildings not only present the parameter value but also demonstrate the probable influence of the attribute values on building forms.

***Method 4: Influential Attribute* Questioning**

This set of questions focuses on significant attributes from the participant's perspective. Once a building is shown, participants are asked to express their opinion about the attributes they find influential. While observing a building image, participants' opinions about several visible attributes are asked, and participants answer those that caught their attention. This method is proposed with the hope of acquiring more limited but more accurate outcomes, discerning attributes that participants find unimportant.

Indirectly Questioning Methods

In these methods, the researchers strive to realize the personal satisfaction of each attribute based on their opinion about a set of building images. Accordingly, there is just one mode of questioning, accompanied by various analyzing methods to extract each attribute preferences. Generally, the participant's opinion about each building is assigned to the building attributes, then the average of each attribute satisfaction rates is the participant’s opinion about the attribute. As a simplified example, if 5 buildings with white material are queried, the average satisfaction level of those buildings is equalized to the preferences of white material. Despite sharing the underlying analysis mode, four analyzing methods result in four outcomes, explained below:

Method 5: Analyzing All Visible Attributes of the Whole Buildings

As the title shows, the buildings’ rates are assumed as preference range of all visible parameters existing in the buildings. In this method, the researcher identifies 5 to 15 easily perceived attributes (average 9.25) for each building; the buildings’ rates allocate to all the visible attributes; then, the average of the attributes’ rates reflect the participant’s opinion.

Method 6: Analyzing Significant Attributes of the Whole Buildings

One may claim that participants may not be able to consider all the existing attributes of a building while expressing their opinion. Accordingly, as an alternative analysis method, the building satisfaction levels are allocated only to the very obvious, strong, and influential composition attributes of the buildings. In this case, 2-7 attributes (average 4.2) are considered significant for each building. The preference ranges of the buildings are assigned only to the significant attributes of the buildings.

Method 7: Analyzing All Visible Attributes of the Extreme Buildings

Concerning the general analysis method, having buildings with a neutral preference range can moderate the satisfaction level of the attributes. Thus, buildings with a neutral level of preference are disregarded in the last two analyzing methods. Building preferences are via a Likert scale out of 9, and the building rates located in the middle third are omitted (rates 4, 5, and 6); only buildings with a high level of like/dislike is considered in the analysis (1, 2, 3, 7, 8, and 9). Finally, as method 7, the satisfaction level of the remained buildings is equated with all the visible attributes in the buildings, like in method 5.

Method 8: Analyzing Significant Attributes of the Extreme Buildings

In a similar vein, the moderately satisfactory buildings are discarded in this method. Otherwise, the building satisfaction levels are equated only with the identified significant attributes of the buildings, like in method 6.

Eight sets of preference rates, as the outcome of each method, require further examination to discover their accuracy and reliability. As the main method of analysis, the eight data are examined by anticipating some other building preferences. Based on the preference ranges extracted from each method and the attributes that exists in some building forms, a preference rate is expected for each building in an adverse way of extracting the attribute preference in the last four methods. Finally, more accurate prediction shows more valid data and a more reliable extraction method. Thus, from a wide range of architectural forms, 45 building images are selected in a way to cover all the questioned attributes, to be applied in the analysis part, and examine the accuracy of the eight methods results. Here, the distance between the expected satisfaction level and the actual acquired preference level is the main root of the analysis.

When the distance between the expectation and actual preference range is less than 1, it is considered as an *acceptable range*, and less than 0.5 is regarded as *exactly mentioned*. For example, based on the attribute preferences, if it is expected to have a satisfaction of 5.2 out of 7, the participant's rate of 6 is assumed as an *acceptable range* (the distance is 0.8). If the participant selects 5, it will be considered "exactly mentioned", since the absolute difference between expectation and selection is less than 0.5 (which is 0.2). The analysis outcomes of the 8 data are illustrated in the table below. The *acceptable range* and the *exactly mentioned* columns reflect the percentage of the 45 questioned buildings from 25 participants. Besides, the *sum of the distances,* the *average distance,* and the *standard deviation* reveal the gap between the expected and actual preference rates of the buildings.

Table 2.1 : Analysis outcomes of the eight examined methods for extracting the individual preferences of architectural attributes.

	Data-generating Methods	Acceptable Range	Exactly Mentioned	Sum of the Distances	Average Distance	SD	Chi-square (p-value)
1	Text-based	**61.7%**	30.0%	49.96	1.11	0.81	✓(0.992)
2	Image-based	**62.2%**	31.1%	49.98	1.11	0.87	✓(0.996)
3	Building-based	**60.0%**	**38.9%**	**41.32**	**0.92**	**0.71**	✓**(0.994)**
4	Influential Attributes of the Buildings	*31.5%*	*16.8%*	*78.72*	*1.77*	*1.09*	✗*(0.001)*
5	Visible Att. – All Buildings	**59.4%**	**37.2%**	**42.19**	**0.94**	**0.67**	✓**(0.999)**
6	Significant Att. – All Buildings	57.2%	32.2%	44.20	0.98	0.66	✓(0.998)
7	Visible Att. – Extreme Liked/Disliked B.	58.3%	30.6%	46.70	1.04	0.75	✓(0.996)
8	Significant Att. – Extreme Liked/Disliked B.	58.3%	35.0%	45.70	1.02	0.78	✓(0.994)

As table 2.1 shows, data 1, 2, 3, and 5 have almost similar *acceptable ranges*; among them, data 3 and 5 possess the highest percentage for *exactly mentioned*. These two columns reflect the accuracy of the expectations and show how precisely the attributes are extracted aright, then participants' opinions about building images can be anticipated. The lowest accuracy belongs to data 4, which degrades the validity of its data collection method. Apart from the percentages, the sum of the distances, their average, and SD also demonstrate the reliability of the method 3 and 5. As these columns show, the lowest distance between the expectation and actual preference is related to data 3 and 5, which is about half of data 4. On average, the distance between the expectation and actual preference of these two methods is approximately 0.9; it means that the preference of a building can be estimated with an accuracy of 0.9. Although it directly reflects the accuracy of the prediction, it reflects the reliability of the raw data and confirms the validity of the attribute extraction method. Finally, as the table shows, data 3 and 5 have the least distance (average 0.92 and 0.94) with the lowest standard deviation (0.71 and 0.67) and reflect the most accurate data and the best methods for extracting the preference of the building composition attributes.

Among the aggregate data, method 3 results in the most accurate outcome. It means, the most reliable attribute preference rates acquire while participants express their opinion about the attributes of a building image. The second-most accurate data belongs to the fifth method, which is among the Indirectly Questioning Methods. That is, the most accurate outcome is acquired while the building's rate is assigned to all the visible attribute values of all buildings; this analysis method is the most reliable method of attribute preference extraction. Although the analysis results reflect the accuracy of the attribute extraction method, the validity and consistency of the study outcome and the reliability of the method are further explored by both one-way chi-square and Cronbach analysis. Both reflect a remarkable consistency of the data and reliability of the analysis. In short, the study outcome, as well as these examinations, acknowledge the credibility of the study.

To sum up, the study with a very high level of validity and reliability shows that, as in method 3, people can express their personal preferences the best when their opinion about the attributes of a building image is asked. This can extract the most accurate personal preference by questioning the pleasantness of each attribute by a directly questioning method. The fifth method attains the second accurate outcome; in this indirectly questioning method, participants rate some buildings and the preference range allocated to all the building composition attributes; the average of each attribute preferences reflects the participant's opinion about the attribute. Finally, regarding the accuracy of the outcomes, both methods can extract the personal preferences of the building attributes reliably. Gathering the data via the third method is time-consuming, and the questions could be hard for laypeople; in contrast, the fifth method has more accessibility and much faster gathering data method, especially when laypeople are addressed. Consequently, regarding the slight difference between the accuracy levels, the fifth method is by far the best method for examining the preference of a large number of participants, especially in case providing the analysis part systematically.

3. MUSICAL ATTRIBUTES

Regarding the aim of the study, this section by examining the studies on musicology provides a set of musical attributes influence on our musical taste and also define a clear method to discover the individual satisfaction of the attributes. Various studies on musical taste have been exploring numerous musical attributes, called as determinants of our musical taste. Various scholars categorized the attributes differently with the hope of attaining a holistic insight on the determinant's roots, including Wapnick, Finnäs, Sink, Toe, and more recently, Schäfer & Sedlmeier (Finnäs, 1989; Schäfer & Sedlmeier, 2010; Sink, 1992; Teo, 2003; Wapnick, 1976). The review papers are not univocal; despite some similarity, they categorize the influential factors differently, convoluting the determinants and their roots. Thus, instead of applying the discussed determinants, at first, a very extensive literature survey has been done, and the most updated attributes affecting our musical taste are discovered. Then, a graph is introduced to reflect the roots as well as the most distinguishable and influential attributes on our musical taste. We have published the outcome of this process as a review paper (S. F. Tayyebi et al., 2020). The gist of the paper is reflected in a way to make a clear understanding on musical attributes and make the booklet a self-sufficient dissertation, otherwise for further information please take a look on the paper. In the subsequent parts, at first, a model is introduced to reflect the root of the musical attributes; then, by concerning the model, the attributes inside and outside of music are mentioned. Consequently, a clear set of musical attributes are provided and followed by discussing different methods of extracting the individual's satisfaction on the attributes.

3.1 The Primary Roots of Musical Attributes

Our model is initiated on a simplified decision-making process, starting from listening to music to the immediate like-dislike reaction, regardless of the long-lasting effects of music and its trace on musical preferences. Generally speaking, music starts its journey as an audible stimulus; an individual receives them under an environmental condition, filters the stimulus by his unique personal attributes, and then perceives some attributes of the music; finally, the first preference decision can be made. This general process reflects four primary roots: the basic musical attributes, our personal issues, environmental conditions, and the perceived attributes. Regarding the conducted investigations, these four issues are divided into two parts: Intra-music factors, including the basic music attributes and so-called Perceived Psychological Attributes (PPA), and Extra-music factors, including personal attributes and environmental conditions (Figure 3.1). As the model shows, the basic music attributes stimulate some musical qualities as the perceived attributes; a single-sided arrow reflects this one-sided relation. Moreover, the reciprocal interrelations between the personal issues and environmental conditions are illustrated by the double-sided arrow between the factors in the model. Worth noting, the order of the influential factors on the decision-making process of the listener are just arranged in a way to facilitate the perception of the model, though, in reality, all these four categorical attributes interrelate concurrently, as the music plays in time.

Figure 3.1 : Main roots of musical attributes.

There are a large number of attributes, known as determinants or variables, in each of these four illustrated categories. Many researchers design their research by focusing on a few attributes among these root categories. On the other hand, instead of concentrating on some specific attributes, other researchers focus on musical classifications as a collection of various attributes. For example, instead of concerning tempo and mode as primary musical attributes, the genre as a representative of some characteristics is being investigated. Similarly, some studies focus on personality types in music taste studies instead of concerning some vivid personal attributes. Thus, to differentiate the single attributes from the classification of the attributes, the model introduced another layer of attributes as Classification Layer, while the attribute-based modes of studies are presented in Basic Layer (Figure 3.2).

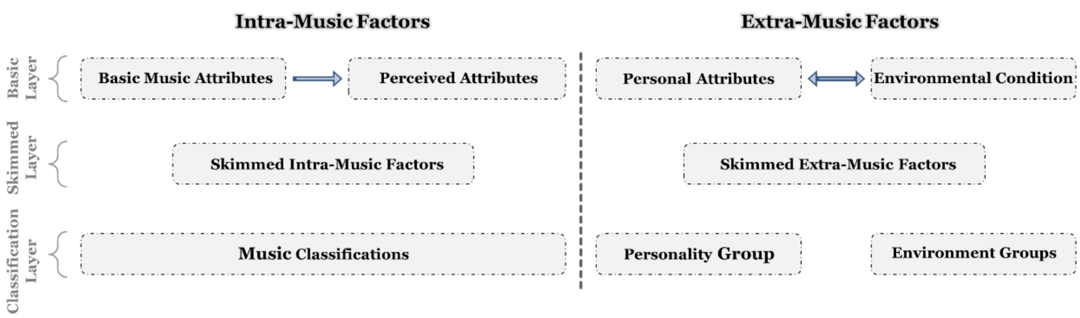

Figure 3.2 : Three layers of musical factors.

Regarding the proposed model of investigations, most of the studies are located either in the basic or classification layers concerning Internal or External factors. Each layer has some flaws and accordingly encountered some critiques. For example, among the internal factors, a large number of studies in the basic layer reflects a very diverse and uncountable number of determinants for music preferences, like concerning 38 perceived attributes in research (Greenberg et al., 2016). Studies on the classification layer also faced many critiques. For example, genre as the most significant one is criticized by many theoreticians and researchers for being ambiguous, subjective, and not being able to categorize reliably (Lippens et al., 2004; McKay & Fujinaga, 2006)(Greasley & Lamont, 2006). This set of studies is introduced to, on the one hand, make the uncountable number of variables more manageable, and on the other hand, to limit the problems within the classification layer. It is more like summarizing or introducing the most significant musical attributes. Accordingly, the newly developed studies can fit neither in the basic layer nor classification layer, rather in a new layer of study in-between. Consequently, a new layer is integrated to our model to reflect the rare but profound studies on musical preferences and shows some musical attributes; this layer called here as Skimmed Layer (Figure 3.2). Finally, after providing a matrix-like graph to gain a general understanding of the roots of the attributes, the next parts point to the main attributes in the intra-music and extra-music factors.

3.2 Attributes on Intra-music Factors

The intra-music factors concern the determinants of musical appreciations within the realm of music. The intra-music oriented investigations, as figure 2 shows, has four main categories: (i) Basic Musical Attributes covers the fundamental notions in the musical realm, like tempo, rhythm, harmony, and so on. (ii) Perceived Psychological

Attributes (PPA) concern the main characteristics of music, like descriptive words ascribed to music, such as happy, sad, sorrowful, fearful, and aggressive, and etc. (iii) Skimmed Factors focusing on the limited number of attributes concerning the real features of music; and (iv) Musical Classifications considers the integral categorization of music pieces, either via its basic musical attributes or perceived attributes or a combination of both. (Figure 3.3)

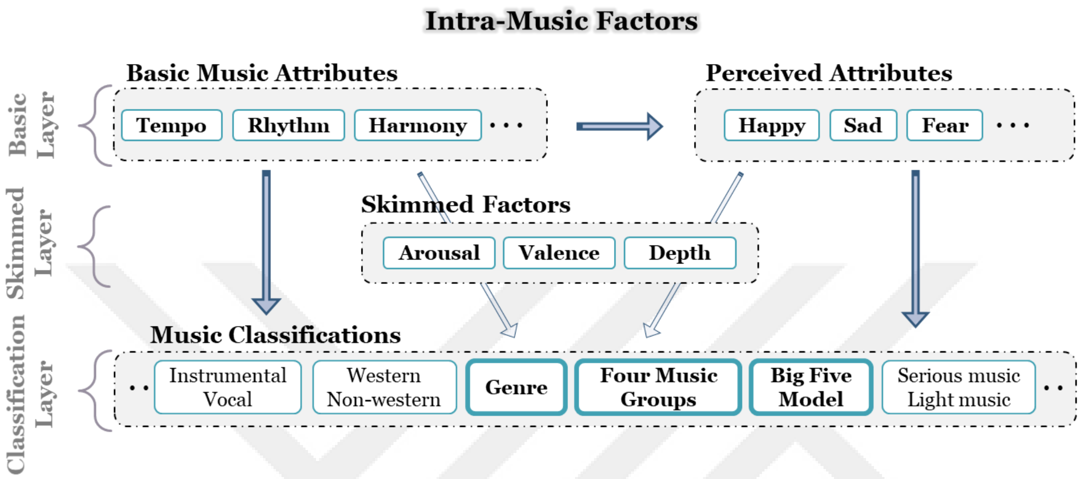

Figure 3.3 : Intra-music factors.

The first set of studies explores the direct relationship between basic musical attributes and musical appreciation. These investigations consider the most rudimentary musical terms, including tempo, rhythm, pitch, harmony, loudness, complexity, melody, dissonances, and even the language of the lyrics, which all covers in the *Basic Layer* of determinants. Investigating the general relationship between basic musical attributes and musical appreciation forms the first mode of investigation in this category. For example, there is a consistent finding on musical harmony that the octave, perfect fifth, and perfect fourth are respectively the most preferred consonant intervals, in contrast to diminished second having the most repulsive dissonant intervals (Davies & Barclay, 1977). In a similar vein, V-I is the most preferred cadence, which never substitutes for any other progression as well as the inversions (B. S. Rosner & Narmour, 1992). Another study shows that enjoyment follows an inverted U-shape in the complexity level of non-vocal music pieces; a moderate complexity level is the most preferred range from simplicity to hardly complex musical compositions (Gordon & Gridley, 2013). Teo, similar to Wapnick, in his studies confirms that both high and low pitch had played a part in musical satisfaction (Teo, 2003) (Wapnick, 1980). Other investigations reflect the direct trace of language and gender of the singer on musical appreciation (Gosselin, 2017) (LeBlanc & Sherrill, 1986). Furthermore, some studies consider more than one attributes to provide an importance hierarchy for the basic musical attributes (Finnäs, 1989; LeBlanc, 1981; Martindale & Moore, 1990; A. North & Hargreaves, 2008; Schellenberg & Habashi, 2015). For example, considering both scale and tempo, a study shows that the order of enjoyment range is a fast major, slow minor, fast minor, slow major (Husain et al., 2002). All in all, a large number of basic musical attributes exist in the studies consider musical taste.

Perceived Psychological Attributes are the second root of the musical attributes influencing our musical taste. Despite various opinions and discussions among the musicians (Evans & Schubert, 2008; Frijda, 2008; Gabrielsson & Lindström, 2001), as psychologists also confirm, many musicians believe that music can express, induce, change, strengthen, and mitigate emotion (Schäfer & Sedlmeier, 2010). Therefore, many scholars reflect the trace of perceived attributes on emotion on musical satisfaction. As Finnäs in his fruitful review paper discussed the precedent studies (Finnäs, 1989), the trace of 38 emotions and attributes are listed and investigated in more recent studies (Patrik N Juslin & Laukka, 2004; Lindström et al., 2003; Rentfrow et al., 2012). According to the papers, the perceived attributes do not possess the same significance value while concerning musical appreciation; happiness, sadness, fear, anger, and tenderness, and love are the most robust reflector of musical tastes. Accordingly, some studies limit their scope with the fewer number of emotions (Eerola & Vuoskoski, 2013). Although these studies are criticized by not having a clear definition for the attributes (Cespedes-Guevara & Eerola, 2018), and neglecting social context (Patrik N Juslin & Laukka, 2004), many studies investigate the direct relationship between the perceived attributes and musical satisfaction. Finally, apart from the studies focusing on the relationship between PPA and other factors like basic music attributes, many studies concern the perceived psychological attributes of music in their studies.

A shortlist of attributes, which are like skimmed factors of the PPA, constitutes the third set of musical attributes concerned in musical taste studies. Apart from the studies trying to make a hierarchy of the influential attributes, some studies have tried to summarize the factors. Instead of assigning an importance level to the attributes, some researchers have skimmed the influential factors and provided a viable list of influential attributes on our music preferences, like years of investigations by Greenberg and his colleagues (Greenberg et al., 2015, 2016). Finally, in a robust investigation with thousands of participants, they introduced three main factors deeply rooted in our musical taste: Arousal, which reflects the energy level of the music, Valence that shows sad to happy emotions in the music, and Depth that concerns the sophistication and emotional depth in the music (Greenberg et al., 2016). Apart from the direct relationship between these three factors and musical preferences, the study reflects the correlation between them and five personality types, as well as 38 perceived attributes of music, indirectly cooperate in musical taste. For example, high arousal dimension positively correlates with intense and forceful and negative loading of arousal correlates with gentle, calming, and mellow; 'Highly on valence component were fun, happy, lively, enthusiastic and joyful and those that had high negative loadings were depressing and sad.' And lastly, positive depth reflects intelligent, sophisticated, inspiring, complex, and poetic music, and negative depth echoes the party music and danceable attributes (Greenberg et al., 2016). These three factors, Arousal, Valence, and Depth, are the attributes in the skimmed layer. (Figure 2.3)

The last root of the musical attributes influencing our musical taste is the musical classifications. Although every single music attribute can be a root for classifications, like tempo (fast/slow), timber (vocal/instrumental), instrumental texture (monophony/polyphony), these classifications point to merely one attribute and thus located in the basic layer of attributes. Concerning various attributes are required to put a classification within this list, like liturgical/secular, western/non-western (Teo, 2003) tonal/atonal or tonal/post-tonal (Tymoczko, 2010), or dividing them into folk, art, and popular music which 'each of these three is distinguishable from the others according to certain criteria' (Tagg, 1982). Among the variety of classification in musical studies concern musical appreciation, finally, two main groups are discussed briefly as evidence of this mode of investigation on musical taste: Genre and Big Five Model. (Figure 3.3)

Genre as a musical categorization, is probably the most popular music descriptor and organizer of large digital music databases. There is a bunch of data in our digital-oriented world that shows a direct relationship between the music preference and genre, as it is reported country and rock are the most favorite music genres in America (Backus, 2018). YouTube, Pandora, Spotify, Amazon Prime Music, and other worldwide music sources by having access to the digital data provide periodic reports on each music genre preferences in various geographical or listener's ages (Buskirk, 2015; Delmonte, 2017; Lopes, 2018). In addition, the relationship between genre and basic musical attributes is an ongoing platform for studies; for example, it is confirmed that genre has relationship between repeating patterns (Lin et al., 2004), music lyrics (Neuman et al., 2016) timbre, rhythm and pitch (Brecheisen et al., 2006). On its basis, many other studies compete on automatic genre classification (Cheng et al., 2008; Costa et al., 2012; Lo & Lin, 2010; A. Rosner et al., 2014; Vatolkin et al., 2014). Consequently, genre as the most well-acknowledged music classification cooperates in music preference studies in both direct and indirect manner.

In contrast to genre mostly involve basic musical attributes, the big five model, like the main four music groups (Rentfrow & Gosling, 2003), concerns more about the perceived attributes and emotions in music pieces. The Big Five Model, known as MUSIC called after their acronyms, consists of Mellow (smooth and relaxing, romantic), Unpretentious or Urban (uncomplicated, relaxing, unaggressive, rhythmic and percussive music), Sophisticated (complex, dynamic, and inspiring attributes), Intense (loud, aggressive, forceful, and energetic, not relaxing), and Contemporary or campestral (percussive, electric, and not sad) (Rentfrow et al., 2011). This more recently developed mode of classification like the old-fashioned genre classifications has been employed in various studies on musical preferences. Apart from the direct relationship between individual preferences of MUSIC-type music pieces, the correlation between genre and MUSIC categories are also discussed as M (soft rock, R&B, and adult contemporary), U (country and folk), S (classical, operatic, avant-garde, world beat, and traditional jazz), I(classic rock, punk, heavy metal, and power pop), and C (rap, electronica, latin, acid jazz, and euro-pop) (Rentfrow et al., 2011). Arising from the relationships, Short Test Of Music Preferences (STOMP) and its revised version (STOMP-R) are also introduced to extract musical taste based on genre satisfactions.

3.3 Attributes on Extra-music Factors

Apart from the factors within the realm of music, some external factors affect our musical preference. They are like secondary issues interrelating our musical taste. Although some studies directly concern the relationship between external factors and musical tastes, most of the studies explore the relationship between extra-music factors and intra-music factors, which indirectly cooperate with our musical preferences. As figure 3 shows, the extra-music factors consist of two main categories that interact with each other: the listener's attributes shared for various music pieces, and the environmental condition shared among various listener of a performance. As Figure 3.4 shows, there are gaps in environmental classification and skimmed factors, which need further analysis. Accordingly, the main attributes in the extra music factors are personal attributes, environmental attributes, and personality groups.

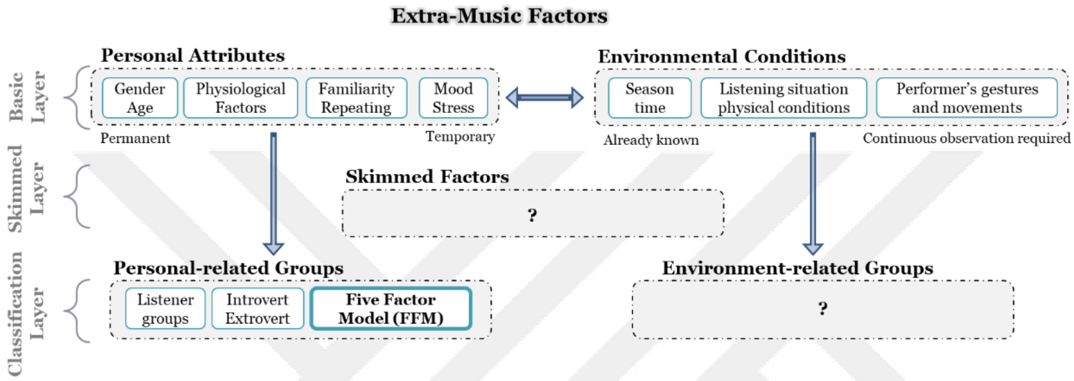

Figure 3.4 : Extra-music factors.

Researchers always consider personal issues as one of the primary roots of our musical tastes; even many researchers explore the impact of various personal attributes, either permanent or temporal, on musical preferences. Many studies discuss the interrelation between musical appreciation and age, ethnicity, gender (LeBlanc et al., 1999), social class, listener's occupation (Foley, 1940), family background (Finnäs, 1989), and education (Gordon & Gridley, 2013; LeBlanc et al., 1996; Miu et al., 2016; Sink, 1992). For instance, youngers, comparing older adults, are more open to diverse music and have fewer prejudiced attitudes toward certain kinds of music (Finnäs, 1989). The listeners' sex influences on their vocal vibrato preferences (LeBlanc & Sherrill, 1986), females like popular music styles more than males (Rawlings & Ciancarelli, 1997); adversely, males prefer louder and enhanced bass and sad music more than females (Chamorro-Premuzic et al., 2010; McCown et al., 1997). A listener with strong racial associations prefers to listen to music that communicates about their racial identities (Marshall & Naumann, 2018). Even the physiological factors of the listeners influence on musical tastes like empathy levels and neural activity of the brain (Bauer et al., 2015; Greenberg et al., 2015). Even the impact of more temporal attributes on musical appreciation is also investigated, like temporary listener mood or having physical and mental stress (Friedman et al., 2012; Husain et al., 2002; Miu et al., 2016; Simonton, 1980; Vuoskoski & Eerola, 2011). Finally, the personal attributes, either permanent or temporal, are among the attributes influencing our musical taste. (Figure 2.4)

Environmental conditions influence on our preferred music pieces and musical tastes in general. People listen to different music pieces while sitting at home lonely or standing in a dance club with their friends, expecting smooth-relaxing music and cheerful rocking music, respectively. Many environmental issues alter our musical preferences. For instance, musical selection may reflect seasonal influences (Pettijohn et al., 2010; Yu & Kang, 2010); the characteristics of preferred music vary with the situation in which that music is experienced' (A. C. North & Hargreaves, 1996); physical context and presence of other people influence on emotional responses to a piece of music (Miu et al., 2016). The musical band races (McCrary, 1993), the body movement of the performer (Broughton & Stevens, 2009), and even observing the performer group (Morrison, 1998) influence on the musical appreciation. All these general attributes of environmental conditions can be among the environmental determinants which affect our musical appreciation.

Lastly, apart from the personal attributes in the basic layer, personal groups as another issue exist in many studies on musical taste. Not only personality traits can interrelate musical appreciations (Vuoskoski & Eerola, 2011), but also musical preferences can be indicative of an individual's personality (Langmeyer et al., 2012). Accordingly, the trace of psychological classifications exists in many studies on musical taste, like dividing people into introvert and extrovert. For instance, the investigation's results show that 'extraverted subjects are inclined to enjoy popular music' (Rawlings & Ciancarelli, 1997), and they prefer upbeat and conventional and energetic and rhythmic types of music like rap and hip-hop, despite some gender differences (Langmeyer et al., 2012). Even among the musicians, extraverts showed a preference for 'emotional' music and introverts for music with formal structure (Payne, 1980). A robust classification is the main five-factor model of personality, known as FFM (Figure 2.4). Following Norman's study (Norman, 1963), The model passed a long way to suggest that the taxonomy of personality can be described through five major traits: (i) Extraversion, (ii) Agreeableness, (iii) Conscientiousness, (iv) Neuroticism, and (v) Openness to experience (John & Srivastava, 1999; McCrae, 2009). Although the SAPA project aims to improve this robust personality classification (Condon, 2018), it exists in many studies on musical preferences and its trace on musical appreciations (Chamorro-Premuzic et al., 2010; Langmeyer et al., 2012; Vuoskoski et al., 2012).

3.4 A set of Musical Attributes

To sum up, the model reflected the roots of our music preference determinants as well as the musical attributes being applied in various studies in musicology. As it is discussed, the intra-music factors reflect the attributes within the realm of music, which interact in musical apperceptions. Among them, five main categories constitute the main attributes related to our musical tastes.

(i) **Basic musical attributes**: they indicate the trace of the fundamental elements of music on our musical appreciations, like tempo, mode, and harmony.

(ii) **Genre:** as the first identifier of musical taste, it is the most common considered attribute among the studies on musical taste. Despite some critiques, many musicologists still find it as the simplest but yet the best reflector of musical taste. This category includes, rock, rap, hip-hop, Classic and etc.

(iii) **Five-factor model (FFM)**: This set of attributes following the initial work by Rentfrow as his colleague is among the most appreciated categories in a musical piece which reflect the listeners' taste. The FFM uses MUSIC as an acronym for the five types, including Mellow (M-Type), Unpretentious (U-Type), Sophisticated (S-Type), Intense (I-Type), and Contemporary (C-Type).

(iv) **Perceived Psychological Attributes (PPA):** they concern the comprehensible qualities of the music and how a piece of music is felt, including happy, sad, intense, mellow, aggressive, powerful, and danceable.

(v) **3-Factor attributes**: as a recently developed set of attributes summing up and organizing 38 attributes within PPA into three dimensions, namely **Arousal** (energy level of the music), **Valence** (sad to happy emotions in the music), and **Depth** (the sophistication in musical preference distinguishers).

The extra music factors reflect the secondary issues influencing our musical appreciation, which need to be considered in musical attribute preference studies. Although these attributes are outside of the musical realm, they mostly influence the listeners and indirectly concern the like/dislike reaction to music pieces. These attributes mainly show what secondary attributes need to be considered in the studies on musical taste. Among them, the personal or listeners’ attributes and environmental conditions are the main roots.

(i) **Personal attributes** concern the listener's criteria. They exist within a spectrum from the most permanent issues like gender, to changeable issues like age and education, and lastly to the very temporal factor, like having stress while listening to music.

(ii) **The environmental conditions** cover the environmental factors from the already known issues like season and time to the factors that require continuous observation, including performer gestures and movements.

3.5 Methods of Extracting the Music Attribute Preferences

Generally, two different methods of extracting the musical attributes are being applied in studies. As the first method, participants directly express their opinion about verbally-explained musical attributes like genres or PPA’s. And as the second method, participants listen to some music excerpts and then rate the piece; accordingly, the rate of the music piece is considered as the rate of its attributes, and thus the attribute satisfactions are indirectly extracted. Even though both methods are being applied, each method has some downside. Directly asking the attributes may have different understandings among people; for example, preferences of pop music may not have identical meanings among different geographical listeners. On the other hand, in the indirect method, while participants rate some music pieces, the influential attributes on the rates are not clear; do the rates related to the genre of the music, to the combination of the instruments, or even tempo of the piece? Thus, in this method, different samples are needed to re-examine the preferences several times. Accordingly, having different samples and musical excerpts makes this method of extracting the preferences much more time-consuming, though it may result in more valid outcomes.

Apart from the two main methods of extracting the musical attributes satisfactions, the preferences of some attributes can reflect the satisfaction rate of the corelated attributes. As an example, the correlations between individual preferences of genre and FFM categories are already investigated; accordingly, the individual taste on each FFM type can be discovered by the correlated genres (Rentfrow et al., 2011). For example, the preferences of classic and jazz music can reflect the preferences of S-Type of music. The correlations between each attribute of the 3-factor category and the PPAs are already investigated by Greenberg and his colleagues (Greenberg et al., 2016). For example, the preferences of the intense, forceful, and aggressive music pieces can reflect the preferences of the music pieces with positive arousal. Thus, as two significant examples, genre can reflect the FFM attributes, and PPA can reflect the 3-factor attribute preferences indirectly.

4. RESEARCH DESIGN AND PROCEDURE

Generally, three studies have been conducted to find answers to the dissertation questions. The first study, as a pilot investigation, explores the correlation between general architectural and musical attributes across limited demographic classes. By learning from the outcomes of this initial study, a correlation correction strategy has integrated into the methodology; accordingly, the two subsequent studies, as the main investigations, deeply explore the correlations between the attributes. The second study, as a small-scale study, investigates the correlations between the preferences of architecture material attributes and musical instruments; and the third study, as a large-scale study, scrutinizes the correlation between the preferences of architectural and musical attributes, comparing the pilot study, across a wider range of demographic classes with a more advanced methodology.

Despite some tiny differences, the methodology of the three papers has an identical structure, with seven steps in three phases. The first phase provides the raw data; a list of the considered attributes is first defined, and then a survey gathering the raw data is prepared and distributed. In the second phase, the participants' responses are analyzed to provide a complete set of attribute preferences. The responses are then filtered out to distinguish the reliable ones, to provide a clear set of architectural and musical attribute preferences of reliable responses. Finally, in the third phase, Pearson's correlation coefficient analysis examines the correlations between every single attribute within different demographic categories. The outcomes of the analysis are then filtered once by the correlation p-value, to filter the statistically invalid correlations. The main two studies also integrated with Bonferroni correction, as a second filtering technique, to skim off the utmost reliable correlations. Since the large-scale study concern a very large number of correlations, clustering methods have also applied to the study to provide a meaningful summary of the results. The above steps are illustrated in Figure 4.1 and explained more in the subsequent sections.

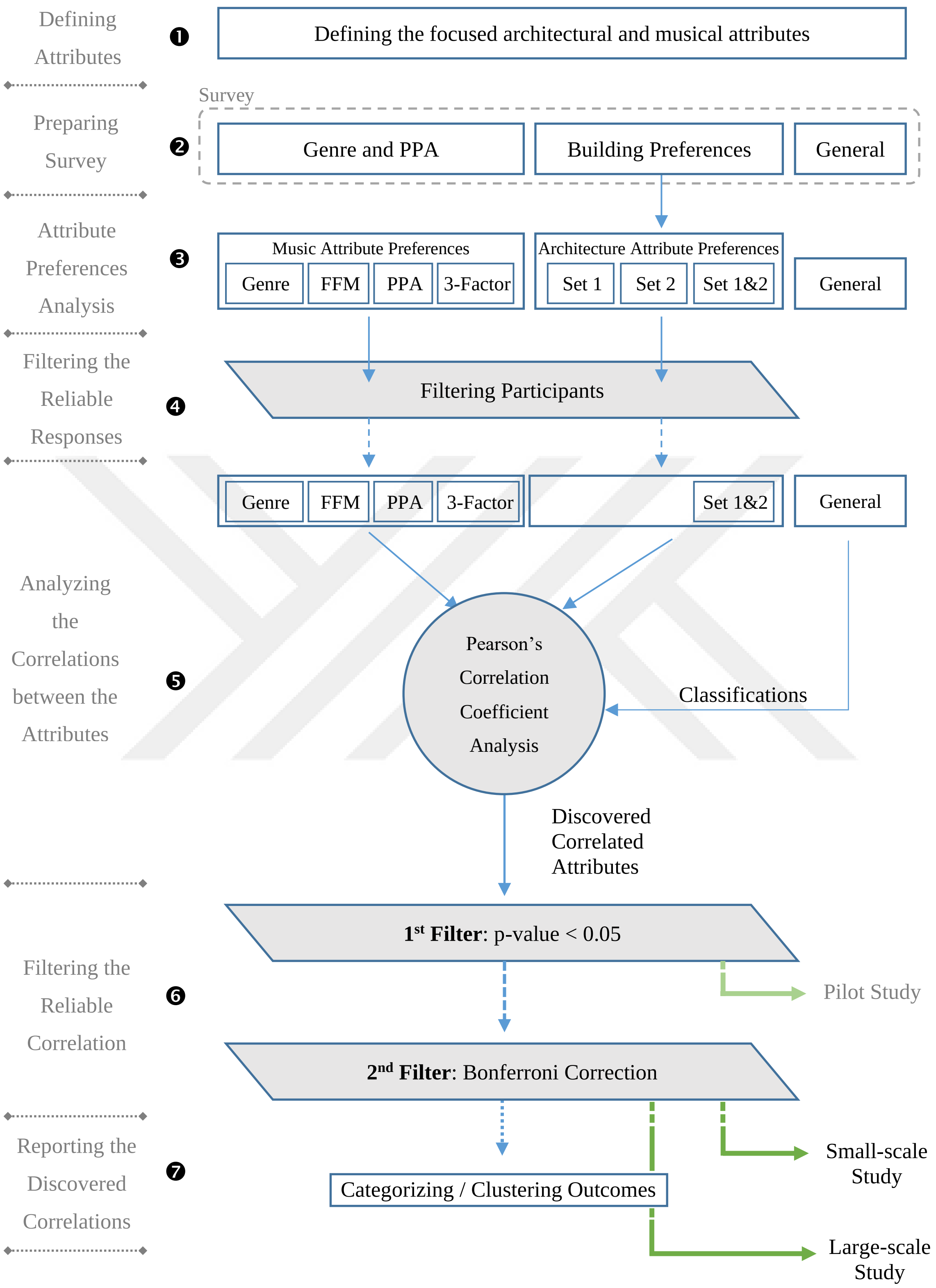

Figure 4.1 : The methodology flowchart.

4.1 Gathering Data

As the first step, a clear set of attributes are provided. The architectural and musical attributes are generally defined based on the previous discussions, reflected in chapters 2 and 3, though they can be considered as part of the limitations of the dissertation. In general, the architectural attributes, including the architecture material attributes of the small-scale study and the attributes related to the big-picture of building features in the large-scale study, are selected in a way to cover the most common attributes in the building facades of diverse building forms. Since the most common attributes are discussed and exampled in Chapter 3, they are briefly listed here.

In the small-scale study exploring the correlations between the preferences of architecture material and musical instruments, the architecture material attributes are the most common values in the category of material color, quality, texture, and reflection. Similarly, musical instruments are selected to cover the most common instrument. Otherwise, since the preferences of the instruments in a family can deductively reflect the satisfaction of the musical instrument family, twelve widely-used musical instruments are selected in a way to cover various musical instrument family, to provide the opportunity to extract the instrument family preferences from the instruments' satisfactory rates of the participants. The selected instruments in each family are String (Guitar, Violin, Cello, Harp), Brass (Trumpet, Trombone), Woodwind (Flute, Clarinet, Bassoon), Percussion (Timpani, Xylophone), and keyboard (Piano). Table 4.1 in the next page provides a clear list of the attributes.

As for the large-scale study, the architectural attributes are the values related to the building indentation, symmetry, complexity, rhythm, pattern, and stress, which they all exampled in chapter 3. There are four main roots for the musical attributes forming our musical taste, including Genre, Perceived Psychological Attributes (PPA), Five-factor model (FFM), and 3-Factor. The attributes in the FFM and 3-Factor categories are pre-defined and limited in number; otherwise, there is a large number of attributes in the genre and PPA categories. In order to define the considered genre and PPA, the method of extracting attributes taken into account. The correlations between individual preferences of genre and FFM categories are already investigated, as discussed in section 2.2.5; on its basis, for each attribute of the FFM category, 2 prevalent genres with the highest correlation rates are selected, to both be considered in the genre category and reflect the FFM attributes preferences, including M-type (soul/R&B, pop), U-type (country, rock and roll), S-type (classic, jazz), I-type (heavy metal, rock), and C-type (rap, electronica).

Similarly, the correlations between each positive and negative value of the 3-factor attributes and PPA attributes are already investigated, as discussed earlier. Based on their study, for each positive value, three strongly-correlated perceived attributes, and for each negative value, two correlated perceived attributes are focused. Finally, 15 PPA are selected to show both participants' opinions about the attributes and reflect their opinion about the six values in the 3-factor category. The 3-factor attributes, and focused correlated PPA are: positive arousal (intense, forceful, aggressive), negative arousal (mellow/gentle, calming), positive valence (happy, fun/joyful, lively), negative valence (depressing, sad), positive depth (sophisticated/complex, inspiring, poetic/deep), negative depth (party music, dance-ability). Consequently, the musical attributes are defined, and the participants' opinion on 10 genres and 15 PPA will reflect their opinion on attributes in the FFM and 3-factor categories.

Table 4.1 : The selected attributes of the small-scale study: architecture material vs. musical instruments.

Material Color	• White • Grey • Black • Light Warm Color • Dark Warm Color • Cold Color	
Material Quality	• Stone • Brick • Wood • Concrete • Aluminum • Cement Plaster	?
Material Texture	• Without Texture/Plain • With some Texture • Full of Texture	
Material Reflection	• Reflective • Very Reflective	

• Piano • Guitar, • Violin, • Cello, • Harp • Trumpet, • Trombone • Flute, • Clarinet, • Bassoon • Timpani, • Xylophone	Musical Instrument
• String • Brass • Woodwind • Percussion • keyboard	Musical Family

Table 4.2 : The selected attributes of the large-scale study: general architectural attributes vs. general musical attributes.

Architectural attribute	Levels		Levels	Musical attribute
Indentation	Flat Moderately Indented Highly Indented	?	soul/R&B pop country rock & roll Classic. jazz heavy-metal rock rap electronica	Genre
Symmetry	Symmetrical Partially-symmetrical Balanced Asymmetrical		M-Type U-Type S-Type I-Type C-Type	FFM
Complexity	Simple Moderately-complicated Complicated		intense forceful aggressive mellow/gentle calming happy fun/joyful lively depressing sad sophisticated/complex inspiring poetic/deep party music dance-ability	PPA
Rhythm	Rhythmic Partially-rhythmic		Positive arousal Negative arousal Positive valence Negative valence Positive depth Negative depth	3-Factor
Pattern	Regular Irregular			
Stress	Horizontal Vertical			

After having a clear set of attributes, the next step aims to gather the participants' preferences of the attributes. A higher number of participants in correlation-related studies increases the credibility of the investigation and the validity of the outcomes. Thus, a survey providing the opportunity to collect raw data from a sufficiently large number of individuals is the best way to collect the raw data. Generally, the survey has two main parts; one part is designed to extract individual preferences in architecture, and one does the same for music. As traces of gender bias exists in many musical tastes and the significance of age and gender is confirmed by the pilot study, the survey also integrated with some demographic questions, comprising the first part of the survey. Thus, the survey starts with a few questions inquiring into the age, gender, and education level of the participants, and followed by some questions on architectural and musical tastes.

With regard to uncovering architectural preferences, there are several ways in which this can be done. However, as it is discussed, the exploration of eight different methods showed that the most reliable – especially for a large sample size – is to ask participants to rate a number of images of buildings and extract the attribute preferences accordingly. Accordingly, participants only need to rate some of the building images. Then the rates are assigned to all the visible attributes of the buildings; finally, the average of each attribute's ratings is assumed to be the satisfaction rate of the attribute. Thus, for the studies, sets of building images are selected in such a way to have each attribute questioned multiple times in different building forms, and the participants are asked to rate the building forms via a 7-point Likert scale. The images and their assigned attributes are presented in Appendices.

As discussed in the literature review, the musical attribute preferences can be extracted from musical pieces or contextualized questions. Extracting individual preferences for the 15 PPAs and the 10 genres requires a large number of music pieces; this makes the survey very time-consuming, reducing the number of responses. Regarding the significance of the number of participants in correlation-related studies, extracting the preferences from musical pieces was not feasible, although this may have generated more accurate data. Instead, the text-based questioning method was then selected, as it is the method used to gather data in many studies of musical tastes. In this way, participants were asked to express their preferences on the 15 PPAs and the 10 genres. For the small-scale study, the participants are asked to express their preferences on the

12 musical instruments, while 10-25 seconds solo instrument music pieces are also prepared to facilitate the recognition of the timber of each musical instrument. Otherwise, to decrease the impact of the excerpt's melody on participants' opinions, they are asked to answer the questions without listening to the samples as far as possible. Finally, in contrast to the indirect questioning method of architectural attribute preferences, the preferences of the musical attribute are collected by rating 15 PPAs, 10 genres, and 12 musical instruments via a 5-point Likert scale.

Consequently, a survey as the main method of gathering raw data is prepared by some demographical questions including age, gender, and education, some architectural images, 10 genres, 15 PPAs, and 12 musical instruments to be rated. It is worth noting that, while the architectural responses are on a 7-point scale, the musical questions are more abstract and cover a wider range of potential tastes and therefore required a more open 5-point Likert scale. Since the analyzing method normalizes the preferences in its essence, the differences of the preference scales do not make any problem in the analysis part. Finally, the survey is made and distributed worldwide on the QuestionPro platform to voluntary participants whose answers remain confidential and anonymous. Altogether, around 1,000 participants attended the survey completion, mostly from the USA and also from Iran, Turkey, Germany, Denmark, Canada, France, and the Netherlands.

4.2 Analyzing the Attribute Preferences

The preferences of the attributes inquired indirectly need a simple analysis to provide a clear list of attribute preferences for the participants. For the music section, the 15 PPAs, the 10 genres, and the 12 musical instruments do not need further analysis as the questions on these are direct, while the preferences for the FFM, 3-factor attributes as well as the instrument families preferences need to be extracted from the genre and PPA and musical instrument ratings respectively. The preferences of the FFM attributes considered as the average of the two highly correlated genres, including M-type (soul/R&B, pop), U-type (country, rock, and roll), S-type (classic, jazz), I-type (heavy metal, rock), and C-type (rap, electronica). Similarly, the preferences of the 6 attributes in the 3-factor category are extracted from the 15 interrelated PPA's: positive arousal (intense, forceful, aggressive), negative arousal (mellow/gentle, calming), positive valence (happy, fun/joyful, lively), negative valence (depressing, sad), positive depth (sophisticated/complex, inspiring, poetic/deep), negative depth (party music, dance-ability). And lastly, the musical instruments belong to a musical family reflect their satisfaction with the families. The instrument families and the selected instruments in each family are String (Guitar, Violin, Cello, Harp), Brass (Trumpet, Trombone), Woodwind (Flute, Clarinet, Bassoon), Percussion (Timpani, Xylophone), and keyboard (Piano). Finally, a simple calculation provides a clear set of preferences for the whole considered musical attributes.

In order to extract the building attribute preferences from each set of images, as briefly discussed earlier, the buildings' ratings are assigned to their attributes, then the average rating for each attribute is assumed to be the final satisfactory rates of every single attribute. This method extracts the architectural attribute preferences from each set of architectural images. In order to increase the internal validity of the study and examine the reliability of the architectural answers, the split-in-half method has been applied to the architectural images, whereby the preferences of each attribute are asked via two sets of architectural images and, by comparing the two outcomes, inconsistent answers can be removed as invalid responses. Thus, the building images are divided into two sets, as presented in the dataset (S. F. Tayyebi & Demir, 2021). The attribute preferences from each set of images are analyzed separately; each set of images reflects a set of attribute preferences for participants, to be later on being applied for filtering the reliable responses. Furthermore, after selecting the valid answers, all the images should be considered in discovering the material attribute preferences. Thus, each participant has 3 sets of attribute preferences extracted from the first, second, and both sets of images, as shown in the methodology flowchart (Figure 4.1).

Once a clear list of attribute preferences had been collected for each participant, in the next step, the unreliable responses need to be filtered out. The first selection criterion is the time spent; a serious response to the survey takes more than five minutes, so any participant who spent under five minutes on it were eliminated from the results.

For the architecture part, comparing the outcome of the first and the second set of the building images – split-in-half method – is the primary source of filtering the invalid responses. For the small-scale study, concerning the correlations between the material and musical instruments, the first filtering criterion is the average distance between the outcomes of the first and the second set of images. Besides, participants with an average discrepancy of less than 0.2 are also omitted; they were too good to be true.

Verifying their answers shows that these people rate the buildings mostly similar; accordingly, the attributes' satisfaction ranges are eventually extracted alike. This initial but significant criterion skims most of the unreliable responses and significantly increases the internal validity of the study. The standard deviation (SD) of the discrepancy between the sets can also identify other invalid responses, even if the average of the differences are within the acceptable range. As another criterion, the SD of the discrepancies must be less than 1.5. Having a high SD means the outcomes were almost correct for some attributes and disparately wrong for others. Despite its covert essence, considering these people in the correlation analysis could affect the credibility of the study outcome.

The large-scale study, concerning the correlation between the general attributes of architecture and music, has the most restricted filtering criteria. For the architecture section, participants have to have rated at least 50 buildings to be considered in the analysis, and they must rate the images within a range of 3 or more. In other words, if their minimum rating of a building is 2 out of 7, they must have rated another building at 5 or more. Failure to meet this criterion means the rates are all too similar and therefore considered as unreliable. In addition, the mean of the building preferences for each participant must be more than 2 and less than 6, and the standard deviation (SD) of the building preferences must be more than 0.75 to be considered as a valid response. Again, failure to reach this standard means the participant rated the buildings similarly, and their responses can be discarded. Furthermore, as the split-in-half method was used, participants with an average discrepancy of more than 1.5 or less than 0.2 between the outcomes of the first and the second set of images are eliminated. Concerning the effect of the SD of the discrepancy between the two sets, participants with an SD of the discrepancy of over 1.5 are also erased. All these filtering strategies erased the invalid responses from the valid participants' ratings.

In addition to the architecture part, the data from the music section also needed refining before the correlations could be extracted properly. The music part of the small-scale study had some criteria to filter out unreliable responses. At first, the participants have to have rated at least six out of twelve musical instruments to be considered in the analysis; otherwise, they are considered as an unfamiliar person to the musical instruments and eliminated from the analysis part. Since considering the neutral participants could weaken the strength of the discovered correlations, participants with the range of preference less than 2 are neglected. For example, if a participant rated all the instruments as 4 or 5 (preference range = 1), he/she would be eliminated from the valid respondents. Failure to meet this criterion means the rates are all too similar and therefore considered as unreliable.

The first filter of the large-scale study was that participants must have rated at least 7 of the 10 genres and 10 of the 15 PPAs to be regarded as valid respondents. Furthermore, considering participants with similar preference ranges would moderate the strength of the correlations and weaken the correlated attributes. Thus, the minimum preference range is considered as 2. In addition, the mean of the rates must be between 2 and 4, and the SD must be more than 0.75 to be considered a valid response; otherwise, the rates are considered as too similar and therefore invalidate the participant's responses. Worth-noting, since the genre and PPA rates reflect the preferences of FFM and 3-factor attributes, valid responses of genre and PPA means reliable preference rates for the FFM and 3-Factor attributes; that is, the afore-mentioned filtering criteria were only applied to questions relating to genres and PPAs, as these also reflect the preferences within the FFM and 3-Factor attributes.

Consequently, the discussed filtering criteria skim out the reliable responses. Once all the valid responses are selected, concerning the split in half method, the outcome of all architectural images analysis is considered as the preference rates of the remained participants instead of the first and second sets of images. The collections of the attribute preferences are finally prepared, with more than 450, and 500 reliable responses for the small-scale and large-scale studies, respectively. All the filtering criteria applied to the database are prepared automatically using code written in Microsoft Excel Developer.

4.3 Analyzing the Correlated Attributes

After establishing clear sets of attribute preferences and filtering out the unreliable responses, the correlations are then analyzed using Pearson's Correlation Coefficient. This analysis examines the existence of correlations among two sets of independent variables, without being concerned with the causality of the relationships. Pearson's Correlation Coefficient analysis has no unit, and the nature of the scoring system has no impact on the outcome of the analysis, providing the proportions of the value sets are the same throughout; the fact that the architectural images are rated on a 7-point Likert scale, and the musical questions on a 5-point scale, makes no difference to the Person's end result. Without any further requirement to normalize the data, the correlations between every single architectural and musical attribute are calculated for all the valid participants. As a result, regardless of the underlying reasons, the analysis shows possible correlations between architectural and musical attribute preferences.

Learning from the pilot-study and finding the demographical classes significant in the discovered correlations, the demographic attributes of age and gender are run through correlation analysis of the small-scale study to discover probable correlations among various participant categories. Apart from the Gender-based classifications, separating males from females, the participants' age is classified into three categories: young adults, including all participants under the age of 25, referred to as *Young*, middle-aged adults including 25-45, referred to as *Middle-aged*, and mature adults which cover all participants over 45, referred briefly here as *Mature*. Further democratic categories can be created by combining the two factors, including Young Male - Middle-aged Males - Mature Males - Young Females - Middle-aged Females - Mature Females. Consequently, the correlations are analyzed across 12 demographical classes: 1 without any classification, 2 gender-based classes, 3 Age-based classes, and 6 classes concerning both age and gender.

The large-scale study has a much more number of demographic categories. The demographic attributes of age, gender, and education are considered in the correlation analysis. Like the small-scale study, the gender divides people into two classes of males and females; likewise, age divides participants into three, referred to here as Age_3_, and 7 categories, referred to as Age_7_. They are like *Age 1: participants Under 18 years*, *Age 2: 18-24, Age 3: 25-34, Age 4: 35-44, Age 5: 45-54, Age 6: 55-64, and Age 7: 65 and Above*. Education also makes five different demographic categories including *Architect* (having academic education in the field of architecture, regardless of their current position), *Musician* (having academic education in the field of music), *Architect-Musician* (referring to those who have academic education in both architecture and music), *Educated* (those who have at least four years of academic education outside of architecture and music), and *Non-Academically-Educated* (those who have no academic education).

The combination of two demographic attribute forms further classes. Applying both the five education-based and two gender-based categories delivers ten new demographic classes. Gender and Age combined create six classes. Similarly, Education and Age (the Age_3_ module) provide a further fifteen demographic classes. However, some of these new categories are deemed invalid as they fail to contain a meaningful number of responses. Finally, the combination of Age, Gender, and Education creates thirty different participant categories, of which seventeen are valid for correlation analysis based on the sample size. Consequently, in the large-scale study, the correlations between the architectural and musical attributes are analyzed within 61 different participant classes. All these classifications and the analysis via Pearson's Correlation Coefficient method are analyzed by writing code in Microsoft Excel Developer.

Not all the outcomes from the correlations analysis are statistically valid and significant; rather, they need some filtering strategy to filter the significant correlations. Pearson's coefficient analysis demonstrates the correlations via a p-value reflecting the statistical validity of the correlation and an r-value reflecting the strength of the correlation. Generally, 0.05 is mostly considered as the critical point of the p-value; it means the probability of extracting a reliable correlation that was not discovered by chance is 95%. In this study, the correlations with a p-value higher than 0.05 are considered statistically invalid. Thus, as the first filtering criteria, correlations where $p\text{-value} > 0.05$ are eliminated.

The remaining correlations are filtered a second time using Multiple Testing Corrections to skim off the most statistically valid correlations. Bonferroni is the most stringent correction test filter where corrected P-value = p-value * n (number of samples in test). Only correlations with a corrected $p\text{-value} < 0.05$ are deemed valid. As an example, if the numbers of participants in two tests were 20 and 200, the correlation must have a $p\text{-value} < 0.001$ and < 0.0001 respectively to be able to pass the Bonferroni correction, referred to here as the second filter. In this case, the probability of discovering a false correlation is respectively 1 out of 1000, and 1 out of 10,000 correlations. The end result of this method is to be left with only the most statistically valid and reliable correlations. Consequently, all the correlations are filtered two times, once by the $p\text{-value} < 0.05$ named here as the first filtering method, and the once with the corrected $p\text{-value} < 0.05$ as the second filtering method. Worth-noting, all the correlations, regardless of their strengths and statistical validity, are indeed the outcomes; thus, they all presented in the appendices, discussed later on. Otherwise, the stronger correlations passed both the first and second filtering methods are discussed in the next chapter, entitled FINDINGS AND DISCUSSION.

The large-scale study looks at a very large number of correlations. Thus, rather than focusing on every single correlated attribute, a summary and an accumulative perspective on the outcome is provided to compensate for the huge number of correlations among 61 categories. In order to give a more holistic understanding of the correlated architectural and musical attributes, the two data reduction modes, namely category-based and cluster-based, are deployed. In the category-based outcomes, very simple calculations are used to arrive at a summary of the correlation outcomes with regard to the demographic classes, while for the cluster-based mode, the K-mean clustering method is applied to provide cluster-based correlations tables. After exploring both Euclidean and Manhattan distances, the K-mean clustering with Manhattan distance is chosen to provide a valid clustering system. It is worth noting that the K-mean clustering is applied multiple times to different sets of correlated attributes to give a more holistic understanding of the attributes with similar trends in the correlations. Consequently, the discovered correlations, after passing through the first and second filters, are categorized and clustered by the huge number of calculations achieved via the execution of VBA code written in Microsoft Excel Developer. The ultimate findings and discovered correlations are discussed in the subsequent section.

5. FINDINGS AND DISCUSSION

In short, after preparing and distributing the survey and gathering the raw data, the personal attributes of the participants are first analyzed. Once the responses from over 1,000 participants were collected, and a clear set of attribute preferences was provided, the valid responses were filtered and, thus, each study was left with a different number of valid responses. The small-scale study with 453 valid responses and the large-scale study with 505 valid responses examined the existence of correlations by the Pearson Correlation Coefficient analysis. Lastly, the analysis outcomes were filtered twice to skim the most reliable correlations and reported in a different manner, regarding the findings of each study.

The final outcomes of the Pearson Correlation Coefficient analysis are indeed the final outcomes. Thus, regardless of the existence or the strength of the correlations, the outcomes of the analysis for every single examined correlation are presented as appendices. Otherwise, the stronger statistically-valid correlations are discussed in this section. The small-scale study concerning the correlations between architectural material and musical instruments and the large-scale study exploring the correlations between the main attributes of architecture and music, regarding their focused attributes, is discussed in two separate subsequent sections. Worth noting, the outcomes of the two sections have provided two other articles which are currently under the review.

Despite the fact that the pilot-study has been done to somehow clarify the methodology and examine the study procedure, the study with more than 700 participants has explored the correlations between 12 architectural attributes and 36 musical attributes within 12 demographic classes; interestingly, the study and outcomes for its own sake were interesting enough to get published as another paper (S. F. Tayyebi & Demir, 2020). Finally, although the study mainly examined the methodology and confirmed the do-ability of the study, it resulted in applying the second filtering method, Bonferroni Correction, to the discovered correlations. Worth noting, from the large number of the interesting discovered correlations, here, I just refer to a graph and two discovered correlations, which are influential in the two main studies, discussed in the subsequent sections.

In the graph below, the background color of each cell reflects the number of statistically valid correlations; the darker greenish shows, the higher number of correlation with p-value < 0.05. The size of the midpoint dot shows the number of strong correlations (r-value > 0.25). In brief, the darker the background color and the bigger dot reflects stronger correlations between the attributes.

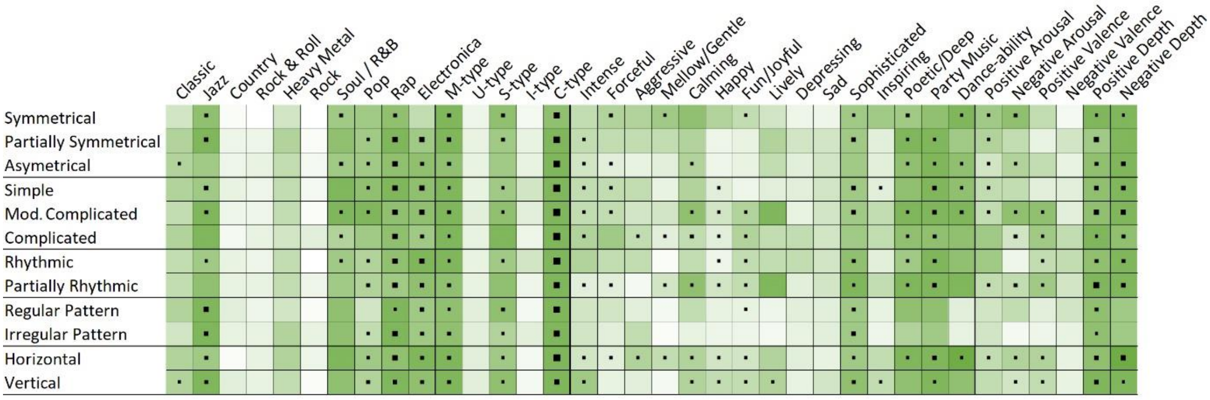

Figure 5.1 : Overview on the correlated attribuets.

darker color = higher number of valid correlations among the 12 categories (p-value < 0.05); bigger dot-size = higher number of significant correlations (r-value > 0.25).

As the figure shows, some musical attributes are more correlated with the architectural attributes, and accordingly, they are like a better distinguisher of architectural attribute preferences. For example, jazz, rap, electronica among the genre category demonstrate a higher number of correlations, and thus they are more likely to provide a better reflector of architectural tastes. Similarly, comparing the correlations in pattern and stress, the last four rows, shows that the preferences of architectural stress are more correlated with the musical attributes, especially in PPA. As a result, this trend confirms the essential requirement of a large number of considered attributes in the main study to discover the strongest correlations; accordingly, the number of architectural attributes in the large-scale study increased from 12 to 16.

Furthermore, the discovered correlations show different trends among various demographical classes. For example, the positive correlations between the preferences of rap and architectural asymmetry among both males and females confirm that rap-followers in both genders have similar trends in preferring asymmetrical forms. But, among the fan of soul music, young females would be more satisfied with symmetrical architectural forms, and middle-aged females would be more interested in asymmetrical forms; the soul-followers reflected an in-contrast trend in different demographical classes. Accordingly, the demographic attributes considered in both studies and the number of demographical classes increased from 12 to 61 in the large-scale study to scrutinize the existence of correlation among the various category of participants. Consequently, by learning from the pilot-study, the two studies are conducted in a more concrete way.

5.1 Small-scale Study: Architectural Material vs Musical Instruments

The small-scale study examines the correlation between architectural material and musical instruments, within 12 demographic classes. As the first outcome of the study, the mean and the standard deviation of the satisfaction rates are tabulated in the dataset, the "small-scale" file (S. F. Tayyebi & Demir, 2021). Despite being out of the main scope of the study, it gives a general insight into the hierarchy of the attributes preferences among the participant categories. The p-value and r-value of Pearson's Correlation Coefficient analysis for every single attribute, as the main outcomes, are also reflected in aforementioned dataset. On its basis, the outcomes are summarized and discussed below in two different modes. The first section discusses on the number of correlations in each demographical class as well as within the attribute categories. It reflects the importance of the demographic attributes and points toward the attributes reflecting a higher number of correlations. Eventually, the second section discusses the strong correlations between architectural material and musical instruments, as the ultimate outcomes.

5.1.1 Correlation across the categories

Table 5.1 presents the number of correlations across the various demographical classes after the first and the second filtering methods. It shows how various demographic classes impact on the number of the discovered correlations; in other words, it shows which demographical attribute plays a more significant role in the correlations between architectural material and musical instruments and, accordingly, is a better classifier of the participants in regards to the small-scale attribute correlations.

Table 5.1 : Number of correlations among the demographic classes.

		All (1 Class)	Gender (2)		Age (3 Classes)			Age-Gender (6 Classes)					
		1. Filter | 2. Filter	1. Filter | 2. Filter		1. Filter | 2. Filter			1. Filter | 2. Filter					
	Number of Correlation (all)	251 | **172**	385 | **117**		418 | **207**			762 | **247**					
	Number of Correlation (r-value > 0.3)	0 | **0**	0 | **0**		5 | **5**			122 | **62**					
	Classes	All	Male	Female	Young	Middle aged	Mature	Young Males	Young Females	Middle aged Males	Middle aged Females	Mature Males	Mature Females
	Number of Participants	453	144	309	79	234	140	20	59	76	158	48	92
1st Filter	Number of Correlation (all)	251	138	247	54	240	124	72	106	169	239	38	138
1st Filter	**Number of Correlation (r-value > 0.3)**	0	0	0	0	**5**	0	**72**	**19**	**5**	**19**	0	**7**
2nd Filter	Number of Correlation (all)	172	3	114	3	200	4	12	19	18	168	0	30
2nd Filter	**Number of Correlation (r-value > 0.3)**	0	0	0	0	**5**	0	**12**	**19**	**5**	**19**	0	**7**

The top part of the table shows the total number of correlations within age- or gender-based categorizations. Dividing people based on their genders does not positively effect on the number of correlations, while age-based classification slightly increases the number of discovered correlations among the considered attributes. In contrast, considering both *Age* and *Gender* in the classification of the samples boosts the number of correlations between architectural material and musical instruments. In other words, it confirms that it is necessary to consider both *Age* and *Gender* for applying the outcomes, as well as designing further investigations on the correlation between architectural material and musical instruments.

The details of the number of correlations within each demographic classes in the bottom part of the table show that there are many more number of correlations within the *Female* classes than *Males*, as well as *Middle-aged* than either *Young* or *Mature* people. Although the Middle-aged class shows just 5 strong correlation, the number of strong correlations passing the second filter in the classes concerning both *Age* and *Gender* are much higher. Once more, it confirms the significance of considering both demographic attributes in the correlation explorations. Among the demographic classes concerning both *Age* and *Gender, Middle-aged Females, Young Females, and Young Males have the highest number of strong correlations. Thus, it is more likely to discover correlations or apply the discovered correlation more meaningful between the* architectural material and musical instrument among the *Young Males, Young Females,* and *Middle-aged Females*.

The number of correlations in each attribute is presented in Figure 5.2. Among the architectural material attributes, White and Light Warm colors, Brick, Cement Plaster, and Full of Texture are the attributes which correlate more with a musical instrument.

Thus, these attributes can be the strongest reflector of musical instrument appreciations. Otherwise, the preferences of cold color or concrete material reflected no relationship with the preferences of any special musical instrument. On the other side, among the musical instrument, Cello, Harp, and Violin, as well as String instrument Family, are highly correlated with architectural material preferences. The individuals’ preferences of these instruments have the potential to reflect their architecture material preferences. Interestingly, Guitar reflected no correlation; the preferences of guitar does not shed light on any possible preferences of architectural material qualities.

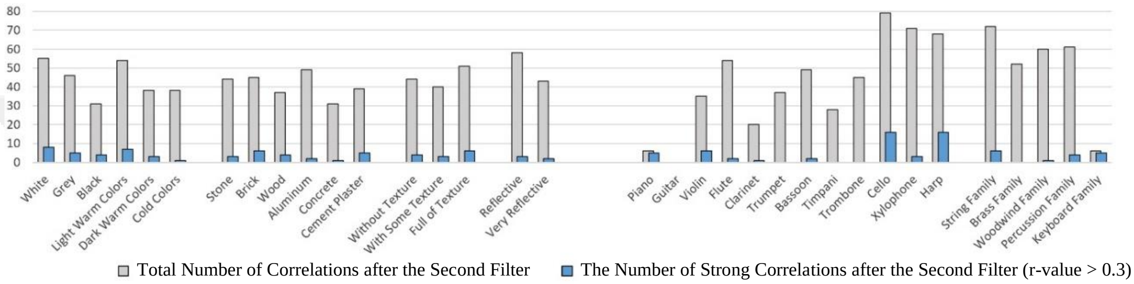

Figure 5.2 : Number of correlations in different attributes.

5.1.2 Correlation across the attributes

The statistically-valid correlations which passed the second filter, either positive or negative, with r-value > 0.3 are presented in the subsequent graphs for discussions. In the graphs, the bars show the r-value of the correlations, reflecting the strength of the correlation. Although the demographic classes in which the correlation exists within are mentioned above each line, to make the graph more legible, the bar color depicts the gender of the participant categories: the reddish for females, the bluish for males, and the greenish for the correlation valid among both genders. Please note that, for the sake of conciseness, the correlations are mostly discussed in just one direction, even though all correlations indicate a two-way reciprocal relationship between two attributes; they are co-related rather than being a one-way in interrelation.

Figure 5.3 reflects the correlations between the musical instrument preferences and both material colors and material reflections. As the graph shows, the strongest correlations exist among the young males. The strong negative correlations among them show that young males who are interested in violin instrument are less likely to be satisfied with grey, black, and dark warm colors in architectural materials.

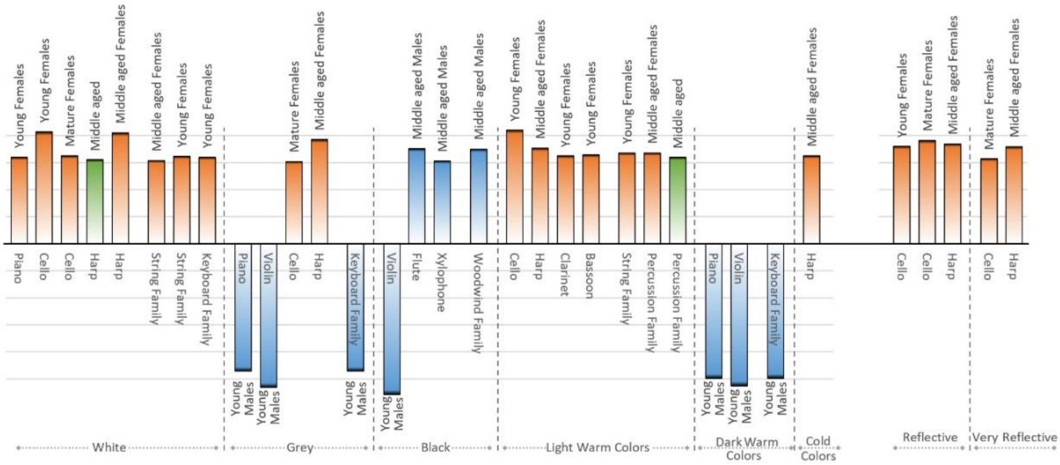

Figure 5.3 : Correlation between material color/reflection and musical instruments.

Furthermore, Preferences of Piano and, accordingly, keyboard instrument family negatively correlate with the preferences of grey or dark warm color among the young males. In contrast, the more young females like piano and keyboard instrument family, the more likely they are to be interested in white architectural material. Thus, we may conclude that preferences of Piano for young people may reflect the preferences of white in contrast to grey or black architectural material.

There is a positive correlation between the preferences of cello and white colors; young females show a strong correlation between the preferences of cello and white/light warm color. Similarly, mature females who are more interested in cello would be more satisfied with white and grey colored materials. Thus, preferences of cello instruments may reflect higher satisfaction of light colors among both mature females, and especially young females.

In a similar manner, a positive correlation between harp and light material shows that being interested in harp can reflect higher satisfaction for light colors. Middle-aged, especially middle-aged females, show that the more they like the harp instrument, the more likely to be interested in white material in building façade. In the same vein, preferences of harp among the middle-aged females can show higher satisfaction for grey, light warm color, and cold color material. Thus, not surprisingly, the more young females or middle-aged females rated string family instruments, the more they would be satisfied with buildings in white or light warm colors.

Middle-aged Males show a strong correlation between black material and preferences of flute and woodwind musical instrument family. The more they like flute or, in general, woodwind family instruments, the more likely to be satisfied with black material in building façade. Furthermore, the correlations show that, higher satisfaction for Xylophone instrument may reflect higher appreciation to the buildings with black material on their facades.

There are positive correlations between the preferences of light warm color materials and clarinet/bassoon among the young females, as well as light warm color and percussion family instruments among the middle-aged, especially middle-aged females. It means the more young females like clarinet and bassoon, and middle-aged females like a percussive instrument, the more they would be satisfied with light warm color material in building facades.

The correlations in the material reflections on the right side of Figure 5.3 show that cello and harp are the two instruments which may reflect higher satisfaction for reflection in building materials. Apart from the enervated correlation between cello and very reflective material among the mature females, the graph shows that young females and mature females who are interested in cello are more likely to be satisfied with reflective architectural materials. Similarly, middle-aged females interested in harp can be more pleased with either reflective or very reflective material in building facade. All in all, the more young or mature females be satisfied with cello or middle-aged females like harp, the more they likely to be interested in the reflection in architectural materials.

Figure 5.4 reflects the correlations between the musical instrument preferences and both architectural material quality and texture. As the graph shows, the strongest correlations once more exist among the young males. Among them, those who are interested in violin instrument seem to be less satisfied with wood or cement plaster, as well as moderately textured materials in general. Even the more they like piano or keyboard family instrument, the less likely they are satisfied with cement plaster as well.

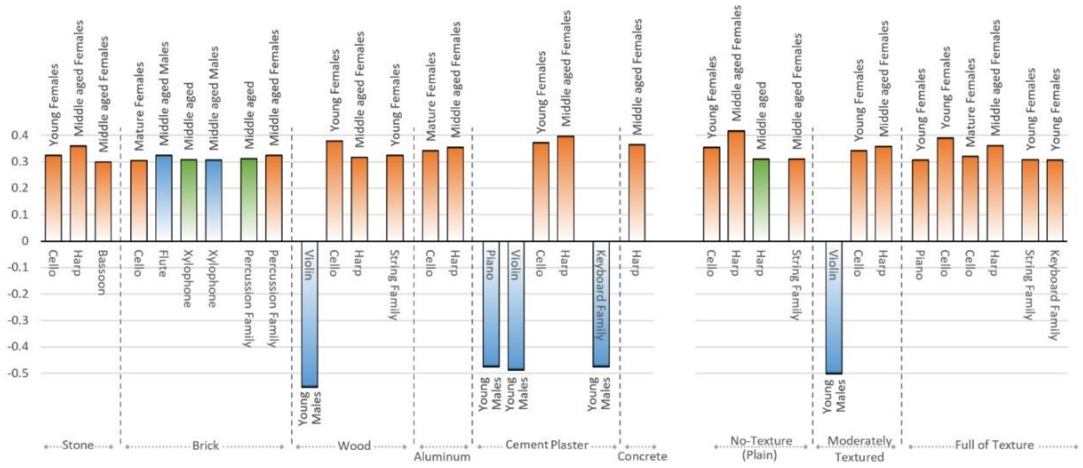

Figure 5.4 : Correlation between material quality/texture and musical instruments.

The more young females like piano, it is more likely to be interested in material possessing some texture, in contrast to plain colored material. The higher satisfaction for string instruments may show higher preferences for wood material among the young females; similarly, those who are interested in cello instrument are more likely to be interested in wood, stone, and cement plaster. In contrast, mature females who are interested in cello are more interested in Brick and Aluminum. Not only the correlations show their priorities, but the difference between young and mature females also confirms the trace of age in the correlation between architectural material and musical instrument preferences. On the other hand, young females and mature females who are interested in cello instrument are more likely to find fully-textured materials pleasant.

As the outcome shows, the preferences of harp instrument among the middle-aged females may reflect higher satisfaction for stone, cement plaster, and concrete, as well as a weak tendency toward aluminum and wood. Although the high number of positive correlation may reflect higher satisfaction for the building preferences in general, the strength of the correlation shows that it is more likely to find a harp-interested middle-aged female be interested in stone, cement plaster, and exposed concrete. Comparing the correlation between the texture pattern shows that middle-aged females who are interested in harp would have a tendency toward few textures, or plain colored architectural material. In contrast to young females and mature females who the preferences of cello may reflect their interested in fully-textured material, middle-aged females who are interested in harp are more likely to be satisfied with plain material, without any texture pattern. This trend has also confirmed by the positive correlation between the preferences of string instrument and plain material among the middle aged females, and full of texture among the young females.

Middle aged males who are interested in Flute reflected a higher satisfaction for Brick material in building façade. Similarly, middle-aged participants who were interested in xylophone and percussive instruments are more likely to be satisfied with Brick material. In other words, the more middle-aged males like xylophone or flute instruments, the more they are to be satisfied with brick in the building facades. Lastly, the correlation between bassoon and stone material shows that middle-aged females who like bassoon instrument more would be more satisfied with the buildings presenting stone in their facades.

5.2 Large-scale Study: Architectural Attributes vs Musical Attributes

The large-scale study, as the main investigation supporting the aim of the dissertation, scrutinize the correlation between 16 architectural attributes and 36 musical attributes across the 61 demographic categories. The outcomes of this extensive examination, in details, are presented in the appendices, and the summary of the final results are presented in two different modes for discussion.

The category-based mode, by shedding light on the number of correlations across different architectural and musical attribute categories as well as demographic classes, gives a general insight about the significance level of the categories with regards to the correlations. This gives a general understanding of the correlated categories on architectural and musical attribute preferences and also points towards the influential demographical attributes to be applied in the possible future studies.

The cluster-based mode, as the title refers, focuses more on the correlated attributes, rather than attribute categories or demographic classes. At first, it shows how the attributes correlate with each other in general, what attributes have similar correlation trends to be allocated in the same cluster. Then, reflecting the correlations between the clusters provides a holistic understanding of the correlations between the general preferences of architectural and musical attributes. Note that while the full details are presented in the dataset, the “large-scale” file (S. F. Tayyebi & Demir, 2021), the discussed outcomes are deliberately limited to the most outstanding cases in order to keep the reporting concise.

5.2.1 Category-based outcomes

The number of correlations in different demographic classes, as the first outcome, shows how various demographic classes impact on the number and strength of the discovered correlations; in other words, it shows which demographical attribute plays a more significant role in the correlations between architectural and musical attributes and, accordingly, is a better classifier of the participants. The correlations among the various demographic categories are presented in Table 5.2. Generally speaking, a higher number of categories means a lower number of people in each demographic class and more homogeneous people within; these two main reasons result in having higher r-values for the discovered correlations. For example, as the table shows, compared to all participants presented in the first row, when the participants are divided into 17 classes in the last row, the average r-value of the correlation rises from 0.14 and 0.23 to 0.47 and 0.58 after the first and the second filter respectively. Thus, the number of categories in each demographic class should be considered in the interpreting of the table.

Table 5.2 : Correlation details across different demographic categories.

	Number of Cat.		1st Filter: p-value < 0.05					2nd Filter: p-value * Sample Quantity < 0.05					Ratio of the Cor. Passed the second filter
	Possible	Valid	Number of Cor.	Mean	SD	Max r-value	Min r-value	Number of Cor.	Mean	SD	Max r-value	Min r-value	
All	1	**1**	**201**	**0.141**	0.053	0.335	-0.154	**42**	**0.231**	0.040	0.335	0.175	21%
Gender	2	**2**	**317**	**0.167**	0.044	0.370	-0.198	**40**	**0.253**	0.023	0.370	0.207	13%
Education	5	**5**	**400**	**0.291**	0.059	0.803	-0.628	**61**	**0.383**	0.039	0.803	-0.628	**15%**
Age_3_	3	**3**	**304**	**0.216**	0.043	0.404	-0.347	**26**	**0.283**	0.016	0.404	0.237	9%
Age_7_	7	**7**	**416**	**0.309**	0.051	0.709	-0.678	**28**	**0.433**	0.026	0.579	0.310	7%
Education / Gender	10	**10**	**525**	**0.367**	0.047	0.971	-0.847	**56**	**0.443**	0.022	0.971	0.240	**11%**
Education / Age	15	**10**	**556**	**0.371**	0.047	0.917	-0.769	**38**	**0.451**	0.019	0.917	-0.451	7%
Gender / Age	6	**6**	**428**	**0.256**	0.050	0.464	-0.446	**34**	**0.344**	0.022	0.464	-0.446	8%
Gender / Age / Education	30	**17**	**722**	**0.471**	0.047	0.978	-0.258	**54**	**0.582**	0.019	0.978	-0.898	7%

There are four different classes while considering one demographical attribute, namely *Gender*, *Education*, *Age_3_*, and *Age_7_*. As the table shows, *Education* and *Age_7_* show the highest outcomes after the first filter, around 400 correlations with a mean value of around 0.3; while after the second filter, *Education* has 61 correlations, while the *Age_7_* gives just 28 valid correlations. *Education*, comparing to *Age_7_* and other classes, has the highest number of correlations after the second filter is applied, and is, therefore, the most influential demographic factor. It followed by *Gender,* which only divides people into 2 classes; it generates the second greatest number of correlations after the second filter has been applied. Lastly, comparing the age-based classes, either *Age_3_* or *Age_7_*, the higher mean values of the correlations in *Age_7_* is ignored due to the difference between the number of classes, which are 3 and 7. Consequently, among the single-attribute classes, *Education* is by far the strongest demographic attribute followed by *Gender* and Age-based classes.

Among the two-attribute categories, *Education/Gender* is the most significant demographic class. Although *Education/Gender* and *Education/Age,* with a similar number of valid classes, show similar outcomes after the first filter, *Education/Gend*er reflects a much higher number of valid correlations after the second filter; it has the highest ratio of correlations passing the second filter. On the other hand, *Education/Age* and *Gender/Age* are of similar significance, since they reflect very similar outcomes, especially when the number of classes is considered. Consequently, despite similar level significance between *Education/Age* and *Gender/Age, Education/Gender* is by far the most significant attribute among the two-attribute categories.

Across all the demographic classes, *Gender/Age/Education* has the strongest positive impact on the strength of the discovered correlations. Otherwise, this class, which potentially can divide the participants into thirty categories, requires a huge number of participants to secure the correlation explorations among them; it seems to be much more idealistic than making a study practically possible. All in all, *Gender* and *Education* as well as *Education/Gender* have the greatest impact on the correlations in practice.

The number of correlations in each of the architectural and musical categories, as the second outcome, shows what categories reflected higher number of correlations, and thus is a better reflector of preferences in another field. Figure 5.5 shows the number of correlations that passed the second filter in each category with regards to the demographic classes. Overall, the highest number of correlations are within *Genre* and *FFM*, while the *PPAs* and *3-Factor are* providing lower numbers of correlations. Although *PPAs* can be a better descriptor of musical taste, genre-based categories are more correlated and seemingly are better indicators of architectural taste. With regard to architecture, *Indentation*, *Complexity* and *Symmetry* show a high number of correlations with musical attributes, suggesting that they correlate more with musical tastes. Despite the huge impact of *Stress* and *Pattern* and lastly *Rhythm* in architectural forms, they provide a lower number of correlations with the musical attributes. Consequently, despite providing much more detail of the correlations among each attribute category in the appendices, in brief, *Genre* and *FFM* in music showed the highest number of correlations and can be a more robust reflector of architectural preferences, as *Indentation*, *Complexity*, and *Symmetricity* in architecture are the strongest category reflecting the musical taste.

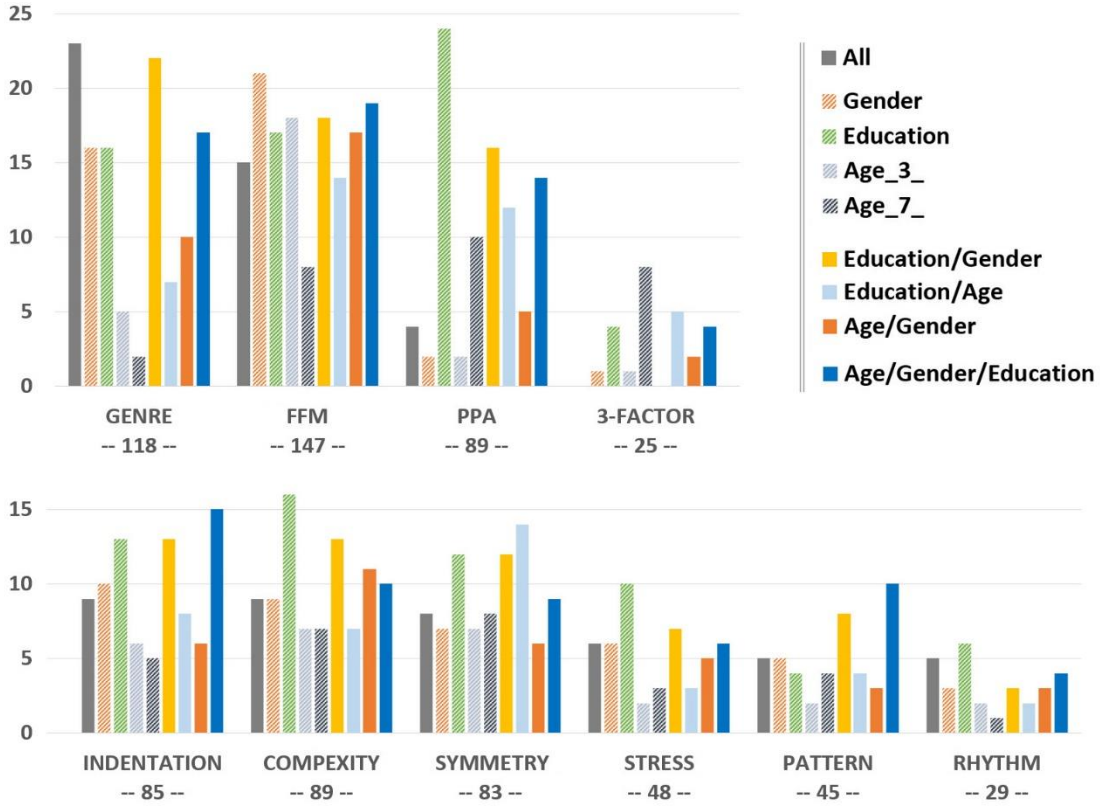

Figure 5.5 : Correlations in architecture and music attribute categories.

The number of correlations differs across the demographic classes. For the musical attributes, *Education* and *Gender* have a higher number of correlations in the *Genre* and *FFM* categories; which it means when the participants are divided based on their education and gender, the categories show the highest number of valid correlations; while *PPA* and *3-Factor* show more correlations when *Education* and *Age_7 are considered*. In other words, *Education* and *Gender* are critical to the correlations between *Genre/PPA* and architectural attributes, while *Education* is the critical factor for the exploration of the correlations related to *PPA*/*3-Factor*. Among the architectural categories, the importance of *Education* as well as both *Education* and *Gender*. are visible among all the architectural attribute categories. All in all, *Education* and *Gender* are the two most significant demographical attributes, while the correlations between the architectural attributes and musical attributes, especially *Genre* and *FFM*, are addressed.

As the third summary of the outcomes, Figure 5.6 shows the matrix of the discovered correlations across the categories. Each cell shows the number of correlations passed the second filter with respect to the demographic classes, as well as providing the total number of correlations among the categories in the right bottom corner of each cell. As the number shows, *Genre* and *FFM* categories are more related to *Indentation* and *Complexity*, and vice versa, suggesting that the preferences in *Genre* and *FFM* best reflect the architectural preferences with regard to *Indentation* and *Complexity*. Although *PPA* and *3-Factor* generally show far fewer correlations, the highest number belongs to the symmetry category; which it means, preferences of the attributes in PPA category can refelct the best the preferences of features related to architectural symmetry. Similarly, preferences regarding *Pattern* and *Rhythm* in architecture are revealed by the preferences within the FFM attributes.

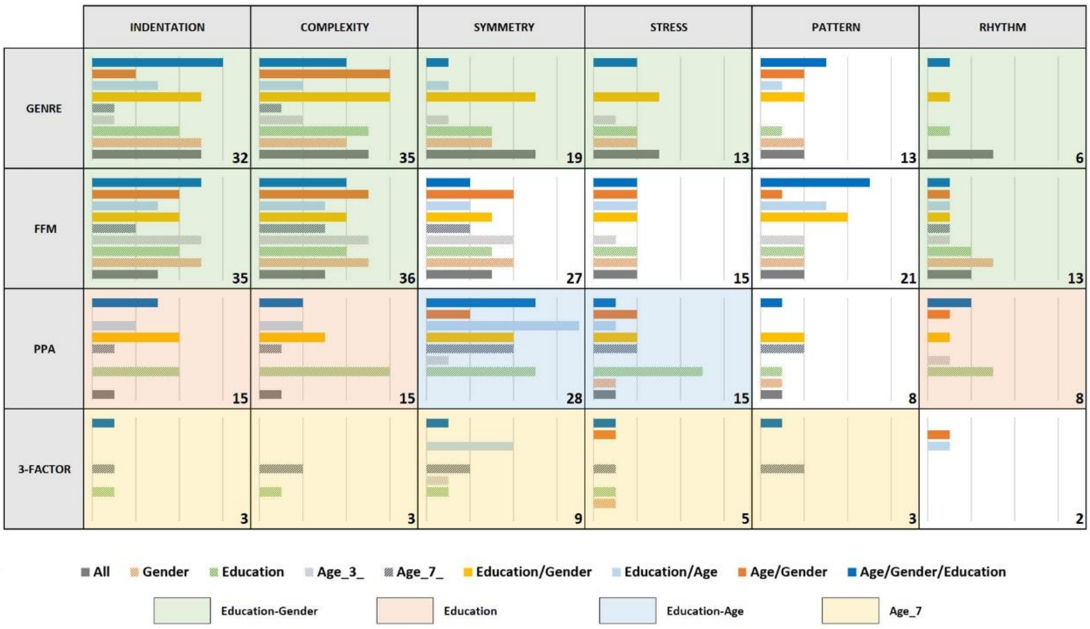

Figure 5.6 : Number of correlations across the attribute categories.

Setting the precise number of correlations in various demographic classes aside, though once more confirms the importance of the demographic attributes, the color overlay of the table cells shows the most impactful demographic attribute of each cell. As it shows, *Education* and *Gender* are the two most significant demographic attributes in the *Genre* and *FFM* categories. Clearly, people of different ages like different types of music, then supposedly age is already reflected in Genre preferences, and thus *Education* and *Gender* will have a greater impact on the correlations. On the other hand, *Education* is the most important demographic attributes while the correlation between *PPA* and architectural Indentation, Complexity, and Rhythm are adressed; while *Education* and *Age* combined is the most influential attributes on the correlation between *PPA* and architectural *Symmetry* and *Stress*. And lastly, the highest number of correlation exists between the 3-Factor attribuets and most of the architectural attribuets, while the participants are divided accurately based on their *Age*. Consequently, attribute preferences related to Genre reflect a higher number of correlations with architectural attributes when *Education* and *Gender* are taken into account, while for the attributes related to *PPA*, *Education* and *Age* play a more important role. In other words, *Education* is a vital demographic attributes in exploring the correlations; *Gender* is specifically impactful with regard to *Genre* and *FFM*, and *Age* is the key demographic attribute for the *PPA* correlations.

5.2.2 Cluster-based outcomes

The vast number of the explored correlations between architectural and musical attributes has been summarized by putting the similar trends in a cluster to manage the large number of correlations and have a more concrete summary of the outcomes. Thus, at first, the correlations between the attributes are tabulated to give a general insight on how attributes correlate with each other, and a dendrogram is also provided to refect the hierarchy of the correlation trends. Then, the attributes possessing very similar correlation trends, in the first layer of the correlation hierarchy, are put together in a cluster to discuss the correlated attributes with regards to the demographic classes. Lastly, from an accumulative perspective possessing a tinge of 'aboutness', the correlated attributes with almost similar trends put in a wider cluster to provide an insight on the correlations between the preferences of the architectural and musical attributes in general.

Various clustering criteria can result in different clustered attributes and dissimilar hierarchical levels. For example, the total number of correlations remaining after the first and second filters can result in two different tables of correlations, and accordingly, two dissimilar hierarchy of the clustered attributes. Each method has its own drawbacks, which make each one unreliable in isolation. For example, concerning the number of correlations passed, the second filter, as the most reliable outcomes, does not cover all the attributes. On the other hand, while the correlations passing the first filter do cover all the attributes, they do not follow the trends of the stronger correlations after the second filter. Therefore, after various attempts using the K-mean clustering method, a meaningful multi-aspect cluster of attributes is acquired, which is on the basis of three tables of outcomes:

1. The first important table in providing the clusters is the number of correlations with r-value > 0.25 that passed the second filter. This is represented by the midpoint dots in each cell – a black dot denotes a positive correlation and a red dot denotes a negative correlation.
2. The second important table is the correlations with r-value > 0.5, which have passed the second filter, and these are represented by the borderline of the cell. Since not all the attributes have a correlation after the second filter, especially the musical attributes, the number of correlations after the first filter is also applied to cluster the remaining attributes.
3. Thus, the third table is correlations with r-value > 0.25, which passed the first filter. This factor is represented in the table by the background color of the cell. The darker the background, the higher the number of correlations it shows.

Figure 5.7 shows the base of the clustering attributes with identical correlation trends, and provides the clustering hierarchy in the form of a dendrogram. Since not all the hierarchy of the clusters derived from the mentioned tables are univocal, the attributes which are more homogenous and univocally presented in the same cluster in different attempts are differentiated by the filled area in the dendrogram. For example, in architecture, *Flat* building façade and *Simple* building form almost always follow the same trend with regards to correlations with musical attributes; they are in the first hierarchical level and reflected by the filled area in the dendrogram. Similarly, the attributes of a *Sense of Symmetry* and *Partially Symmetry*, *Moderately Indented* and *Moderately Complex*, and *Highly Indented* and *Fully Complicated* are reflecting the same trends and accordingly put in the same cluster. Interestingly, the simiarity between the correlation trends, and accordingly clusters, shows the robust impact of architectural complexity.

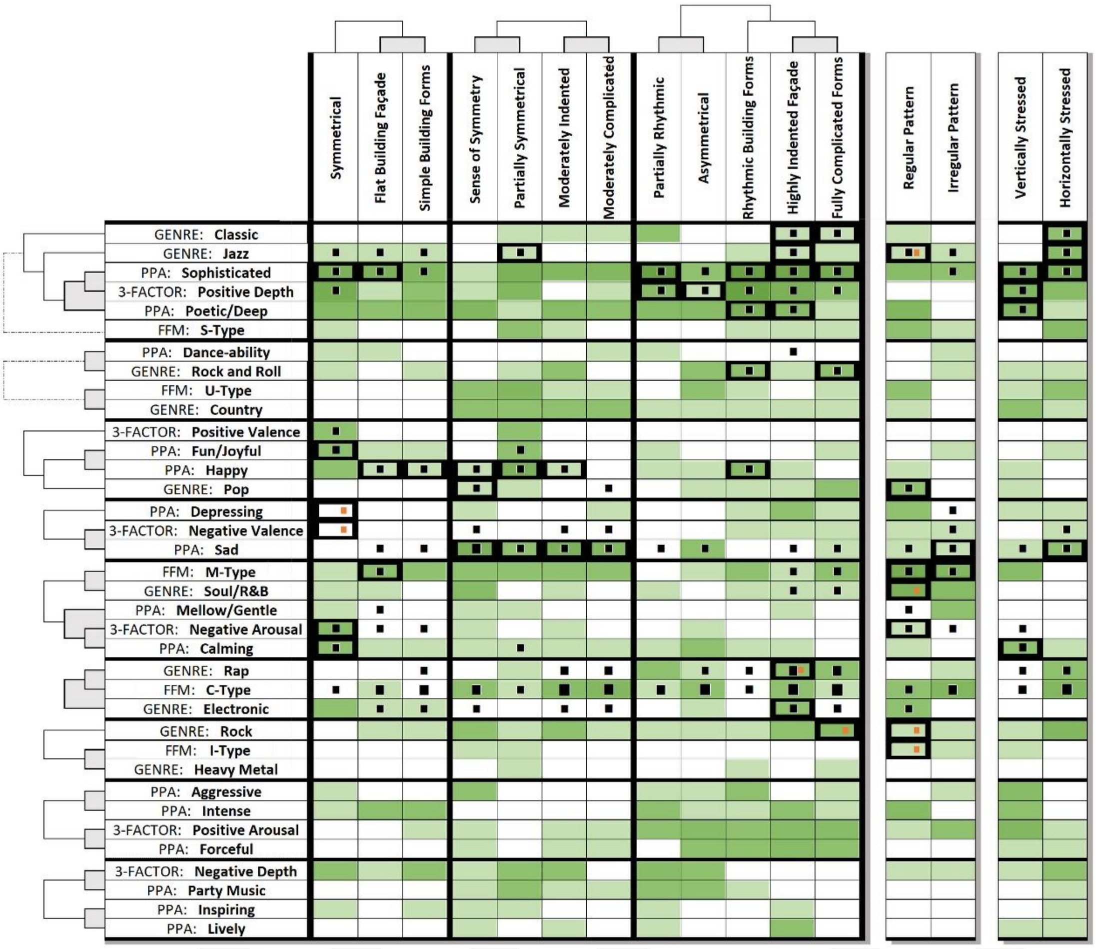

Figure 5.7 : Base of the clustering the attributes with identical correlation trends.

There is a similar story for the correlation trends among the musical attributes; as an example, sophisticated music, Poetic/Deep, and Positive Depth echo similar trends in terms of correlations with architectural attributes. These attributes are also allocated to the same cluster and grayed out in the dendrogram. In contrast to the limited category of the architectural clusters, the musical attributes reflected larger number of clusters discussed more in the subsequent parts.

Please consider, the Pattern and Stress architectural attributes reflect very different trends and accordingly are put in very different clusters in the clustering attempts; thus, instead of applying any priorities to place them in a special cluster, they are considered as independent attributes. In addition, *S-type*, *U-type*, and *Country* music are placed, just at this level, in the vicinity of the clusters reflecting similar qualities in music; to differentiate them from the hierarchy of the correlations, they are separated by a dotted line in the dendrogram.

Despite this graph provides the basis of the attributes clustering, each cell can show if the attributes correlate with each other, before putting them in the same cluster. For instance, it shows that there are positive correlations among different demographic classes between a preference for *sad* music and a *sense of symmetricity*, *partially symmetricity*, *moderately indented* and *moderately complicated*. This suggests that people who like sad music also appreciate moderate attributes in a building façade, as opposed to exaggerated architectural features. As another example, a preference for *rock* and *intense music* negatively correlates with a preference for regular patterns in architecture; that is, the more people like rock and intense music, the less likely they are to appreciate the existence of regular pattern in architectural elements. Consequently, Figure 5.7 provides the clustering hierarchy by reflecting the attributes with similar correlation trends, though it also shed light on the correlated attributes before discussing them in a clustered manner.

After putting the attributes with very similar correlation trends in the same cluster, Figure 5.8 shows the correlations between the clustered attributes. In the top line of each cell are three numbers; on the left is the number of strong correlations (r-value > 0.50) that passed the first filter; in the center is the number of moderate correlations (r-value > 0.25) that passed the second filter; on the right is the number of strong correlations (r-value > 0.50) that passed the second filter. The demographic classes within which the strong correlation passing the second filter is valid are presented on the bottom line of each cell, and the classes reflecting more than one time are shown with an asterisk. Since more detailed information is also presented in the dataset (S. F. Tayyebi & Demir, 2021), the demographic class numbers are kept consistent among the table provided here and the appendices. Please note that, for the sake of conciseness, the correlations are mostly discussed in just one direction, even though all correlations indicate a two-way reciprocal relationship between two attributes. Furthermore, to reflect the correlations more succinctly, the cluster names are presented with a "~" sign showing the most ostensible attribute of the cluster, differentiated by the underline in the graph.

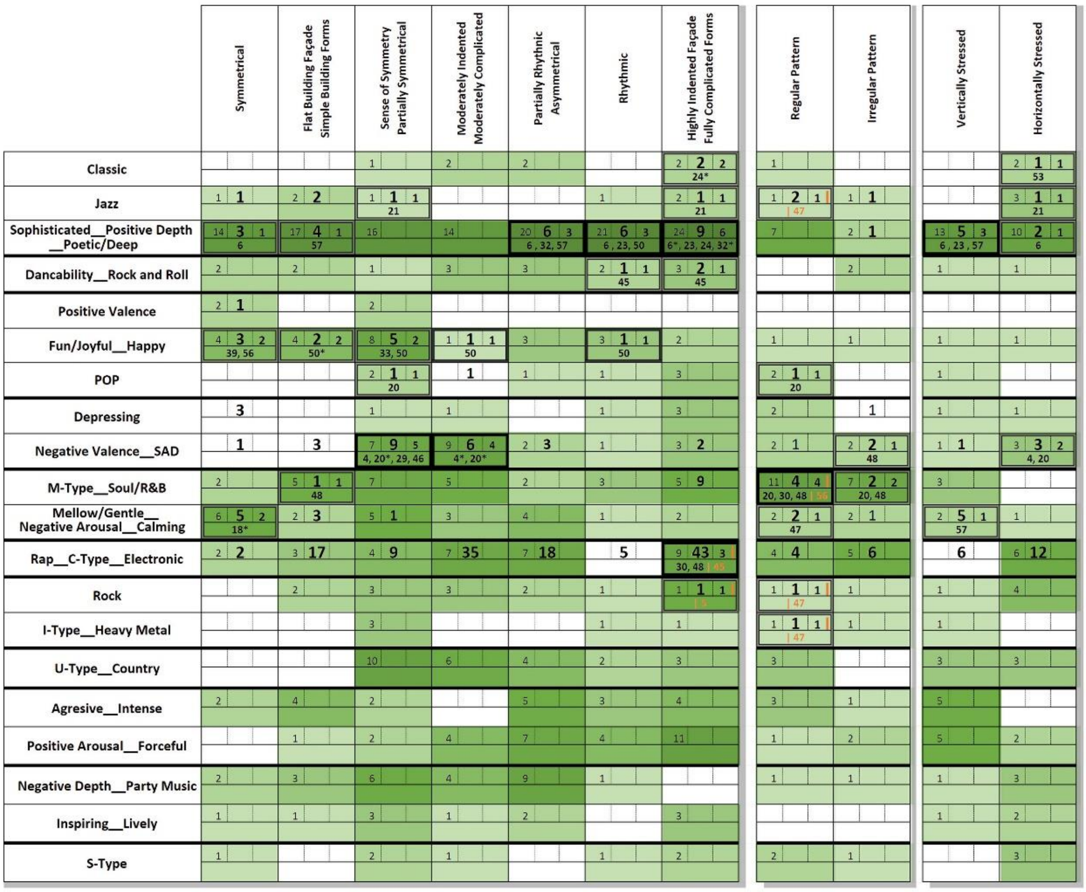

Figure 5.8 : Correlation details between the clustered attributes.

Demographic class number: 4: Architects, 5: Musicians, 6: Architect-Musician, 18: People over 65yrs, 20: Female Architects, 21: Male Musicians, 23: Male Architect-Musician, 24: Female Architect-Musician, 29: Middle-Aged Architects, 30: Mature Architect, 32: Mature Musicians, 33: Male Architect-Musician, 39: Young Male, 45: Middle-Aged Male Architects, 46: Middle-Aged Female Architects, 47: Mature Male Architects, 48: Mature Female Architects, 50: Mature Male Musicians, 53: Middle-Aged Female Architect-Musician, 56: Non-Academically-Educated Young Male, 57: Non-Academically-Educated Young Female.

As the first outcome, ~sophisticated~ music positively correlates with either fully symmetrical or asymmetrical, partially rhythmic, and rhythmic forms among the *architect-musicians*, and ~fully-complicated~ among both *male* and *female architect-musician*. The more an *architect-musician* likes sophisticated music, the more likely they are to be interested in complicated, rhythmic, apparently asymmetrical or fully symmetrical architectural forms. Similarly, *mature musicians* show a positive correlation between the preferences of ~sophisticated music~ and ~fully-complicated~ architectural forms, as well as partially rhythmic and asymmetrical building forms; that is, the more *mature musicians* like sophisticated music, the more likely they are to be interested in complicated architectural forms with an asymmetrical essence. The results also show similar trends between those with a preference for jazz with ~fully-complicated~ as well as ~sense of symmetricity~ in buildings among the *male musicians*. All in all, among *architect-musicians, male musicians, and mature musicians, a preference for* sophisticated music positively correlated with a higher level of appreciation for complexity, rhythm, and asymmetry in architectural forms.

Middle-aged male architects show a positive correlation between the preferences of *dance-ability* in music and *rhythmic* building forms. It is more likely to find a *middle-aged male architect* a fan of rhythmic building forms if he/she is interested in music with dance-ability.

A preference for ~happy~ music reflects a preference for symmetrical buildings among *young males*, as well as partially symmetrical buildings among the *mature male musicians* and *male architect-musicians*. Thus, it is more likely to find a male fan of ~happy~ music interested in the sense of symmetricity in architectural forms, especially among young males and male musicians. In addition, there are positive correlations between a preference for ~happy~ music and flat, simple, moderately complicated, rhythmic building forms among the *mature male musicians*; in brief, if they like ~happy~ music, they are likely to be interested in simple and rhythmic architectural forms. All in all, a preference for ~happy~ music may echo a preference for symmetricity, simplicity, and rhythm in architectural forms, among the *mature male musicians* and *male architect-musicians*.

Pop music also shows positive correlations with symmetricity in buildings among the *female architects*. The more they like pop music, the more they enjoy symmetrical architectural forms.

On the other hand, there is a similar trend between the preferences of sad music and ~moderately complicated~ forms among the *architects*, especially *female architects*. Similarly, there is a positive correlation between sad music and a sense of symmetricity among *architects*, *female architects*, *middle-aged architects*, and *middle-aged female architects*. From this, it can be concluded that architects, especially female practitioners, who have a preference for sad music, are likely to appreciate architectural forms that are moderately complicated with a hint of symmetricity.

There are positive correlations between ~mellow~ music and symmetricity for people over 65 years; the more they like mellow music, the more they are interested in architectural symmetricity. Similarly, ~soul~ music also positively correlates with ~simple~ building forms among the *mature female architects*; that is to say, a preference for soul music among female architects over 45 years is likely to accompany a preference for simple building forms.

Preferences for ~rap~ music and ~fully complicated~ building forms correlate negatively among *middle-aged male architects*, and positively among *mature architects*, especially *female mature architects*. Of the architects who enjoy rap music, the middle-aged males are likely to be less interested in complicated architectural forms, whereas older females are likely to appreciate such complexity. On the other hand, among the musicians, a preference for rock music negatively correlates with preferences for architectural complexity. Musicians who like rock, like architects who enjoy rap, are likely to be less appreciative of complicated architecture.

Regular pattern as an architectural attribute negatively correlates with jazz, rock, and ~intense~ music, and positively correlates with ~mellow~ music among the *mature male architects*; in other words, the more they like mellow music, and dislike jazz or intense music, the more likely they are to appreciate regular architectural patterns. Otherwise, the negative correlation between ~soul~ music and regular patterns among *young male* shows that the less they are interested in ~soul~ music, the more they would be interested in regular patterns in architectural forms. In contrast to the young males, *female architects* show a positive correlation between the preferences of ~soul~ music and the existence of a pattern, either regular or irregular; among them, those who rate ~soul~ music higher tend to have a higher level of satisfaction with buildings possessing a pattern in their formal structure. Lastly, mature female architects show a positive correlation between ~sad~ music and irregular pattern; so a strong preference for sad music may coincide with a preference for irregular patterns in architectural forms.

Among the architectural stress attributes, there is a positive correlation between a preference for jazz music and horizontally stressed buildings among the *male musicians*. The more they like jazz, the more they would be interested in horizontality in architecture. Similarly, higher preferences for ~sad~ music correlate with a preference for horizontality in building forms among architects and females. In other words, architects, and especially female architects, with a preferences for sad music, and *male musicians who enjoy* jazz, are likely to appreciate horizontality in building forms. On the other hand, a preference for ~sophisticated~ and ~mellow~ music tends to come with a preference for verticality in building forms for young females under the age of 18. Finally, the results show that the more *architect-musicians* are interested in ~sophisticated~ music, the more they would enjoy seeing stress, either vertical or horizontal, in building forms; the males are more inclined towards a preference for verticality.

Consequently, Figure 5.9 shows the number of correlations between the clusters of architectural and musical attributes, in total. On the chart, grey indicates the correlations passing the first filter. Although these correlations have not passed the second filter, they may reveal certain tendencies and, secondly, they may pass the second filter by increasing the number of participants or repeating the examinations. Thus, the greyish lines can give an insight into probable correlations. Elsewhere in the graph, blue and yellow colors indicate positive and negative correlations, respectively, having passed the second filter. Existence of the stronger correlations, r-value > 0.5, reflected by dark colors, dark blue for strong positive correlation, and dark yellow for strong negative correlation. For the sake of clarity and differentiating from the first layer of clustering, the cluster names are all in capital letters in the following discussion.

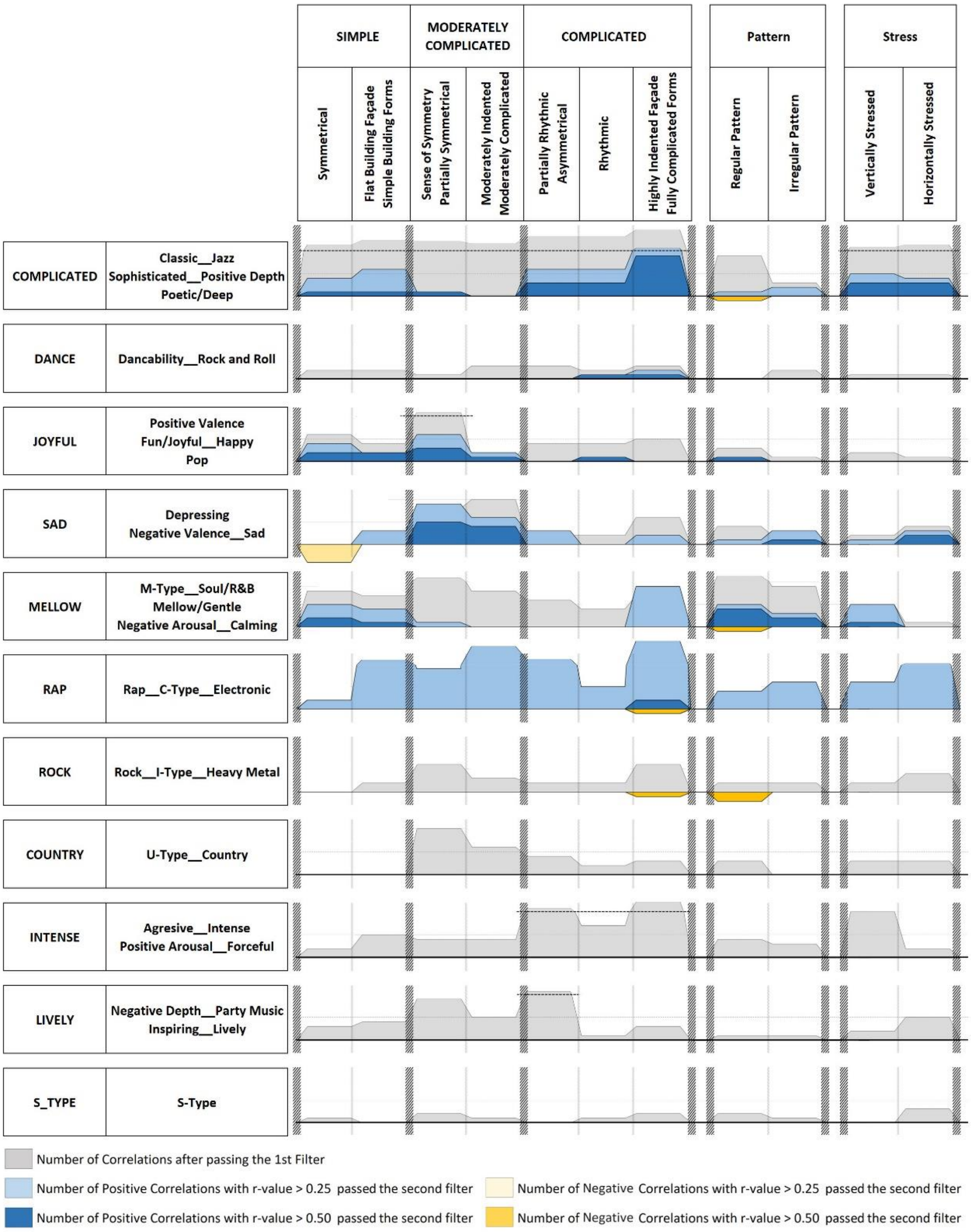

Figure 5.9 : Correlations between the clustered architectural and musical attributes.

As the most significant outcome, there is a positive correlation between a preference for COMPLICATED music and COMPLICATED architectural forms. Despite the existence of very few positive correlations with the simple forms, those who prefer complicated music seems to have a more positive opinion about complicated architectural forms. In addition, preferences of COMPLICATED music coexist with a positive opinion on architectural stress, either vertical or horizontal, in building facades. Therefore, those who like complicated music are more interested in complicated forms possessing formal stress, rather than more neutral forms with moderate complications.

Dance music followers seem to have a preference for rhythmic and complicated forms; in short, those who like DANCE music would be interested in COMPLICATED architectural forms.

Those who like JOYFUL music seem to be more interested in architectural forms with a trace of symmetricity or that are fully symmetrical. In addition, they are more likely to be interested in simple and moderately complicated building forms. Thus altogether, a strong preference for JOYFUL music is accompanied by a higher appreciation for SIMPLE and MODERATELY COMPLICATED building forms.

Those who enjoy SAD music are unlikely to appreciate symmetricity in architecture, though they may like partially symmetrical buildings, and possibly have a slight preference for asymmetrical forms. Furthermore, they are likely to be more interested in moderate complexity in building forms, as opposed to simple or fully complicated building forms. Finally, as the graph shows, a preference for SAD music may lead to a preference for MODERATELY COMPLICATED building forms. There is also a slight tendency towards regular patterns and horizontality.

An enjoyment of MELLOW music can correlate with higher preferences for symmetrical architectural forms. Although there is a larger number of correlations with fully complicated, there are fewer but stronger correlations between preferences for MELLOW music and simple architectural forms. Thus, it is more likely to find a fan of MELLOW music interested in SIMPLE architectural forms, though there might be occasional preferences for very complicated building forms as well. On the other hand, MELLOW music fans are likely to enjoy verticality in vertically-stressed forms as well as architectural patterns, especially regular ones with much simpler structures. Thus, MELLOW music followers expressed a tendency toward simple architectural forms, as well as showing some preference for regular pattern rather than irregular ones and verticality rather than horizontality.

Among the people who prefer RAP music, there is a tendency toward complicated building forms. Both the number of correlations passing the second filter and the larger number of correlations after the first filter among the RAP followers confirms that it is more likely to find them interested in COMPLICATED building forms. On the other hand, RAP fans show a high number of correlations after the first filter in almost all architectural attributes except symmetricity; this trend shows that there is a positive correlation between the ratings of the buildings in general and RAP music. Therefore, apart from their tendency toward COMPLICATED forms, RAP followers rated the buildings higher in comparison with people who like other musical clusters. The correlations after the first filter also reflect that there might be an appreciation of pattern and stress, especially irregular patterns and horizontal stress.

There is a negative correlation between a preference for ROCK music and Regular patterns in architecture. In addition, the first filter correlations suggest that ROCK fans may have a tendency toward the preferences of MODERATELY COMPLICATED and COMPLICATED building forms. Although the results confirm these preference correlations, the limited number of correlations indicates the need to consider the demographical classes for more specific discussions.

Since the rest of the musical clusters do not present any strong correlations after passing the second filter, the number of correlations passing the first filter can provide hints towards probable preference tendencies. For example, COUNTRY and LIVELY music followers may prefer MODERATELY COMPLICATED building forms. In addition, those who like INTENSE music may have a positive attitude towards COMPLICATED architectural forms and vertically stressed building facades.

6. CONCLUSION

The dissertation examined the correlations between the preferences of some architectural and musical attributes. To provide a clear set of architectural attributes, as the first challenge, a study is designed to introduce a list of architectural features via a systematic method. Likewise, an investigation reviewed more than 200 different studies in musicology to provide the most updated list of musical attributes involving our musical taste. Then, after clarifying the architectural and musical attributes, extracting the personal preferences of the considered attributes were the next challenge of the study. Although the review paper reflected that directly inquiring the preferences of the musical attributes can provide valid raw data, extracting the architectural attribute preferences has not been thoroughly discussed in previous studies. Accordingly, another study is designed to introduce a concrete method to reliably-extract the architectural attributes preferences of an individual. Consequently, the outcomes of the three studies provided a concrete platform to examine the correlation between the preferences of the architectural and musical attributes.

Apart from the pilot-study provided a general insight into the correlations, two main studies investigated the correlations between the attributes. A small-scale study examined the correlations between the preferences of 17 attributes related to architectural material and 17 attributes related to musical instruments, among the 12 demographical classes; and the large-scale study, as the main investigation, scrutinized the correlations between the preferences of 16 architectural attributes and 36 musical attributes, within 61 demographical classes. Regarding the aim of the dissertation, every single examined correlation presented in the appendices can be considered as the conclusion of the study; otherwise, to provide a more holistic understanding of the outcomes, the gist of the whole papers results is reflected conclusively in a categorized manner.

As the first important outcome, the studies confirm the importance of demographic classes in the correlation between the preferences of architectural and musical attributes. Not only the pilot-study shows the influence of the demographic attributes on the correlations, the number and the strength of the correlation in the small-scale study also confirms that concerning either age or gender does not suffice for the correlation explorations; instead it makes more sense to consider both demographics to have a stronger correlation between the preferences of architectural material and musical instruments. The large-scale study, concerning age, gender, and education in the correlation analysis, shows that even education impacts more on the discovered correlations. In particular, Gender and Education are the most influential demographic attributes for the correlations related to Genre and MUSIC-type; and Education and Age play the most significant role in the correlations with PPA and 3-Factor. Interestingly, other studies have confirmed the significance of demographic attributes on architectural attributes, including gender (Erdogan et al., 2013), education (Erdogan et al., 2010), and the combination of the three attributes of age, sex, and educational level (Gifford, 1980). This study replicated the importance of the three demographics.

The number of correlations reinforced that significance of demographic classes; it shows which people category reflected higher number of correlations, and thus it is more likely to find stronger correlations within. *Females* more than *Males* and people between 25 and 45 years old more than other people demonstrate correlations between the preferences of architectural material and musical instruments. With respect to general attributes, *Young Males*, *Young Females*, and *Middle-aged Females* reflected the highest number of strong correlations between architectural and musical attributes preferences. It is more likely to find or apply the discovered correlation across these demographic classes. Consequently, the demographic attributes require a close consideration when it comes to further investigation or application of the discovered correlations.

In addition, some attributes and attribute categories possess a higher number of correlations. For example, the preferences of white, light warm colors, and brick in architecture are more correlated with the preferences of musical instruments, while the preferences of materials with cold colors, as well as exposed concrete, had the least number of correlations with the musical instrument appreciations. On the other hand, in contrast to a guitar, cello, harp, and violin reflected the greatest number of correlations with architectural material preferences. This trend is also valid among the attribute categories. For instance, material color and material qualities are categories reflecting the most number of correlation with the musical instruments. The large-scale study, with its accumulative perspective, confirms that *Genre*, *MUSIC-Type* among the music attribute classifications, and *Indentation*, *Complexity* and *Symmetricity* among the architecture attribute classifications reflect a higher number of correlations, suggesting that these categories are better reflectors of individual's tastes in another field.

As the main outcome of the studies, a selected list of the stronger discovered correlations is restated to sum up the correlated attributes. The small-scale study shows that while young females like cello instruments it is more likely to be interested in stone, wood, fully-textured, and light color material in building façade. Likewise, for mature females, preferences of cello reflect higher satisfaction for brick, full of texture materials, aluminum, reflective, as well as light-colored material; similarly, those who are interested in harp show higher satisfaction of light color materials. We may conclude that, with some 'aboutness,' higher satisfaction for cello, harp, or string family instruments, reflect higher satisfaction for light material among the females. Young males who rate more to piano were less likely to be interested in cement plaster material. Interestingly, the accumulative perspective toward the correlations can also present the overlapped attributes. For example, the positive correlation among the young females between the preferences of cello instrument and stone, light color, reflective, and wood material, may reflect that young female who is interested in cello instrument are more likely to be satisfied by well-polished reflective light-colored stone, and reflective laminated wood. Similarly, for mature females who are interested in cello, buildings with reflective aluminum or brick material possessing some texture would be rated the highest. Finally, apart from the correlations for its own sake, having an accumulative perspective can show a more holistic understanding of the preferences, especially when the application of the correlations is the main concern.

The results of the large-scale study show some interesting correlations between the attribute preferences among the demographic classes, though the study mostly considers the holistic understanding of the correlations. *Male musicians*, *mature musicians*, and *even architect-musicians* who are interested in sophisticated music tend to prefer sophisticated formal architectural qualities, including complexity, rhythm, and a-symmetricity. A *middle-aged male architect* who is a fan of rhythmic building forms would be more interested in music with dance-ability. Female architects who are interested in pop music and males who are interested in happy and joyful music are more likely to be attracted to fully symmetrical architectural forms. On the other hand, the more architects, especially females, enjoy sad music, the more likely they are to be interested in moderately complicated buildings with a tinge of symmetricity in the formal structure, in contrast to fully symmetrical forms. Among the architects who are rap followers, older females are more interested in architectural complexity, while middle-aged males are less likely to be interested in complicated forms. People over 65 show a higher preference for symmetricity if they are interested in mellow music; similarly, female architects over 45 years prefer the simple building forms when they are interested in soul music.

Furthermore, among the correlations related to architectural stress, preferences for sad music for *female architects* and jazz music for *male musicians* tend to have a preference for horizontality in building forms. In addition, the more *architect-musicians* are interested in sophisticated music, the more they will like the existence of architectural stress, either vertical or horizontal. Among the correlations in an architectural pattern, *mature male architects* who highly rated regular patterns were more interested in mellow music and less interested in jazz, rock, and intense music. Y*oung males* who are interested in a regular pattern would be less interested in soul music; by contrast, *female architects* who enjoy soul music tend to like architectural patterns, both regular and irregular. Furthermore, a preference for sad music may reflect an enjoyment of irregular patterns among the *mature female architects*.

Since the large-scale study explores very large number of correlations, clustering method is also applied to summarize the correlated attributes and reveal any overall trends in the correlation. In architecture, the attributes in the categories of symmetricity, indentation, complexity, and even rhythm have interrelated trends with regards to their correlation with musical attributes; thus, they form three clusters pertaining to the complexity levels: SIMPLE, MODERATELY COMPLED, and COMPLICATED, reflecting the significance of complexity in the discovered correlations, as confirmed by many studies on both musical satisfaction (Gordon & Gridley, 2013) and building preferences (Herzog & Shier, 2000) (Tinio & Leder, 2009) (Imamoglu, 2000). Pattern and Stress, on the other hand, tend to be more independent and are accordingly seen to be more autonomous formal qualities. More trends were revealed with the musical attributes and the way in which they correlate with the architectural ones, named COMPLICATED, DANCE, JOYFUL, SAD, RAP, ROCK, INTENSE, and MELLOW.

Finally, the clusters-based outcomes confirm that, despite the existence of very few positive correlations with the simple forms, those who prefer the attribute in the COMPLICATED music cluster seems to have more positive opinions about COMPLICATED architectural forms. There are strong correlations, albeit very few in number, that shows that those who like DANCE music seem to prefer rhythmic and complicated buildings. Those who like JOYFUL music seems to be more interested in the symmetrical, partially symmetrical forms, simple and moderately complicated building forms. SAD music followers don't tend to like symmetricity in architecture, but do prefer partial symmetricity and a-symmetricity; they showed a strong tendency toward MODERATELY COMPLICATED architectural forms in general. Among the MELLOW music followers, in general, it is more likely to find them interested in SIMPLE architectural forms, though there might be some rare cases that prefer very complicated building forms as well. Although it seems that *RAP* followers award higher ratings to building preferences in general, the results show that there is a tendency in them towards COMPLICATED building forms. However, some buildings with a moderate level of complexity may also engage them.

Pattern and stress also reflect some general preference tendencies. MELLOW music followers show a higher preference for the existence of patterns in architectural forms, especially *regular patterns*. Similarly, JOYFUL music followers seem to tend towards *regular patterns* in architecture. On the other hand, those who prefer COMPLICATED music, as well as SAD music, are more interested in *irregular patterns*. Those who enjoy RAP have a preference for either *regular* or *irregular patterns* that exude a sense of repetition in the formal structure. They also show a preference for stress, either vertical or horizontal, in building façades, as do those who prefer COMPLICATED music. Although SAD music followers prefer to see horizontally stressed buildings, people who enjoy MELLOW music prefer to have vertically stressed building forms. Worth mentioning, a glimpse over the general preference correlations show the similar cognition characteristics between the preferred architecture and musical attributes; it suggest the hypothesis that there is a similar cognition and internal interpretation between the visual architectural attributes and audible musical attributes.

Now extracting the architectural preferences from the musical taste is more achievable than ever before, which can be placed shoulder to shoulder to extracting them from architectural forms. Altogether, the large number of discovered correlations reflects the huge potential behind the correlations between the appreciation of architectural and musical taste. From an architectural point of view, the discovered correlations providing a bridge between the architectural appreciation and musical taste can result in a better understanding of the client's taste by their musical appreciation. That is, considering the musical preferences of a person enable architects to discover the satisfactory architectural attribute. Since having the preferred attributes in a building form will increase the satisfaction rate of the building appearance in general (Baskaya et al., 2006), this study finally enables architects to design more pleasant architectural forms for their clients.

Even discovering the satisfactory architectural attributes based on musical taste can be integrated with the extracting them by architectural images. As the study conducted during the dissertation shed a light on the method of extracting the satisfactory visual attributes through architectural images ratings (Tayyebi & Demir, 2020), the final outcomes reflected the possibility of extracting the satisfactory architectural attributes from musical taste. Interestingly, the combination of the two methods can open new gates to solve the mystical satisfactory architectural attributes for laypeople, though it may need further examination before getting widely utilized. Regarding the fact that architects had not be able to reliably uncover the satisfactory architectural attributes of lay people, and can poorly predict how laypersons would visually assess buildings (Nasar, 1988) (G. Brown & Gifford, 2001), the outcomes can assistant architect to fill the gap between their and laypersons set of values, and powerfully unlock the laypeople's architectural taste.

In addition, the discovered correlations can be applied to a group of people, geographic condition, or a set of people; then, their shared satisfactory musical attributes, can reflect the pleasing architectural taste among them. For instance, the shared characteristics of children music, can reflect the visually pleasing architectural attributes to be potentially used in the design of kindergarten. Similarly, the shared musical attributes of local music can potentially disclose the architectural attribute which can improve the building appearance satisfactions. Furthermore, this study also provided a reliable platform to apply the huge number of studies on musical appreciation as reflectors of the architectural attribute preferences, though there may still be a long way to go before such insights are widely utilized in the design process of a building.

Lastly, this dissertation by discovering a large number of correlations between architectural and musical attributes preferences from people's point of view created a bridge between architecture and music. Future study can analogically strive to strengthen the bridge, or attempt to pass over the bridge and make it much more practical; they can introduce and examine some feasible methods to use the discovered correlations. The analogical bridge can be strengthened by applying some limitation in the considered attributes to discover a more robust set of correlations in future studies. For instance, limiting the attributes to a special geographical location enabling researchers to focus on the correlation between widely-visible architectural features and folk musical attributes or local musical instruments, thereby providing more feasible set of correlations among the local people. The discovered correlations, especially the stronger ones, can be the focus of future investigations; this allows researchers to scrutinize a fewer number of correlations via various analyzing methods which could be integrated by an interview, and discover more concrete sets of correlations. As an example of practical suggestions to analogically pass over the bridge, the study can make a building preference predictor game; with the assistance of Artificial Intelligence the game can have a dynamic and self-improving character; thereby provide an opportunity to accurately uncover building preference prediction.

This study consequently confirms the existence of numerous correlations between architectural and musical attributes from people's perspective, as it is discussed from composer's and architect's point of view: Architecture and Music Are Indeed Interrelated.

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CURRICULUM VITAE

Name Surname : Seyed Farhad Tayyebi
Place and Date of Birth :
E-Mail :

EDUCATION:

- **Architecture Engineering:** 2009, Islamic Azad University, Faculty of Architecture, Architecture Department
- **M.Sc. in Architecture:** 2013, Eastern Mediterranean University, Faculty of Architecture, Architecture Department

PROFESSIONAL EXPERIENCE AND REWARDS:

- 2009-2011 Working Fulltime in the Organization of School Renovating, Develop, and Equipping, Bojnourd, Iran.
- 2009 Onward, Working Fulltime, Parttime, and Project-based, as Architectural Technician/Architect at Mandegar Sazeh Architectural Firm, Bojnourd, Iran.
- 2010 Achieving 1st Place in architectural design competition of "Where is the Mehr Mosque?"
- 2013 Receiving the licenses of "Engineering Order and Construction Law" and "Engineering Order and Construction Law Executive Regulation"
  License No: 38-100-00069
- 2015 Achieving the honored-design position in the provincial architectural design competition of Imam Reza Square Monument.

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