ISTANBUL TECHNICAL UNIVERSITY ★ GRADUATE SCHOOL

A FRAMEWORK FOR DESIGN EVALUATION WITH HERMENEUTICS AND MEASUREMENT SCIENCE: DESIGN EVALUATION THROUGH QUANTIFICATION

M.Sc. THESIS

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ISTANBUL TEKNİK ÜNİVERSİTESİ ★ LİSANSÜSTÜ EĞİTİM ENSTİTÜSÜ

HERMENÖTİK VE ÖLÇME BİLİMİ İLE TASARIM DEĞERLENDİRME ÇERÇEVESİ ÖNERİSİ: NİCELLEŞTİRME YOLUYLA TASARIM DEĞERLENDİRMESİ

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Deniz Oskay, a M.Sc. student of ITU Graduate School student ID 523181002, successfully defended the thesis/dissertation entitled "A FRAMEWORK FOR DESIGN EVALUATION WITH HERMENEUTICS AND MEASUREMENT SCIENCE: DESIGN EVALUATION THROUGH QUANTIFICATION", which she prepared after fulfilling the requirements specified in the associated legislations, before the jury whose signatures are below.

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To my family,

FOREWORD

I would like to express sincerely my gratitude to my supervisor Assist. Prof. Dr. Ethem GÜRER for the fruitful observations, suggestions and guidance during the process of this master thesis despite the long distances emerging from pandemic conditions.

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June 2021

Deniz OSKAY
(Landscape Architect)

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ABBREVIATIONS

AHP **:** Analytic Hierarchy Process

DQI **:** Design Quality Indicator

POE **:** Post Occupancy Evaluation

SYMBOLS

cm **:** Centimeter

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A FRAMEWORK FOR DESIGN EVALUATION DRAWN WITH HERMENEUTICS AND MEASUREMENT SCIENCE: DESIGN EVALUATION THROUGH QUANTIFICATION

SUMMARY

The term 'design' is mostly used as both a noun and a verb, and it may refer either to the end product or to the process. On the other hand, the design process and the design product are intertwined. The thesis aims to examine the 'design' in terms of its evaluative characteristics by considering its measurability. Experts participating in the design process can provide an understanding, interpretation, and judgment on design quality, which can help create a foundation for measuring design quality. The thesis provides a comprehensive and rational framework to structure a decision problem, represent it, and quantify its tangible and intangible elements to clarify the process of the design evaluation. Because the quality of architectural design may be appraised from various perspectives, finding systemic approaches is both crucial and challenging. The main objective of the thesis is to present a possible evaluation framework to architectural design for the improvement within the design process by considering tangible and intangible components of the architectural design. Hence, the thesis aims to translate the evaluators' judgments into decisions and clarify the unambiguous terms within the design team by developing a common language through the processes of operationalization and quantification. Therefore, understanding metrological concepts and recognizing their limitations are prerequisites for interpreting data obtained within the architectural evaluation process. Besides, the design evaluation can be regarded as one of the most ambiguous design processes in terms of its measurability since it inherently includes objective and subjective understandings. As a crucial process, measurement emerges in different design stages, such as doing site surveying as an objective measurement and making questionnaires as a subjective measurement. Hence, the thesis aims to clarify a hermeneutical framework to expand the design evaluation process with theories from measurement science. By doing so, both objective and subjective understandings in the design evaluation are addressed with a hermeneutical process due to the dual nature of hermeneutics. Therefore, the goal is to frame design evaluation not just by degrading into either objectivism or subjectivism but rather by accepting the existence of both objectivism, subjectivism, and beyond. One way to consider how these debates intertwine and contribute to the explanation of each other is to view them from a hermeneutical perspective. On the other hand, design problems are not well-defined problems to be solved, but rather the initial state of a design situation involves ill-defined problems, i.e., a lack of adequate knowledge to allow the designer to reach conclusions directly. After a comprehensive literature review on historically proposed design methodologies, the research concludes that what designers do is continuously shifting between general and detail, function and form, problem and solution, aims and means, and supports the existence of a hermeneutical event within the design process. Therefore, an interpretative approach to an ill-defined situation can support the design evaluation process instead of a well-defined problem-solving activity. Since design

inherently involves highly complex information, it is critical to understand how it is transmitted and interpreted properly, meaningfully, and effectively. Such an endeavor necessitates a reconsideration of design byways of its epistemology (rules to reach the truth), metrology (measurement techniques and sciences of the uncertain), and a methodology (knowledge of the methods) in order to understand how the design evaluation process progresses. In the scope of the thesis, measurement is considered a specific form of evaluation, that is to say, acquiring meaningful data in an interpretative way that signifies subjective components of measurement as well, by considering the inevitable presence of the evaluator's judgment. The novelty of the proposed framework is hence its attempt to focus on design evaluation through its measurability with a cross-disciplinary approach by taking assistance from measurement science and hermeneutics since they share similar concerns within the field of design. The thesis dwells on grounded theory methodology, which constructs its hypothesis and theories depending on collected data and analysis. In the scope of the thesis, data are obtained from measurement science and hermeneutics to propose a framework for the design evaluation. The convergence and divergence of different interpretations presuppose a common language in which these interpretations are formulated and opposed. Terminologies from measurement science can support the need for that common language. The architectural design comprises both tangible and intangible components. The reasoning system that hermeneutics and measurement science use can guide to make each component measurable as much as possible. Since there is not a proper instrument that can be calibrated to measure a 'design,' these instruments have to be constructed and developed specifically for each design process itself by considering the context-dependency of each design process. Besides, ill-defined problems cannot be solved by traditional analyses, such as by reductionist methods. Thus, there is a need for a cross-disciplinary approach to deal with ill-defined concepts and benefit from their findings. Therefore, the proposed framework aims to quantify tangible and intangible components of the architectural design by way of operationalization, since in the design evaluation, most of the criteria, such as sustainability, are not definite before one makes an operation in order to define it. Hence, the thesis aims to demonstrate that the evaluative actions in the design processes can and must be re-formulated with the understanding of measurement science and hermeneutics theories to build up a holistic and integrated negotiation of quantitative and qualitative evaluations within the design process.

HERMENÖTİK VE ÖLÇME BİLİMİ İLE ÇİZİLEN TASARIM DEĞERLENDİRME ÇERÇEVESİ ÖNERİSİ: NİCELLEŞTİRME YOLUYLA TASARIM DEĞERLENDİRMESİ

ÖZET

'tasarım' kelimesi hem isim hem de fiil olarak kullanılmakta olup, son ürüne ya da sürece atıfta bulunabilir. Öte yandan tasarım süreci ve tasarım ürünü iç içedir. Tez, ölçülebilirliğini göz önünde bulundurarak 'tasarımı' değerlendirici özellikleri açısından incelemeyi amaçlamaktadır. Tasarım sürecinde yer alan bireyler tarafından verilen ve tasarım niteliğine ilişkin olan anlayışlar, yorumlar ve yargılar, tasarımın niteliğinin ölçülmesine temel sağlamak için kullanılabilir. Tez, bir karar problemini yapılandırmak, temsil etmek ve tasarım değerlendirme sürecini netleştirmek amacıyla, somut ve soyut unsurları birlikte göz önünde bulundurarak ölçmek için kapsamlı ve rasyonel bir çerçeve sunmaktadır. Mimari bir tasarımın niteliği farklı açılardan değerlendirilebileceğinden sistematik yaklaşımlar bulmak oldukça karmaşıktır. Tezin temel amacı, mimari tasarımın hem somut hem de soyut bileşenlerini göz önünde bulundurarak ve tasarım süreçlerini ile tasarım ürünlerini iyileştirme amacı güderek mimari tasarım için olası bir değerlendirme çerçevesini sunmaktır. Bu nedenle, değerlendiricilerin yargılarını kararlara dönüştürme yoluyla ve operasyonelleştirme ve nicelleştirme süreçleri aracılığıyla ortak bir dil geliştirerek tasarım ekibi içindeki belirsiz terimleri netleştirmek amaçlanmaktadır. Bu netleştirme yolunda, mimari değerlendirme sürecinde elde edilen verilerin yorumlanması için metrolojik kavramları anlamak ve sınırlarını tanımak ön koşuldur. Ayrıca tasarım değerlendirmesi, doğası gereği hem nesnel hem de öznel anlayışları içerdiğinden, ölçülebilirliği açısından en belirsiz tasarım süreçlerinden biri olarak kabul edilebilir. Ölçme aktivitesi, nesnel bir ölçüm olarak saha araştırması yapmak ve öznel bir ölçüm olarak anket yapmak gibi tasarımın farklı aşamalarında ortaya çıkmaktadır. Bu nedenle tezin amacı, tasarım değerlendirme sürecini ölçüm biliminin teorileri ile genişletme yoluyla hermeneutik bir çerçeve sunmaktır. Böylelikle tasarım değerlendirmesinde hem nesnel hem de öznel anlayışlar, ikili doğası gereği hermenötik bir süreçle ele alınmaktadır. Böylelikle tasarım değerlendirmesinin, yalnızca nesnel veya öznel unsurlarına indirgenerek değil, hem nesnelliğin, hem öznelliğin, hem de bu ikisinin ötesinin varlığını kabul ederek çerçevelenmesi amaçlanmaktadır. Bu tartışmaların nasıl iç içe geçtiğini ve birbirlerinin açıklanmasına nasıl katkıda bulunduğunu düşünmeye başlamanın bir yolu, onlara hermenötik bir perspektiften bakmaktır. Öte yandan, tasarım süreci çözülmesi gereken iyi tanımlanmış problemlerle tanımlanamamaktadır, daha ziyade, bir tasarım durumu, başlangıç durumu muğlak tanımlı problemlerle, yani tasarımcının sonuca doğrudan ulaşmasını sağlayacak yeterli bilgiye sahip olmamak ile karakterize edilir. Günümüze kadar önerilmiş olan bazı tasarım yöntemleri üzerine kapsamlı bir literatür taramasının ardından, tasarım süreçlerinin, genel ve detay, form ve işlev, problem ve çözüm, amaçlar ve araçlar arasında sürekli geçiş yapmak olduğu görülmüştür. Aynı zamanda, önerilmiş olan tasarım süreçlerinin çokluğu, tasarım süreci için evrensel ve kabul görmüş tek bir tasarım süreci olmadığının göstergesidir. Bu durum, tasarım sürecinin bağlam-bağımlılığının, doğa bilimlerinin anlayışlarının doğrudan tasarım sürecine uyarlanmasına baskın geldiğini göstermektedir. Bu durum, hermenötik bir anlayışa dair ihtiyacı desteklemektedir. Bu anlayış, tasarım süreci için iyi tanımlanmış bir problem çözme etkinliği yerine, muğlak tanımlarla başlanan bir duruma yorumlayıcı

bir yaklaşım uygulanmasını içermektedir. Her ne kadar tasarım değerlendirmeleri için farklı yaklaşımlar önerilmiş olsa da, tez kapsamında önerilen çerçeve, ön tasarımdan nihai tasarıma kadar tasarım süreçlerinin tüm aşamalarında kullanılmak üzere geliştirilmiştir. Tasarım sürecinde erken alınan kararların, nihai ürünün niteliğinin değerlendirilmesinde dikkate değer bir rolü olduğu genel olarak kabul edilmektedir. Ancak tasarım değerlendirmesi için ihtiyaç duyulan bilgilerin çoğu tasarım sürecinin sonraki aşamalarında elde edilir. Öte yandan hermenötik gösterir ki, parça ve bütün sürekli birbirleriyle karşılıklı bir ilişki içindedir ve birbirlerinden beslenme yoluyla anlam ortaya çıkar. Bu nedenle bir tasarımın yalnızca son ürüne dönüştükten sonra değerlendirilmesi, tasarım sürecinde ortaya çıkması muhtemel anlayışları elimine etmektedir. Bir tasarım, yalnızca son ürüne dönüştükten sonra değerlendirilmeye tabi tutulduğu taktirde, buradan elde edilecek bilgiler çoğunlukla olumlayıcı nitelikte olmaktadır, veya gelecekteki tasarım süreçlerine bilgi olarak dahil olabilmektedir. Aksine tasarımı, tasarım süreci içerisindeyken sürekli bir değerlendirmeye tabi tutmak, tasarımın yalnızca belirli aşamalarında görünür olabilecek durumların da tasarım sürecine dahil olmasını sağlayabilmektedir.

Tasarım faaliyeti doğası gereği oldukça karmaşık bilgiler barındırdığından bu bilgilerin ne kadar doğru, anlamlı ve etkili bir şekilde iletildiğinin ve işlendiğinin farkında olmak çok önemlidir. Bu durum, epistemoloji (gerçek bilgiye ulaşma kuralları), metroloji (ölçüm teknikleri ve belirsizin bilimleri) ve metodoloji (yöntemlerin bilgisi) açılarından tasarım değerlendirme sürecinin nasıl ilerlediğini anlamak için yeniden ele alınımını gerektirmektedir. Tez kapsamında ölçme, değerlendirici yargısının kaçınılmaz varlığı göz önünde bulundurularak, ölçmenin öznel bileşenlerini de kabul eden yorumlayıcı bir şekilde anlamlı verilerin elde edilmesini içeren belirli bir değerlendirme biçimi olarak ele alınmaktadır. Bu nedenle önerilen çerçevenin yenilikçi özelliği, tasarım alanıyla benzer kaygıları paylaştıkları için ölçüm bilimi ve hermenötikten yardım alarak disiplinlerarası bir yaklaşımla tasarım değerlendirmesine ölçülebilirliği üzerinden odaklanmaya çalışmasıdır. Tez, toplanan verilere ve analizlere dayanarak hipotezini ve teorilerini oluşturan gömülü teori metodolojisine dayanmaktadır. Tez kapsamında, tasarım değerlendirmesi için bir çerçeve önermek adına hermenötik ve ölçüm bilimlerinin anlayışlarından yararlanılmaktadır. Ölçüm bilimlerinden yararlanmanın en büyük getirilerinden biri, genellikle soyut durumların ölçülmesi söz konusuyken ölçüm sonucunun gerçekten ölçülmek istenen unsura denkliğini değerlendirebilecek herhangi bir altlık bulunmamasıdır. Bu nedenle, ölçüm bilimlerinin kavramları ve anlayışlarının tasarım değerlendirme sürecine dahil edilmesiyle, bu denkliğin netleştirilmesi amaçlanmaktadır. Öte yandan, farklı yorumların yakınsaması ve farklılaşması, bu yorumların formüle edildiği ortak bir dili varsayar. Ortak bir dile olan bu ihtiyaç, ölçüm biliminden gelen terminolojilerle sağlanabilir. Mimari tasarımın hem somut hem de soyut bileşenlerden oluştuğu ve her bir bileşeni mümkün olduğunca ölçülebilir kılmak için hermenötik ve ölçüm biliminin kullandığı akıl yürütme sistemlerinin yol gösterebileceği görülmektedir. Bir 'tasarımı' ölçmek için kalibre edilmiş herhangi bir araç olmadığı için, bu araçların her bir tasarım sürecinin bağlam-bağımlılığı göz önünde bulundurularak her bir tasarım süreci için özel olarak inşa edilmesi ve geliştirilmesi gerekmektedir. Ayrıca, literatür taramasında muğlak problemlerin indirgemeci yöntemler gibi geleneksel analizlerle çözülemediği görülmüştür. Bu nedenle, muğlak kavramlarla başa çıkmak ve bulgularından yararlanabilmek için disiplinlerarası bir yaklaşıma ihtiyaç duyulmaktadır. Tez kapsamında önerilen çerçeve, mimari tasarımın somut olmayan bileşenlerini operasyonelleştirme yoluyla ölçmeyi amaçlamaktadır, çünkü tasarım değerlendirmesinde, sürdürülebilirlik gibi

kriterlerin çoğu, tanımlanması için bir işlem yapılmadan önce belirli değildir. Bu nedenle tez, tasarım süreçlerindeki değerlendirme eylemlerinin, tasarım sürecinde nicel ve nitel değerlendirmelerin bütünleşik bir müzakeresini oluşturmak için ölçüm bilimi ve hermenötik teorilerinin anlayışıyla yeniden formüle edilebileceğini ve edilmesi gerektiğini göstermeyi amaçlamaktadır.

1. INTRODUCTION

1.1 Problem Description

Much of the current architectural quality improvement program has been focused on measuring to provide higher quality. Measuring and evaluating design quality has therefore become a significant challenge. At the center of this discussion, there is the question of how to define and assess value. The design quality is hard to determine since it includes both objective and subjective components. While specific design components can be measured objectively, some indicators are intangible and have judgmental characteristics. Definition of the main criteria for architectural design quality has always been a significant issue, dating back to ancient times. Since Vitruvius, many researchers and practitioners develop ideas about what the criteria should be to assess quality.

On the other hand, the question of whether it is possible to find universal criteria to be applied to all design products in the same way, is still valid since what characterizes the design evaluation process is its dependence on the context and the evaluator. The design evaluation process is about making data-driven decisions, and the data is to be interpreted by the evaluator, which inherently and inevitably includes interpretation. What makes it harder to reach an ultimate interpretation is the characterization of situations with multiplicity (meaning layers) and plurality (multiple meanings that lead each interpreter to develop divergent but still equitably valid meanings from the same situation).

In the 21st century, measurement is considered the basis of all experimental and theoretical research, including social sciences and natural sciences. Besides, measurement is mainly regarded as the source of trustworthy and reliable knowledge that includes a wide range of human activities to support decision-making processes. Throughout the twentieth century and until today, philosophers of science have given a great deal of attention to answer the question of what science is and what makes science distinct from other human activities. The judgments about what activities can

be considered scientific inquiry has a projection in the field of design. When the history of proposed design methods is examined, it is revealed that most of the proposals had aimed to position design activity with its relation to science.

On the other hand, design activity deals with ill-defined problems that cannot be solved by traditional analyses, such as reductionist methods or the methods of empiricist scientists. This consideration necessitates the need for a cross-disciplinary approach to deal with ill-defined concepts. Moreover, this definition of design activity put other more local questions forward, which the thesis aims to find answers to:

- Where does design stand between natural sciences and social sciences?
- What is the appearance of hermeneutics in the design evaluation process?
- How can the measurability of design be defined?
- What is the relationship between measurement and evaluation, and how does this cooperative relationship project itself in the design evaluation process?
- Can measurement science and hermeneutics contribute to design evaluation by using their interrelationship, and is it possible to propose a flexible framework to be used in the design evaluation processes?

1.2 Aim and Scope

Design evaluation is a systematic examination of the outcome of an activity to identify the degree to which the original objectives have been accomplished. According to Foque (1982), working with messages carrying highly complex information is part of the design process. So, it is crucial to understand how information is transmitted and appropriately processed meaningfully and efficiently. The thesis focuses on some local questions, but the general aim of these questions is to conclude with an understanding that examines the measurability of a design product and to contribute to architecture's measurability by revealing and examining the measurable and unmeasurable parts in order to extend the understanding of the design evaluation process. Since measurement activity has a powerful dependency on the nature of the subject matter, its application, and the context, measurement should be performed to make its definition explicit and satisfactory, which is remarkably difficult. Over the past decades, measurement and evaluation of design quality have drawn much attention to both academics and

practitioners. However still, despite the fact that existing quantitative or 'positivistic' studies are beneficial for scientific practice, they do not address the 'softer' and intangible aspects of quality (Dewulf & Van Meel, 2004). Besides, there cannot be found comprehensive research on quantifying design quality before the design process begins (Harputlugil & Gültekin, 2009). Hence, an adaptive-rational approach that does not obscure the existence of the tacit knowledge but lets it emerge in the measurement process can be considered a fruitful approach. Therefore, the thesis aims to provide a framework for the design evaluation process through the understandings from hermeneutics and measurement science since there are common challenges to be overcome, and they can contribute to the understanding and explanation of each other.

1.3 Outline

In Section 2., two types of research are used to answer the questions of Section 1.1. First is the descriptive approach that the thesis attempts to answer how the design process progresses and its relations with science. By analyzing logical structures of proposed design methodologies and depending on theoretical research, the thesis aims to understand the structure of the design processes and their relation with science. The second approach used in Section 2. is the prescriptive one, which attempts to answer the question of how the design process should be understood with its relations with sciences. Hence, firstly the design methodologies that are offered, and depending on what characteristics they are categorized, are investigated with literature review. Then, the potential misunderstandings are revealed not to distort the real nature of the design process. The differences between science and design activities are examined in Section 2. Departing from different approaches of respectable researchers such as Simon (1996), Cross (1993), Willem (1990), Eder (1995), Ayıran (2002), March (1984), Lawson (2005), Alexander (1964), and Glynn (1985), it is concluded that one of the main difference between scientific activity and design activity is, while the design is necessarily prescriptive, science is predominantly descriptive. On the other hand, researchers such as Gasparski (1993) and Willem (1990) emphasize the complementary bearings of design and science in contrast to previously mentioned ones. The diversity of explanations for the link between design and science demonstrates that there is no common and conclusive understanding of the nature of the connection, or that it is complex, or that its operational purpose can characterize it.

On the other hand, attempts to separate design and science, or to suggest alternative sorts of linkages between them, demonstrate that one of the key concerns in design research is the relationship between design and science, particularly in terms of their methods. By depending on this, there may be some misconceptions concerning the design process. A closer examination of putative links between design and science in the context of methods throughout history is required to overcome these possible misconceptions. On the other hand, it is seen in Section 2.1 that, in the examination of the history of the relation between design and science, the term 'science' mostly refers to the natural sciences, whereas as Snodgrass and Coyne (1997) pointed out, design activity does not belong to the domain of the natural sciences, which is based on formal logic, but rather to the domain of the human sciences and hermeneutical sciences, which is based on understanding and interpretation processes. In Section 2.2, to clarify the differences between the natural and human sciences, the Anglo-American and the Continental understandings of the demarcation are examined. Firstly, we investigated the trials of using methods of the natural sciences into the human sciences, and the impossibility of this approach is revealed. Later, the traditional demarcation of the natural sciences and the human sciences are investigated and seen that it is discredited with a more current and accurate examination of the natural sciences, since the traditional assumptions embrace a classical empiricist perspective of the natural sciences, which was generally discarded later on with the contributions of Kuhn, Feyerabend, Hanson, Popper and many, by revealing the existence of theory-ladenness in the natural sciences as well. Hence, the inclusion of interpretation even in the natural sciences is accepted. Consequently, the boundary between the natural and social sciences has started to blur, especially with the emergence of complexity sciences, fuzzy logic, and quantum theories. Accepting the role of interpretation in all disciplines leads researchers to deny crucial differences between the natural sciences and the social sciences since all-knowing presupposes background assumptions. The theory-ladenness in science finds itself a role in design activity as well. As Archer (1981) puts it, design, like science, is a way of looking at the world and imposing structure upon it. Correspondingly, explicit theories in science and design are not formed from neutral data, as traditional empiricists presuppose, but from data already pre-structured by implicit hypothesis, which corresponds to the observation's theory-ladenness. As Glynn (1985) points out, the success of a scientific theory or a design solution is not determined by their affirmative connection to scientific facts or design issues but rather

by the fact that all observations in the area of science and design are mediated by implicit hypotheses or solutions. This argument elucidates the communicative character of both science and design, the importance of tacit knowledge in every design activity (covered in Section 3.3), and the necessity of the hermeneutical process (discussed in Section 3.4). According to Bernstein (2009), both in the natural sciences and the social sciences, there is a rise in the re-emergence of the hermeneutical dimension. The difference that the natural and human sciences make is in the way the nature of the design process is addressed and reveals that their understandings of problem-solving are radically different.

In Section 3., the notion of the use of hermeneutics as a metaphor for understanding, in general, is examined, and the circular characteristics of hermeneutics are explained in order to reveal how one understands and concludes with interpretations. Pre-understandings give meaning to a structure, and also they are what makes things intelligible. As a result, all interpretations include a basis on pre-understandings. To say that someone brings prejudicial preconceptions to an activity does not entail that such preconceptions cannot be made explicit, questioned, corrected, or abandoned. Therefore, the goal should be to expose the preconceptions to critical thinking during the study process, rather than to eliminate them, since, without preconceptions, understanding would not be possible. Gallagher (2004) demonstrated how hermeneutics explains the process of understanding following what cognitive science suggests by exemplifying schema theory. On the other hand, Jahnke (2012) proposes that the use of critical hermeneutics of Ricoeur may provide a better foundation for design activity, considering that critical distancing dimension to interpretative activity cannot be found on Gadamer's philosophical hermeneutics. However, how to come up with a single interpretation if understanding is a circular process is a continuously challenging question of hermeneutics. Hence, in Section 3.1, the limits of interpretation are examined. According to Bernstein (2009), any interpretation or understanding can be challenged, questioned, and superseded by a better, clearer, and more reasonable interpretation. Since understanding cannot be thought independently from interpretation, one of the consequences of the hermeneutical paradigm is to avoid objective meaning and advocate the possibility of continuous re-interpretation and understanding. Because there is no brute data at this level, the interpretative debate over meanings is theoretically unending, and another interpretation can contest every

interpretation. This approach differs from the logical empiricist verification method since verifying the hermeneutical circle is focused on the coherence of the interpretation within itself rather than on brute data. According to Taylor (1971), the study of intersubjective meanings inherent in social reality requires moving beyond the limitations of science rooted in traditional epistemology of empiricism focused on verification. By depending on this, an interpretative process within the hermeneutical community that combines the approaches of Ricoeur and Gadamer is represented in detail in Section 3.1, which includes evaluator, evaluative activity, critical reflexivity, the fusion of horizons (degree I), the fusion of horizons (degree II), validation that includes affirmation and falsification, and conclusion. When the issue is about to be concluded with a single interpretation, as it is required in practical research, such as evaluating a design, the consensus might be reached after evaluating each evaluator's interpretation by depending on their assertions to validate their interpretation. Tacit understandings are of great importance in order to conclude with an interpretation. However, before examining the role of tacit understanding, there is a need for an exceeding of the object-subject dichotomy. Section 3.2 involves a discussion about the coexistence of objectivity and subjectivity in the design process. According to the objectivist account of evaluation, there is an embedded value of the design that does not include any interpretative property, and the evaluator's task is to uncover the value. In contrast, the role of the rules is to specify how the evaluator can uncover the real value of the design in the evaluation process. On the other hand, according to Snodgrass (1996), objectivity in any design evaluation is unachievable. The reasons for this assertion are examined, and seen that even if the evaluators are totally dedicated to the same set of criteria for selection, they may reach different results, which does not point out that these choices are arbitrary since the unattainability of objectivity does not necessarily lead to subjectivity. The object-subject dichotomy, which dates back to Descartes, is accountable for this exclusionary and incompatible premise of objectivity and subjectivity. Hence, to accept the unattainability of objectivity does not necessarily mean that it does not follow any norms or criteria. Depending on detailed explanations in Section 3.2, approaching design as an interpretative and hermeneutical event opens other ways to understand what designers have in their minds. In that sense, the evaluation depends on the evaluators' preconceptions, tacit understandings, experiences, and anticipations corresponding to the rules and criteria. In section 3.3, the role of different types of knowledge in the

design process, since design activity depends on modes of thought and ways of knowing that are poorly defined and understood. Therefore, one of the tasks for design research should be examining the informal knowledge that cannot be made explicit yet. Different terminologies proposed by Ryle (1949), Polanyi (1962a), Cross et al. (1981), Archer (2005), and Heidegger for the implicit knowledge are explored. The multiplicity of the terminologies clarifies that there are things that can be distinguished from a complicated pattern of things without determining which traits are distinguishing. Moreover, there appears a situation that unspecifiable particulars can be comprehended only by depending on its total comprehension, such as how the hermeneutical circle progresses. Similarly, designing does not have a single and fixed value but myriad constructions of value depending on private preconceptions (Snodgrass, 1996). The chapter concludes that any understanding that does not include tacit knowledge is unattainable. Section 3.4 states that different types of knowledge are related to hermeneutics in the design process. Section 3.4 investigates the atomistic language model to support the assertion that excluding the hermeneutical process from design evaluation to achieve objectivity means ignoring the essence of any design process since there are sorts of knowledge not based on brute data. Consequently, the value of a design is not constant but changes accordingly with the interpretation, hence the evaluation. Therefore, instead of covering the design process as a problem-solving activity, it is proposed to use the metaphor of interpretation of a text to describe the design process. Besides, Ritter and Webber (1973), Schön (1983), Lawson (2004), and Coyne (2005) define design problems by being 'wicked,' and according to Finkelstein (2003), the wicked problems are subjected to what is called 'weakly defined measurement,' or simply, soft measurement. Because requirements cannot be expressed clearly, an ill-defined problem is defined by a lack of adequate information to allow the designer to reach conclusions that conform to the needs. The lack of clear criteria necessitates the practical use of tacit knowledge. Ambiguous facts and uncertain relationships come up in systems in which correlations between quantitative variables are weak, but a weak correlation is still something other than a lack of correlation and is the subject of science (Moles, 2018). The use of statistics in the scientific investigation may be an example of ambiguous circumstances yet still worth investigating. Design, according to Foque (1982), entails coping with messages carrying extremely complex data. Therefore, it is critical to understand how information is transmitted and processed properly, meaningfully, and efficiently.

Hence, there is a need for an epistemology (rules for reaching the truth), metrology (measurement techniques and sciences of the uncertain), and a methodology (knowledge of the methods that will enable the human to understand the uncertain things) to understand how the design evaluation process can be demystified. Considering that design includes both tangible and intangible components or measurable and unmeasurable parts, the immeasurable reveals itself through measurable parts by attempting to determine the components of the immeasurable traits. Because there are similar concerns to be discussed, and because measurement is unquestionably one of the essential aspects of scientific thought, the terminology of measurement science has a high potential for the stage of 'uncovering' the immeasurable components. As a result, measurement science may provide beneficial understandings to generate design evaluations, and therefore on measurement.

Section 4 discusses the concerns that measurement science deals with. Since measuring activity depends on the nature of the subject matter, its application, and the context, the measurement should be performed to make its definition explicit and satisfactory, which is remarkably difficult. Some definitions offered by Suppes (2002), Michell (1999), Prasad (2004), and many others are examined to define measurement and to demonstrate the relationship of measurement and evaluation within the scope of the thesis. The approach that equates measurement to quantification is discredited. Mari et al. (2017) indicate that only quantities are regarded as measurable grounds on the historical convention instead of a logical necessity. According to Gallagher (2004), some phenomena have meaning but cannot be quantified or objectified without losing their meanings and hence fall into the realm of hermeneutics.

Moreover, to deny the actuality of these facts is what is unscientific. In the scope of the thesis, measurement is regarded as equal to quantification. It does not limit the area of knowledge that includes not-quantifiable entities with the use of pragmatic measurement. In the case of the design evaluation, the instrument is the judgments of the evaluators of the design team or the hermeneutical community. Correspondingly, measurement is regarded as a specific type of evaluation in the scope of the thesis, i.e., obtaining meaningful data in an interpretative manner that includes subjective components of measurement while taking into account the inevitable presence of the measurer's or evaluator's interpretations. In other words, measuring may be seen as a procedure for gathering data about the qualities of empirical phenomena. By relying

on this, to understand how the notion of measuring has evolved, it is essential first to take a historical viewpoint and reveal that measurability has profound implications for the development of measurement science. Hence, in Section 4.1, an overview of the development of measurement theory throughout history is examined and concluded with the assertion that measurability was and is a problem in both the natural and the social sciences. As a result, to propose a framework for the design evaluation process, a pragmatic perspective on measurement science is considered valuable, concentrating on the epistemic aspects required from measurement science terminology. Therefore, various measurement science terminologies have been chosen to be utilized in the design evaluation process to expand the domain of knowledge and practices in design evaluation by relying on allied disciplines that share common problems, such as measurability. In Section 4.2, concepts from measurement science to be used in the design evaluation are introduced. These concepts are the scales of Stevens, representational measurement theory, and pragmatic measurement theory. It is clear that many design-related concepts are value-laden, and their definitions, evaluations, and measurement have value-relevant consequences. Because all measuring and evaluation methods are tailored to their intended goal, achieving a non-'theory-laden' approach is neither feasible nor desirable. Similarly, Ferris (1994) demonstrated that what data signify is something that data transmit about the world, but that significance is something that the evaluator attributes to the data based on their understanding of the nature of the object they are investigating.

Sections 1 to 4 aim to justify the pre-acceptances of the proposed framework for the design evaluation that combines terminologies from the measurement science and hermeneutics. Therefore, Section 5. is an introductory stage for the proposed framework. The architectural design comprises both tangible and intangible components. To make each component measurable as much as possible, the reasoning systems of hermeneutics and measurement science can guide since they share similar concerns. Since there is no instrument to perform a measurement procedure for design structure, these instruments have to be constructed and developed specifically for each design process, considering the context-dependency of each design process. Therefore, in Section 5.1, a literature review is investigated that queries design measurability and evaluation. It is seen that problem understanding and problem resolution are intertwined, which means to find a problem somehow means to find a solution.

Therefore, the main problem in the design process is firstly the formulation of the problem. The operationalization process is introduced in order to make measurable the unmeasurable attributes of a design. Later, Analytic Hierarchy Process (AHP) is examined to gather and categorize different perspectives to increase the quality of architectural design, and the shortcomings of AHP are analyzed. Later on, another attempt associated with the design quality evaluation is introduced, that is, the Design Quality Indicator (DQI), and the drawbacks of DQI are examined. Therefore, measuring and evaluating design quality has become a significant difficulty for designers, construction experts, and clients.

By depending on the deficiencies mentioned earlier and learning from their outputs, the characteristics of the proposed framework for the design evaluation process are introduced in Section 5.2. Firstly, post-occupancy evaluation (POE) is investigated. Early decisions in the design process are emphasized since, as Volker (2010) points out, tools developed to obtain data on architectural design quality are generally used for POE. Hence, POE can only provide information for later projects or renovation, but not for the current project; hence, they are limited regarding their contribution to the design process. On the other hand, the proposed framework plays as a link between the theoretical and empirical worlds and a tool for thinking. In Section 5.2, the pre-acceptances of the thesis are introduced to clarify how they correspond to the proposed framework. The pre-acceptances include using different scales and weights of importance, the importance of in-process evaluation, transcendence of object-subject dichotomy, the complexity and the context-dependency of design, and a multi-evaluator framework.

Section 5.3 comprises the general introduction of the proposed framework. The framework includes three stages that are definitions, quantification, and re-thinking definitions. While the process of definitions considers the question of 'what to consider,' the process of quantification searches for 'how to measure,' and re-thinking definitions is about 'how to interpret.' In Section 5.3.1, definitions are further introduced. The importance of the definitions is, sometimes the theoretical context and the measurement to be performed may not match, since, in the design evaluation, the categories are based on loosely interconnected characteristics. Therefore, since the measurement is a process made on purpose, its first step should be describing the criteria to be measured and the disclosure of the indicators of the criteria, which

necessitates the process of definitions. Later, in Section 5.3.2, the process of quantification is examined. To evaluate or measure a design, one must convert non-numerical values into numerical values through a process known as operationalizing, and the definitions of criteria and their indicators are put into a scaling system.

Moreover, the weighting of the criteria and indicators should be designated as well. Then, in Section 5.3.3, the process of re-thinking definitions is examined. In re-thinking definitions, the evaluative process is re-considered through their accuracy and precision, and the interpretation of the quantification results is performed. Furthermore, in Section 5.4., an exemplar is proposed to demonstrate how the proposed framework can be used as a tool for thinking through the use of DQI's criteria.

2. POSITIONING THE DESIGN ACTIVITY

Herbert Simon (1996) explains one of the differences between natural sciences and design by pointing out that while the natural sciences are concerned with how things are, designing is concerned with how things should be, emphasizing the normative presence of design discipline. Cross (1993) adds a further difference between sciences and design activity, which is the need for a method vital to science, where it verifies the results. However, it is not helpful in design since the results are not reproducible. Similarly, Willem (1990) states that the overall purpose of design activity is not to produce knowledge, but instead to take action and adjust the environment. Eder (1995) states that the main aim of scientific activity is to establish the generation of knowledge, whereas design is about the beneficial use of the generated knowledge. Ayıran (2002) covers the same situation by stating that design aims not to explain but instead to become the explanation's subject. March (1984) expresses a similar thought by stating that while science examines existing forms, design generates new forms. Finally, Lawson (2005) emphasizes another difference between science and design: because scientific issues do not meet the description of design challenges, the processes of science and design cannot be considered comparable.

To summarize, one of the most significant distinctions between science and design is that design is necessarily prescriptive, whereas science is primarily descriptive. As a result, designers may be seen as prescribing and constructing the future, whereas scientists deal with explaining the present and forecasting the future. Hence, Lawson states that what designers do is prescriptive rather than descriptive, contrary to what scientists do. Alexander (1964) shared an analogous approach by asserting that scientists strive to discover existing structure components while designers work to shape new structure components. Glynn (1985) further claims that design activity develops from knowledge of universal rules to practical invention of specific alternatives. In contrast, science advances from observations of single events to the theoretical hypothesis of universal laws. Moreover, Ayıran (2005) states that science and design are two entirely different fields on aims, tools of explanation, operation conditions, and in their forms of evaluation.

Gasparski (1993) proposes a relatively distinct approach compared to the ones mentioned earlier. Since theories are not discovered but are constructed, the relationship between science and design is cyclical: a theory is designed first, then a design is tested against theoretically grounded knowledge. Willem (1990) approaches the relationship between design and science in a similar perspective by asserting that design brings science to life; in other words, when science is employed to effect change, it becomes visible. What is proposed by Willem (1990) is that only through design can science be made apparent, and therefore science progresses beyond pure knowledge merely through design and gets operational consequences. By depending on the definition of Willem (1990), design activity can be interpreted as the intentional development of anything, and by using the knowledge that comes from science, science finds a place to reveal itself. According to Willem (1990), the value of science depends on three main qualities: firstly, it is the inherent value of knowledge; secondly, the potential uses of the prior knowledge to produce new knowledge; and thirdly, its use in design activity. The approaches asserted by Willem (1990) and Gasparski (1993), by contrast to previously mentioned ones, do not emphasize the contradictory realms of design and science but instead assert a complementary bearing. The multiplicity of explanations of the relationship between design and science reveals that there is not a common understanding of the nature of this relationship or reveals that the relationship is multifaceted or can be defined according to its operational purpose.

On the other hand, efforts to dissociate design and science or propose different types of relationships between them reveal that one of the significant concerns in design research is the relationship between design and science, mainly in the context of their methods. At this point, the difference between method and methodology should be emphasized since they are commonly and mistakenly used by each other. In the literal sense of the word, a methodology is the science of methods and a collection of methods and techniques. In contrast, a method is a predetermined way of acting to achieve a specific aim. Gasparski (1983) states at least two meanings of the term 'methodology.' The first meaning is often interpreted as the procedure or a set of rules of information processing or research. In this sense, methodology refers to a 'method,' or technique, or program of action. The second use of the term methodology is the science of methods. In this sense, a methodology is a scientific discipline whose domain consists of methods. Gasparski (1993) introduces some definitions for clarification:

- 1st definition: A method is a technique of action that is used systematically to attain the goal of the activity.

- 2nd definition: A set of methods related to the same kind of actions is called methods.

- 3rd definition: A study of the philosophical underpinnings of procedures in any human endeavor is called the methodology, for example, science methodology, design methodology, etc.

Therefore, Gasparski uses the concept' design methodology' in the latter sense, a discipline that deals with the methods used in design-making. In sum, while the first interpretation can be understood as descriptive, the latter can be thought of as prescriptive.

To continue with the significant concerns of design research, Cross (1999) indicates that there are three categories in design research taxonomy:

- Design epistemology that corresponds to the research towards 'designerly ways of knowing.'

- Design praxeology is the study of design processes

- Design phenomenology is the study of the form and configuration of artifacts

In the scope of the thesis, the focus will be on the first two categories of Cross, which are the designerly ways of knowing and the processes of design activity. The multiplicity of approaches about the relationship between design and science reveals no commonly accepted understanding of the relationship. Therefore, there may be misunderstandings about the nature of the design process. In order to reveal these potential misunderstandings, there is a need for a closer look at proposed relationships between design and science in the context of their methods and methodologies throughout history.

2.1 Relation between Science and Design through Proposed Design Approaches

The concerns about the relationship between science and design had emerged mainly at two periods in the modern history of design: the first period was the 1920s when there was a search for scientific design products, and the second period was the 1960s, led by the emergence of the concern for the scientific design process. From the 1950s

to 1960s, there was a great effort in different disciplines to devise design methods to deal with the complexity and the uncertainty in the existing design inquiry. Cross (1982; 1993) distinguished the science of design, design science, and scientific design to clarify the differences between approaches that are commonly confused. Even though these conceptualizations do not belong to Cross himself, and each of them is defined by other practitioners, Cross has categorized them to reveal the differences for clarification. This categorization includes scientific design, design science, the science of design, and one understanding that Cross (1982) offers, design as a discipline.

According to Cross (1982; 1993), scientific design is the modern and industrialized design that differs from pre-industrial, craft-oriented design and is founded on scientific knowledge while employing both intuitive and non-intuitive design approaches. The reason that triggers the development of new methods, as known as the design methods movement, is the assumption that modern and industrial design is overly complicated for the mere use of intuitive methods.

Buckminster Fuller, a radical technologist, used the term ‘design science decade’ to describe the 1960s when he advocated for a ‘design science revolution’ based on science, technology, and rationality to address developing human and environmental issues (Cross, 1982). The ideas of Descartes highly influenced the design thinking of the time. Descartes (1998) proposes breaking down all the problems under investigation into as many components as feasible and as many as are necessary to address them most efficiently and initiated the emergence of operations research and decision-making inquiries with the developments in computer science. These inquiries played a highly influential role in the origins of new design methods during the 1960s. The decomposition aims first to solve the sub-problems separately and then to make a synthesis of these individual solutions to attain an integrated solution as a whole. As Cross (1993) asserts, the term ‘design science’ is first used by Gregory, or as Cross (1983) himself asserted in another paper, it is first used by Buckminster Fuller, but later adapted by Gregory, in the Conference on ‘The Design Method’ in 1965, even though later other definitions for design science have appeared. Snodgrass and Coyne (1992) define design science as employing scientific models to structure and focus research on the design process while working with the conjecture of the models corresponding to the design process in a logically deducible manner and continue that this approach hides more than it reveals. According to Hubka and Eder (1987), design

science is a system of logically connected knowledge in the realm of design that includes technical information and methodology. On the other hand, design science also deals with deriving the appropriate information of the natural sciences to bring it to a form that is suitable for the use of the designer. The attempts to establish a design science have guided some concerns to formulate a single rationalized design method that is grounded on formal theories and language. Hubka and Eder (1987) cite a more straightforward interpretation of design science proposed by Hansen (1974), that is, "to recognize laws of design and its activities, and develop rules." The approach of Hubka and Eder (1987) can be concluded in a way that the constitutive attributes of design science are:

- Applied knowledge from natural sciences,
- Use of the theory of technical systems,
- Development of a theory of design processes,
- Development of a design methodology.

These definitions emphasize the systematic characteristics of design science, where the procedures of design activity are organized in their most systematic way. The fundamentals of design methods developed in the 1960s depend on the division of the process into well-defined steps. Briefly, the values of design science can be related to the following keywords: objectivity, rationality, and universalism, which are the constitutive concepts of 'scientific' ways of seeing the world (Cross et al., 1981). Hence, the Cartesian approach of breaking down the problem into units to use partial solutions and combine them to reach the general solution was adopted. For example, Alexander (1964) considers the design process an error reduction or error-correcting process with a Popperian approach that depends on falsification. Alexander (1964) proposed a mathematical system of decomposing design problems into small and manageable parts. These small and manageable parts hereafter aimed to be evaluated based on logical and transparent criteria that can be assigned to correspond to the 'goodness of fit between the context and the form. Alexander's method of breaking down the problem into parts, solving the parts, and then assembling the solved parts to conclude with an overall solution, that is called reductionism, necessitates the separation of the entire system of interest into well-understood components to be processed and the subsequent construction of a new conclusion. According to

Sydenham (2003), when the limits of effects on a problem are not apparent, in other words, when there is no closed system model, which is essential for reductionist problem solving, this type of problem-solving technique does not lead to solutions. Another reason to fail reductionism in the design process lies in the premise that sub-system solutions lead to reticulation and can be incorporated back into the whole. In sum, design science emphasizes that designing is a goal-oriented problem-solving activity to deal with design problems. However, later it was disturbed by socio-economical and philosophical changes in the late 1960s and 1970s (Linden et al., 2011).

In the late 1970s, under the influences of Kuhn, Popper, and Feyerabend, which can be considered as external influences since they do not directly belong to the 'designerly tradition,' a paradigm shift in design methodologies occurred. Jones (1984) had criticized the methods of reductionists by emphasizing the role of emergence and initiative approaches in the creative and investigative processes as Linden et al. (2011) narrate, with the decline of the rationalist paradigm, the new paradigm concentrated upon specific tools such as mind maps, scenario techniques, and usability tests for design activity and integrated with various non-design disciplines. The science of design, differently from design science, is defined by Simon (1996) as "... a body of intellectually tough, analytic, partly formalizable, partly empirical, teachable doctrine about the design process" (p. 113). Grant (1979) states a common understanding among designers and design methodologists that design activity is not and cannot be a scientific activity since designing itself is non-scientific. On the other hand, Grant (1979) again supports that design research might be a scientific endeavor; in other words, design activity could be the subject of research. Another definition of the science of design, which is proposed by Gasparski (1990), is "the science of design (should be) understood, just like the science of science, as a federation of sub-disciplines having design as the subject of their cognitive interests." Finally, Cross (1993) concludes with the definition of 'the science of design' as a body of work to improve design knowledge through scientific inquiry. According to Willem (1988), design is a process of intentional development rather than a science. Merriam Webster dictionary (1987) describes 'science' as "… the state of knowing: knowledge as distinguished from ignorance or misunderstanding". So that, by following this definition, Willem defines (1988) the things that can be known about design as what

constitutes the science of design. Another perspective on the design and science relationship is that design ‘makes science visible' through its reliance on scientific knowledge and applying scientific information to practical challenges (Willem, 1990).

Schön (1983) notably challenged the fundamental positivist philosophy of the ‘design science’ movement and proposed a constructivist framework. Schön (1983) also criticized Simon’s (1996) view of the ‘science of design’ since it focuses on solving well-formulated problems while professional design practice deals with ill-defined problems. Schön (1983) explores practical epistemology, which some practitioners do bring to situations of ‘uncertainty, instability, uniqueness, and value conflict’ and calls for it a ‘reflective practice.’ Even though The Sciences of the Artificial, the book of Simon, had a positivist character, and is based on technical-rationality, Simon (1996) argued that ‘the science of design’ may be a basic foundation of intellectual activity that can provide communication across the arts, sciences, and technology. Therefore, Simon (1996) suggests that studying design can be an interdisciplinary study accessible to all creative making activities that create the artificial worlds. Instead, Cross (1982) presents a view of design as a discipline, not as a science, but as a science of design based on reflective design practice, saying ‘design as a discipline. The fundamentals of this approach assert that certain types of knowledge are exclusive to designers, which Cross (1982) calls ‘designerly ways of knowing’. The thesis signifies design as a discipline with its peculiarity and emphasizes its interdisciplinary essence to support its potential with other related disciplines that share common concerns.

As seen, the efforts of creating an effective relationship between design and science have not reached an end, and most of the approaches are discredited by following researchers and practitioners. In the brief historical overview of the relationship between design and science, ‘science’ is mainly accepted as the natural sciences. Nevertheless, as Snodgrass and Coyne (1997) emphasized, design activity does not belong to the formal logic-based realm of natural sciences but rather to the domain of human sciences and hermeneutical sciences that stands on the processes of understanding and interpretation. This approach also may have a point to be criticized since it accepts the definition of natural science from the traditional empiricist point of view, which many researchers later on criticized. This situation necessitates a closer look at the demarcation of the natural sciences and social sciences to reveal the currently accepted demarcation between them to reveal the position of design activity.

2.2 Between Natural Sciences and Social Sciences

There are differences in the Anglo-American and the Continental understandings of the nature of the social sciences. In the Anglo-American tradition, intellectual disciplines are divided into three sub-sciences: natural sciences, social sciences, and humanities. On the other hand, in the Continental tradition, the trichotomy returns into a dichotomy between the Naturwissenschaften as natural sciences and the Geisteswissenschaften as moral sciences. The Anglo-American thought considered social sciences just as natural sciences, regarding individuals in their social relations. The assertion depends on the assumption that the social sciences do not differ from the natural sciences in kind but differ in degree. Therefore, according to the understanding of that time, the methods used in the natural sciences can be extended by the analogy of the social sciences. On the contrary, in the Continental tradition, there was a tendency to think of social disciplines as forms of Geisteswissenschaften.

The positivist approach, which is considered chiefly under Anglo-American understanding, argues for the unity of science, saying that both the natural sciences and the human sciences must belong to one single method. According to this view, the human sciences can only assert their certainty and truth by using the models and methods of natural sciences since the methods of the natural sciences are accepted as the only source of specific and objective knowledge. According to Snodgrass and Coyne (1999), although the models and methods of the natural sciences are effective in manipulating and controlling physical events, they are unsuitable for application in human sciences because of their distorted and deceptive structure when applied to the study of human behaviors and interactions, since their domain of interest is different. Snodgrass and Coyne (1999) further state another crucial difference between the natural sciences and the human sciences: self-reflexivity, since in the human sciences, it is humans who reveal the investigations, and again it is humans who are under investigation. Hence, the study itself is a component of what is being studied. What self-reflexivity signifies in this relationship because humans cannot step outside to analyze themselves as an outer object. As a result, when applied to the study of the human sciences, the objective requirements of the natural sciences are self-defeating. Dilthey (1976) asserts the demarcation between the Naturwissenschaften and the Geisteswissenschaften as the natural sciences search for ‘explanations’ of natural phenomena, while the latter grounds on the aim of ‘understanding.’ Dilthey further

tried to enhance the methods of the human sciences to be considered as respectable as those of the natural sciences, not by imitating the methods of the natural sciences directly, but by developing its methods, since the validity of methods is relative to the subject matter. As Gadamer (1973) narrates, Husserl also defended that the application of the naturalistic concept of objectivity to the human sciences is 'absurd.' Popper (1991) similarly points out that, to adapt the scientific methodology that bases on determinism and positivism into social sciences is an utterly improper stance. The methods of the natural sciences are not even proper for themselves.

Hesse (1972) gathers five main differences accepted traditionally between the natural and the social sciences. First, the natural sciences' experience is objective, testable, and not dependent on theoretical explanation. Data and theory are inextricably linked in the human sciences since data are determined based on theoretical interpretation. Then the facts are reconstructed based on the interpretation. Secondly, the theories of the natural sciences have artificial characteristics or models and allow the explanation employing hypothetico-deductive logic. In contrast, in the human sciences, theories are mimetic reinterpretations of the facts themselves. Moreover, the standard of a good theory in the human sciences is understanding meaning and intention, not deductive interpretation. The third difference is that the law-like relations are external in the natural sciences, whereas, in the human sciences, the relations are internal. Dreyfus (1980) explains the third assertion with other words while asserting that the scientist's interpretative practices have no bearing on the construction of theories in the natural sciences. In contrast, the same interpretive practice plays a leading internal role in the human sciences. The fourth assertion is about the use of language. The language of the natural sciences is exact and formalizable, which means meanings are univocal. On the other hand, the language of the human sciences is irreducibly equivocal and adapts itself to particulars continually. The last claim is that meanings are distinct from facts in the natural sciences, but in the human sciences, meanings are the facts themselves. Hesse (1972) interprets these distinctions so that they are untenable according to the recent and more accurate analysis of the natural sciences since these five points accept the definition of the natural sciences from a traditional empiricist view that is universally discredited later on. The traditional definition of the natural sciences assumes that the only ground of the scientific knowledge can be given in theory-independent experience, and theories can only make ontological claims if they are

reducible to observables. In sum, the aim of the natural sciences from the point of view of a logical empiricist was to develop extensive theories that then form the presuppositions to explain phenomena as a body of deductively connected empirical generalizations. Later on, like Kuhn, Feyerabend, Hanson, Popper, and many others emphasized, the observations of the natural sciences are theory-laden as well, which is, each empirical conjecture to be used as a starting point to a scientific activity employs concepts that interpret the data in terms of it. Scientific study is a phenomenon that is somewhat defined by the contents of the mind of those who participate in it, yet it is objectively real. However, seeing a scientific study in this light as objectively real runs counter to the notion that 'objective' means 'independent of thoughts' or 'mind-independent.' Certainly, this does not imply that scientific research is not objectively real, but rather that something about the concept of objectivity is flawed (Ingthorsson, 2013). Popper (2002) similarly states that observations are always interpretations in the light of theories, and Kuhn (1996) continues, “many... will surely want to say that what changes... is only the scientist's interpretation of observations” (p. 120). Dreyfus (1980) claims that there is no such objectivity even in the natural sciences in understanding theoretical holism. The very conception of objective knowledge is a philosophical mistake leftover from Descartes’s rationalist interpretation of the implications of Galilean science. This critique of the established understanding of natural sciences implies that it includes interpretation like any other human cognitive endeavor. Natural scientists must determine what to accept as the relevant facts and their theoretical meaning. Hence, there is no possibility of finding neutral, un-interpreted data to decide between competing hypotheses even in the natural sciences. To verify a theory in the natural sciences, one moves in a circle from hypothesis to data and data to the hypothesis in return. Hence, in theoretical holism, the only difference between the natural sciences and the social sciences is that in the natural sciences, the existence of interpretations has been repressed, whereas in the social sciences, for some unknown reasons, have never succeeded in covering up the conflict. Hence, in the view of theoretical holism, as Dreyfus (1980) narrates, all understanding is a question of epistemology and a question of theoretical knowledge, which asserts that there is no significant distinction between social and natural scientific knowledge. On the other hand, measurement is an important indicator to designate the certainty of any science. According to Gürsakal (2007), with the emergence of complexity sciences, fuzzy logic, quantum theories, etc., the concrete methods of the natural

sciences took a step towards social sciences by avoiding its concrete methods. Hence, instead of 'borrowing' the natural sciences and adapting them directly to the social sciences, it is necessary to investigate the 'common' concepts and perspectives of natural sciences and social sciences that may serve as 'bridges.'

Hesse (1972) gathers the characteristics of post-empiricist accounts of the natural sciences in five categories parallel to the traditional categorization, as shown in Table 2.1. Firstly, in the natural sciences, data cannot be considered separately from theory. According to the theoretical explanation, what to accept as data is again decided in light of theories. Secondly, theories of the natural sciences are not external models in a hypothetico-deductive schema. Instead, one makes hypotheses, deduces the observable consequences of these hypotheses, and then compares the consequences with actual observations since they are the way the facts themselves are seen. Thirdly, the law-like relations in the natural sciences are internal, since what to count as fact or not is constituted in the light of the theory again. Fourth, the language of the natural sciences is irreducibly metaphorical and inexact as well, and fifth, the meaning in the natural sciences is again determined by the theory, since their understanding comes from theoretical coherence instead of their correspondence to the facts.

Table 2.1 : The comparison of the traditional empiricism definition of the natural sciences and the post-empiricist account, adapted (Hesse, 1972).

Traditional empiricist understanding	Post-empiricist understanding
Data are objective, testable, and independent of theoretical explanation	Data are not detachable from theory
Theories are artificial models, yielding explanation in the sense of a logic of hypothetico-deduction	Theories are not external models, they are the way facts are seen in themselves
The law-like relations are external	The law-like relations are internal
The language is exact, formalizable, and literal	The language is metaphorical and inexact
Meanings are separate from facts	Meanings are determined by the theory

Feyerabend (1975) further states that the scientific inquiry of all observations and facts are eventually theory-laden, and hence, science has always been ‘sloppy and ‘irrational’ than its methodological portrayal. Gadamer (2009), in addition to Feyerabend, argues that the modern method obsession distorts and obscures the ontological character of understanding. Kuhn (2018) similarly states that there is

neither any systematic decision procedure nor any neutral algorithm for theory selection. Even when applied correctly, it might persuade everyone in a group to conclude with the same decision. The theory-ladenness in science finds itself a role in the design activity as well. As Archer (1981) puts it, “Design, like science, is a way of looking at the world and imposing structure upon it.” Hillier et al. (1972) similarly noted that:

Far from being removed from the field of science, the cognitive schemes by which we interpret the world and pre-structure our observations are increasingly seen to be the essential subject matter of science. The question is not whether the world is pre-structured but how it is pre-structured. The idea of pre-structuring has immediate and fundamental applications in design. We cannot escape from the fact that designers must, and do, pre-structure their problems in order to solve them (p. 3).

The concept of rational design is generally regarded as it conforms to science's deductive logic and orthodox canons. In other words, the idea of rational design considers rational design equal to explicit knowledge as well as a limited type of reasoning, which is not the most convenient interpretation of rational design. Instead, Abel (1979) proposes another interpretation of rational design that depends on the criterion of critical awareness and a self-conscious process of social communication. Namely, the first approach equates rationality to a restricted mode of deductive logic, while Abel (1979) emphasizes the need for critical awareness. Moles (2018) similarly states that being rational is not a situation to come up with, but it is instead an approach. Therefore, we conclude that the explicit theories in science or design do not emanate from neutral observations as suggested by traditional empiricists but instead originate from the observations that have already been pre-structured by the implicit hypothesis that corresponds to the theory-ladenness of the observation. So that, as Glynn (1985) signifies, the achievement of a scientific hypothesis or a design solution is not contingent on their agreement with scientific facts or design problems. However, instead, all observations are mediated by implicit hypotheses or solutions in the field of design. This assertion clarifies the communicative nature of both science and design and reveals the role of tacit understanding found in every design activity discussed in Section 3.3 with the need for or to accept the existence of the hermeneutical process that will be discussed in Section 3.4.

According to Snodgrass and Coyne (1997), design activity does not fall into the area of the natural sciences with its relation to formal logic, but instead more related to the area of the human sciences and the hermeneutical sciences with their dependence on understanding and interpretation. As seen in Section 2.1, the efforts to approximate the design field to the natural sciences depend on the definition of the characteristics of the science. Suppose the traditional empiricist definition of the natural sciences is accepted. In that case, we can claim that design activity is for sure not in the domain of the natural sciences. However, when the post-empiricist account of Hesse (1972) is accepted, design activity can be regarded as not that far from the natural sciences, since in the account of Hesse (1972), the logic of science is circular, data are interpreted within the theory. The theory is constrained by empirical data by reinterpretations and self-corrections of it. It is discovered that the current interest in the role of interpretation in all disciplines leads researchers to deny the existence of crucial differences between the natural sciences and the social sciences since all-knowing presupposes background assumptions. Hence, no theory corresponds to things as they are in themselves. As Bernstein (2009) states, both in the natural sciences and the social sciences, there is a rise in the re-emergence of the hermeneutical dimension of science.

Similarly, there has been a growing acceptance in the field of design to act design in its terms, as Cross (1999) emphasizes as well, it is not necessary to act design as an imitation of science nor a transcendent art since the design has –and should- its own intellectual culture and its way of knowing; with the vocabulary of Cross (1982), there is a ‘designerly ways of knowing. Coyne (1991) exemplifies this dichotomy by stating that understandings of the design processes mostly polarized around two exclusive positions: design as an objective inquiry that considers designers as objective experts, and design as a self-expression activity, that regards designers as artists with creative genius. Therefore, one of the challenges of the design discipline should be preserving the position of design as ‘design as a discipline’ by preserving its interdisciplinarity. The thesis proposes to improve the understanding of the design activity and its integration with science; there is a need for an unconventional approach to knowledge of human inquiry. Since, as Hesse (1972) stated, in the human sciences, the ‘logic’ of interpretation is circular, that is to say, the part cannot be understood without looking at the whole. The whole itself is dependent upon the relations of the parts. Besides,

data cannot be understood without context; that they are dependent upon the relations of data and context themselves, which approximate design activity to the human sciences. Putnam (1979) similarly recognizes that the field of knowledge is wider than the field of science. Levy (1985) supports this approach by stating that, now, science is not viewed as a single fixed method that focuses on a certain way of comprehending the universe. Rather, it is a rational activity that is expanded for recognizing, organizing, and solving problems. Levy (1985) further states that this broader understanding of 'scientific' inquiry gives a more balanced picture of the present discussion over the links between science and design.

Furthermore, in light of this broader perspective, it is practically axiomatic that 'knowing that' and 'knowing how' are both science and design domains. So, science can now be characterized as using various systems of reasoning to solve conceptual and practical problems. Simon (1996) accordingly states that the easiest way to find out what kind of logic is required for design is to see the designer's logic when thinking critically. Therefore, this expanded understanding of the scientific inquiry offers a broader perspective on the dispute over the link between science and design.

This chapter concludes that the natural sciences and the human sciences are different from different points of view. However, as Snodgrass and Coyne (1997) ask, what difference does this difference make? The difference that the natural and human sciences produce is in the way the nature of the design process is addressed and reveals that their understandings of problem-solving are radically different. According to Koberg and Bagnall (1981), design is the process of creative problem-solving. This definition of Koberg and Bagnall (1981) make researchers such as Ayıran (2005) ask when defining design, why insisting on the ‘problem’ concept that based on typical science terminology and carries connotations from mathematics and physical sciences, and why avoiding to define ‘design’ as a direct creative activity that is based on interpretation.

On the other hand, Snodgrass and Coyne (1977) define design activity in another way, that is to say, by comparing it to the interpretation of a text. Hence, design should be considered an interpretative activity instead of an activity that aims to solve a problem. On the other hand, a particular method in science always aims to give the same results when we follow the rules. In contrast, it is neither possible nor desired in any design activity. Hence, the mere use of logic-based models would be deficient in

understanding the design process, and there is a need to disclose the hermeneutical aspect of design activity.

3. DUAL NATURE OF HERMENEUTICS

The term hermeneutics is used for the study and theory of interpretation. In early modern times, hermeneutics was attempting to decode the original meaning of the words. Schleiermacher (1998) considers understanding dialectically as an interaction of objectivity and subjectivity, not solely as the objective meaning of a text but by also considering the author's intention. Later on, Dilthey tried to establish hermeneutics as a methodology for the social sciences by emphasizing the companion between the 'subject' and 'object.' Therefore, history is treated as a text, and analysis of the past has become a problem of decoding text (Lueger & Hoffmeyer-Zlotnik, 1994). Therefore, hermeneutics (interpretation of texts) can be used as a metaphor for understanding in general.

In contrast to textual interpretation's purely prescriptive questions, philosophical hermeneutics raises questions about what understanding and interpretation are and how they operate, rather than how one should interpret and understand. Philosophical hermeneutics is an approach that questions traditional questions, such as how one comes to know and understand, and arrives at recognizing understanding through interpretation. For example, Gadamer reframes the question of being by describing understanding as to the mode of existence's being. Even though the origins of the hermeneutical circle can be traced back to ancient rhetoric, it was called a process of interpretation by the Romantic hermeneuticists such as Schleiermacher, Dilthey, and Ast to be later developed by Heidegger, Gadamer, Ricoeur, and many others. The philosophical hermeneutics of Gadamer is developed as a dialogical form of thought since dialogue is the best way to understand a complex problem. Interpretation is not accepted as the result of a distanced view of a scientific interpreter that aims to develop an unbiased understanding but as a dialogue in which different perspectives meet. This encounter of 'hermeneutic experience' leads to what Gadamer (2009) calls fusion of horizons.

What constitutes the hermeneutical circle in any interpretative process is the circular relationship between the whole and the parts; that is to say, the whole and the part give

meaning to each other; therefore, understanding is circular. Meaning acquires its structure from pre-understandings; that is what makes things understandable. Hence, all interpretation operates with the pre-understandings. To clarify, in every act of interpretation of a text, as the hermeneutical circle says, the general meaning of a sentence reflects and adjusts the meaning of the word. Hence, the whole can be understood by its parts, and by considering the parts, the whole can be comprehended. The circle seems to have a logical contradiction. If one understands the whole before the complete understanding of the parts, and if parts acquire their meanings from the whole, how is it possible that this understanding activity starts? The paradoxical-seen situation results from the use of formal logic since the sole use of formal logic is deficient for the explanation of the understanding process, considering understanding begins somehow. Gadamer (2009) explains this paradoxical-seen situation by pointing out that every act of understanding is always performing an act of projecting, that is to say, one projects oneself a meaning for the text as a whole just at the moment that some initial meaning emerges in the text. The initial meaning develops only as a result of one's specific assumptions about a particular meaning, and Gadamer (1989) continues, “Working out this fore-projection, which is constantly revised in terms of what emerges as he penetrates the meaning, is understanding what is there” (p. 269). In other words, there are initial intimations of one about the meaning of the whole, and one interprets the parts according to that intimations or expectations, similar to the subsidiary knowledge of Polanyi (1962a) that will be discussed in Section 3.3. Hence, the act of interpretation brings anticipation, even though it is vague or informal, just in the light of these anticipations, the parts can be illuminated. Snodgrass and Coyne (1977) explain the process by following Gadamer, one projects a meaning of the whole before the beginning of reading a text, and understanding of the text appears per this projection. This initial projection is revised as a continuous process as the reader delves deeper into the meanings of parts since the initial projection is unclear and only exists as a frame at first.

However, moving into parts requires revisions to constitute the meaning, and the meaning of parts can be again understood in the light of the whole. Thus, understanding of the whole arises gradually and consistently via this process of back-and-forth thinking. As Heidegger (1962) and Gadamer (2009) both assert, every act of understanding is guided by this anticipated projection of meaning since while sensing

a thing, one continuously senses it as something. This can be explained in a way that, in the act of understanding, one does not first perceive it as an object, and then stick a meaning on it, since the interpretation already includes pre-understandings which makes understanding possible, as Heidegger (1962) asserts, "Whenever something is interpreted as something, the interpretation will be founded essentially upon the fore-having, fore-sight, and fore-conception. An interpretation is never a presuppositionless apprehending of something presented to us" (p. 191-192). The initial projection takes its roots from what Heidegger (1962) calls fore-structures of understanding and explains that, before one starts the act of interpretation, one has already placed the matter to be interpreted in a particular context, hence, always approach the matter from a pre-given perspective, and comprehends it in that specific way. Bernstein (2009) similarly points out that no information is available without preconceptions and prejudices.

To argue that one brings prejudiced presuppositions to an activity does not mean that those presuppositions cannot be made explicit, questioned, amended, or abandoned. When the hermeneutical inquiry process is acting in an open and unrestricted manner, this is precisely the essence of the process (Snodgrass & Coyne, 1977). Hence, the task should not be to remove these preconceptions but to make them subjects of critical thinking in the research process. Similarly, Gadamer (2009) terms Heidegger's fore-structures 'prejudices', which does not have any pejorative meaning contrary to its common usage. In the era of Enlightenment, there was a 'prejudice against prejudice' which Gadamer (2009) asserts is a highly erroneous approach, since it does not reflect the nature of consciousness and aims to purify the concept 'prejudice' from its pejorative connotations since all understanding necessarily includes prejudices and the existence of prejudices are needed for understanding as well. The use of the concept in a pejorative way distracts the nature of understanding. The prejudices of one cannot disappear, nor is it the desired situation since prejudices are the way to open one to the world to search for truth in interpretation.

Gallagher (2004) states that there is a deep tension between hermeneutical interpretation and science. If one adopts one side, the other is regarded as not valid anymore. However, as Gallagher (2004) demonstrates, science is fundamentally hermeneutical, i.e., scientists make interpretations that are productively affected by the scientific tradition to which they belong. Since the social sciences are mostly regarded

as dealing with understanding and the natural sciences are related to explanation, explanation includes no less interpretation than understanding by following Gallagher. Furthermore, Gallagher (2004) demonstrates that what hermeneutics uncovers is consistent with what cognitive science discovers, so they are not in opposition. To exemplify the existence of pre-understandings in the hermeneutical process by examining cognitive science, 'schema theory' can be investigated, that is, a theory regarded under cognitive psychology, and the concept of corrigible cognitive schemas to explain how one understands an object. The notion of 'schema' implies that existing information is arranged into patterns used to learn and acquire new information. These schemas allow the assimilation of new knowledge through already established schemas, and in return, the schemas can adapt to new information by changing or accommodating themselves. Schema theory's explanation is thus consistent with the hermeneutical circle's explanation. Simon (1996) similarly states that when problem-solving activity actualizes in semantically rich domains, a significant portion of the search occurs in long-term memory and is led by information found there. In memory, the change is adaptive; that is to say, it updates the knowledge of what it is about, and provides new knowledge, and enhances current processes by introducing new procedures that contribute to the capabilities in specific work areas. This process of change in memory contents must be taken into account in any scientific theory of human thought.

To conclude, the meanings cannot be understood if they are isolated, such as words that do not occur in a sentence, or design tokens that do not belong to any design situation, that is to say, when there is no pre-knowledge about the whole in its context. Thus, according to Taylor (1971), when one speaks about the 'meaning' of a given predicament, concepts that have the following articulations are used:

- For a subject: Meaning is for a subject, hence, not the meaning of a situation in vacuo.

- Of something: Meaning is of something; in other words, one can distinguish a given item and its meaning. Therefore, all meanings are of something.

- In a field. Things are meaningful only when they are related to the meaning of other things in the field, which means there is no single and unrelated meaningful element. Hence, a shift in the other meanings may involve a shift in the given element. Therefore, meanings can only be characterized by other meanings.

Taylor (1971) continues that some terms can only be explained using other concepts and cannot be understood without referring to them. For example, a comprehension such as a ‘good design’ can be explained by referencing other concepts that necessitate the hermeneutical circle. These interpretations cannot be explained or justified except by reference to other interpretations and their relations to the whole. To understand these concepts, there is a need for a specific experience and an understanding of a particular language, not just as words, but as a particular language of mutual interaction and communication found in the hermeneutical community. Snodgrass (1996) defines hermeneutical community as a community that shares specific modes of interpretation. Snodgrass (1996) himself takes the concept of ‘hermeneutical community’ from the ‘interpretative community’ of Fish, which is often regarded as ‘language community,’ a community that shares a common discourse language. However, Snodgrass (1996) prefers the concept of ‘hermeneutical community’ instead of ‘interpretative community’ since hermeneutics is more a practical application than a sole consideration of interpretation.

On the other hand, Jahnke (2012) asserts that the ‘critical hermeneutics’ of Ricoeur may provide a better foundation for design activity since critical distancing dimension to interpretation cannot be found in Gadamer’s philosophical hermeneutics. Ricoeur's hermeneutics recognizes the interrelation between epistemology (interpretation) and ontology (interpreter) and avoids the Cartesian object-subject dichotomy. Therefore, philosophers such as Habermas and Ricoeur proposed an approach of critical hermeneutics that builds on the hermeneutics of Gadamer but departs from several aspects. For example, Habermas (1990) asserts that adopting a critical perspective is necessary when making interpretations. This critical perspective is what Ricoeur argues is missing in Gadamerian hermeneutics.

Hence, Ricoeur proposes the necessity of identifying and removing the unproductive pre-understandings from productive ones (Farooq, M. B., 2018). As seen, Gadamer (2009) argues that an interpreter never engages with the world without pre-understandings. The prejudices or pre-understandings are necessary conditions for one’s understanding of the instant situation. Therefore, understanding occurs when there is a fusion of horizons of the past and present. The term horizon refers to the range of visions available from a particular vantage point (Gadamer, 2018). The pre-understandings of the ones shape the horizons. There appears to be the problem of the

limits of interpretation if the hermeneutical circle progresses as a circular process; how to come up with one single interpretation remains a continuously challenging hermeneutic question.

3.1 Limits of Interpretation

According to Bernstein (2009), any interpretation or understanding can be challenged, criticized, and displaced by the better, the more transparent, and the more appropriate interpretation. One should avoid the mistake of thinking that there is no rational way of making and demanding such practical comparative judgments since there are no fixed, firm rules by which one can distinguish better interpretations from worse ones. Meaning is not something that is there to be discovered but takes place only through the occurrence of understanding and in the understanding itself. Therefore, one of the most fundamental problems in hermeneutics is the limits of interpretation. According to Eco, even though there is not a legitimate way to interpret a given text in a certain way, there are still certain constraints that limit the range of interpretations (Gorman & Gracia, 1990). There are two extreme views on limits of interpretation. At one extreme, any interpretation has no limits, and at the other extreme, there can be only one correct interpretation of a given situation. According to the latter view, there should be a criterion outside the circle of interpretation to refer to the truth or falsity of interpretation. Gadamer (2009) explains this as entering the hermeneutical circle is not a choice; one already finds oneself in it with all one's thinking and actions. Hence, even though some criteria that stand apart from the circle would have appeared, it would be a result of the hermeneutical process again, and therefore would have included interpretation. The crucial point here is how to refer to the interpretations of their correspondence. There can be better or worse interpretations in sciences that do not arise from their truth or falsity. For example, according to Heidegger, Dreyfus (1980) narrates that what interprets better is its flexibility and openness to dialogue with other interpretations. The characteristic of the hermeneutical paradigm is the circular link that it establishes between understanding and interpretation. Since understanding cannot be thought independently from interpretation, one of the consequences of the hermeneutical paradigm is to avoid objective meaning and advocate the possibility of continuous re-interpretation and understanding. Bernstein (2009) similarly narrates that, according to Gadamer, it should not be misinterpreted

that one needs to cleanse themselves from all their prejudices and preconceptions to grasp or know the things themselves objectively. On the contrary, the meaning of things themselves can only be grasped through the circle of understanding, a circle that presupposes pre-structures that allow one to understand.

The hermeneutic circle enables a deepened understanding since understanding expands beyond subjectivity's bounds into the general realm and then reacts back to subjectivity. Therefore, in a hermeneutic circle, any phenomenon is approached by gradually building the context and moving circularly towards an increased understanding. Soeffner (2004) describes understanding as to the process of giving meaning to an experience, and to understand the other is the process of which one gives meaning to the experience in a way that relates to events in the world that others have given meaning to. Therefore, understanding is not an invention of the social sciences, and it did not initially arise from a specific theoretical perspective but as a daily routine practiced by human beings. Similarly, for Taylor (1971), what makes an interpretation correct lies in its ability to make confusion clearer. This necessitates the making sense of the ‘same’ meaning with other expressions. Hence, interpretation in Taylor’s sense aims to produce more sense of an object. This making sense moves in a hermeneutical circle since the interpretation of a situation can only be explained or justified by reference to other interpretations and the whole. Since humans are necessarily self-interpret, meanings are interwoven with interpretations, and interpretations are bound to what is interpreted. Interpretation is therefore not wholly distinguishable from what it is about since there are no structures of meanings independent from their interpretations. Thus, according to Taylor (1971), if the interpretation attains more clarity than what immediately appears, hermeneutics achieves its goal.

On the other hand, since there are no raw data at this level, the interpretative debate over meanings is theoretically infinite, and another interpretation can contest every interpretation. This process does not correspond to the verification process of the logical empiricist view since the verification of the hermeneutical circle does not ground on brute data but on the consistency of the interpretation within itself. The convergence or divergence of interpretations presupposes a shared language for expressing and opposing these interpretations. Much of these common languages are rooted in practices within the hermeneutical community. Therefore, the intersubjective

meanings are not subjective but are constitutive elements of the reality itself. Since intersubjective meanings constitute reality, there is no possible verification process in hermeneutical sciences such as logical empiricist natural sciences. Common meanings are the basis of the hermeneutical community, which includes shared practices and tacit understandings. Hence, according to Taylor (1971), there is a need for going beyond the bounds of science that roots in traditional epistemology of empiricism based on verification to the study of intersubjective meanings embedded in the social reality.

For both Gadamer and Ricoeur, the meaning of an entity must be sought not in the intention of the work in itself but in the horizon that the work opens (Varlık, 2017). Through understanding and interpretation, the horizons may develop and open ways to new understandings that are not the same as previously existing pre-understandings. By uncovering unproductive and productive understandings, the interpreter attempts to come up with new meanings and new horizons of understanding. As a result, the interaction between the whole and the parts should not be regarded as a vicious cycle because the hermeneutic circle does not remain stationary but rather gains new information continuously. Therefore, the circle has the potential for one to gain new knowledge. Interpretations thus process whereby the first interpretation is constantly revised as one gets a greater understanding of the subject which makes a constant interplay between the whole and the parts. This situation can be viewed as an optimization process in which one seeks to determine the best overall interpretation given the current conditions. Gadamer asserts that any emphasis on any designed method to arrive at unattainable objectivity will fail to uncover any accurate understanding.

On the other hand, as Habermas argued, if hermeneutics does not take an explanatory critical stance, it will be unable to detect distortion, which supports the assertion of Ricoeur while asserting that critique is fundamental to generate new meanings (Jahnke, 2012). Ultimately, Ricoeur proposes an attitude for understanding that includes both the critical approach of Habermas, which focuses on explanation and the interpretative approach of Gadamer. In Figure 3.1, the interpretative process within a hermeneutical community through interpretations is represented by combining the approaches of Ricoeur and Gadamer.

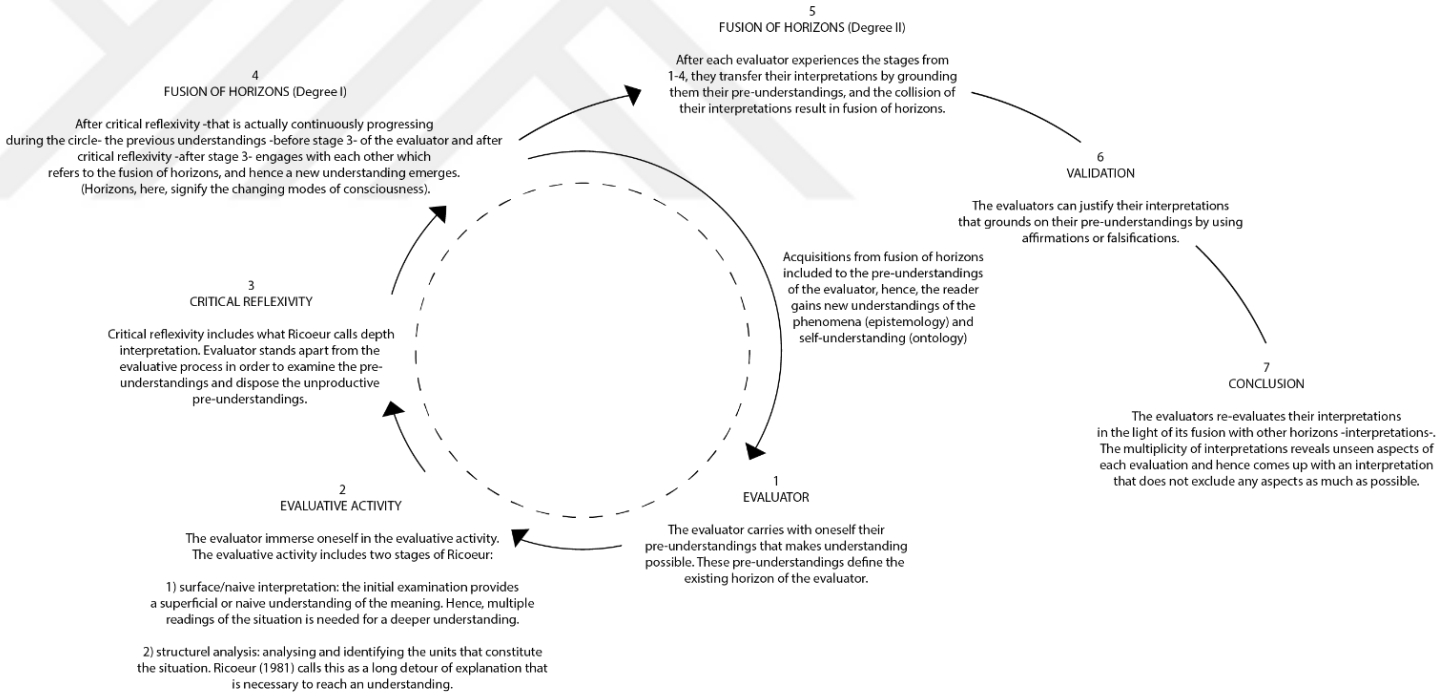

Figure 3.1 : The interpretative process within the hermeneutical community that combines the approaches of Ricoeur and Gadamer.

The process mentioned above includes processes that are:

1.Evaluator: As discussed, all interpretations are inherently value-laden. Each interpretation begins with the reflection of the existing pre-understandings of the evaluator, and these pre-understandings enable one to understand the meaning.

2.Evaluative activity: The initial reading of a situation usually only provides a superficial or naïve understanding about the situation (Ricoeur, 1981). The naive understandings refer to the interpreter's already-formed schema, or anticipation of meaning, which may or may not be verified as the interpretation progresses (Geanellos, 2000). Therefore, the first look at best provides a framework about what to expect next. Multiple readings of the same situation should be regarded to reach a deeper understanding of the situation.

3.Critical reflexivity: Critical reflexivity can allow the evaluator to reflect on their pre-understandings and assumptions. Moreover, only through critical reflexivity, the evaluator can distinguish their unproductive pre-understandings from the productive ones. According to Farooq (2018), critical understandings must strike a balance by enabling the circumstance to question one's own preconceptions while also allowing one's own preconceptions to confront the situation. The key here is that one should not dominate another. Even though critical reflexivity is considered a particular stage in the process, the adoption of critical reflectivity should simultaneously continue through the whole process, which is the crucial characteristic of Ricoeur's hermeneutic theory of interpretation. Besides, J. Stuart Mill (1974) states that if all experience of one tends to confirm a specific thesis, and have no experience tending to disconfirm it, then one can only depict phenomena as those one has experienced, and the contrary would be inconceivable. Therefore, critical reflexivity aims to demand one expand one's horizon as much as possible to distinguish which pre-understanding is used to conclude with an interpretation and how they contribute to the interpretation.

4.Fusion of horizons (degree I): After critical reflexivity, the previous understandings -that exists before stage 3- of the evaluator and after critical reflexivity – that emerged after stage 3- engages each other, that refers to the fusion of horizons, and hence a new understanding emerges. Horizons, here, signifies the changing modes of consciousness.

In Figure 3.1, between stages 4 and 1, there is a level where one engages one's new understandings to their pre-understandings. Hence, it is also a process of self-understanding. Accepting one's participation in the process of interpretation also brings the acknowledgment of the self evolves in the process as well; thus, in Ricoeur's words, "richer self may be received." Similarly, Taylor (1971) defines humans as self-interpreting animals, and all understandings take their starting point from the understanding of the self; therefore, all understanding includes self-understanding. That is to say, interpretation reveals new ways of being, which provides the interpreter with a new ability to know oneself. By doing so, the interpretative understanding reveals new possibilities of seeing things differently. In sum, as Snodgrass and Coyne (1997) point out, an interpretation invokes new interpretations. For example, sketching in the design process may recall or lead to other ideas or interpretations.

5.Fusion of horizons (degree II): The subjective opinions of each evaluator are necessary conditions for the hermeneutical process, but not sufficient, since there is a need for validation. Interpretation in hermeneutics can become an endless process because each interpretation can lead to new understandings and insights. To break this cycle, the evaluator must come up with a reasonable conclusion to the procedure (Debesay et al., 2008); when stages from 1 to 4 repeat themselves for each evaluator, different interpretations engage with each other. In this stage of engagement, while evaluators transfer their interpretations to each other, there is a need for a yardstick to decide if one interpretation is more plausible than the other to conclude the circle of interpretation. As Farooq narrates (2018), this yardstick in Gadamer is tradition, which makes sense of one's reality. Tradition does not ground on an irrational base; hence it is generally accepted as an acceptable yardstick. On the other hand, since traditions are shaped by society, they can change over time, which makes traditions not in a stable state. Therefore, the yardstick in an interpretive activity is decided chiefly by depending on the evaluator's existing body of literature, background, and tacit knowledge. What makes it harder to reach an ultimate interpretation is, situations are characterized by multiplicity (layers of meaning) and plurality (multiple meanings that lead each interpreter to come up with different but equally legitimate meanings of the same situation). As Geanellos (2000) narrates, in Ricoeur's notion of validation, there is a tension between accepting the diversity of interpretations while still demanding the presence of a criterion by which to compare different views. Hence, Ricoeur

endorses the plurality of interpretations and states that they may be polysemic, and words and sentences mostly have ambiguous natures.

6. Validation: Different evaluators may be using different modes of justification and explanation. Ricoeur (1971) points out that “validation is not verification” since verification is not a convenient measure to judge the knowledge of hermeneutics (p. 107). On the other hand, for Ricoeur, not all interpretations are equal since some interpretations are mostly more plausible than others. The process of validation aims to clarify how one grounds their interpretations. Koch (1993) suggests one should comprehend how interpretations were reached, even if they disagree with the interpretation's structure. Mostly, the best the interpreter can do is use the examples by showing how they ground on the pre-understandings to reveal how the specific interpretation is constructed. Hence, this aim refers to the uncovering of the pre-understandings that one grounds their interpretations. The evaluator has to thematize their pre-understandings to transfer the interpretation's justification to other evaluators. In other words, it is necessary to describe what pre-understandings are taken into account in relevance to one’s interpretation in a presentation. In this stage, one can justify their interpretations by depending on either affirmations or falsifications. Even though there can be found grounds for reasonable understandings, there is not a fundamental understanding to be reached in hermeneutics. On the other hand, in practical research, resource-related factors have the potential to limit the refinement of one’s understanding. Therefore, practical research necessitates finding a plausible endpoint for interpretation. Gadamer (1989) states that an ongoing dialogue does not permit a conclusion, and it would be a poor hermeneutics if there would be an expectation of the last word. Hence, contrary to Gadamer’s understanding, it is accepted that not all interpretations can be considered equally plausible, and the evaluators can achieve a great deal by justifying their interpretations. The aim of asserting validating information is not to prove the interpretation but to support it.

6.1. Affirmation: According to Eco, any particular interpretation of a text can only be accepted when another part of the text verifies it; if another part is refuted, it should be rejected. Hence, one of the strategies to justify any interpretation can be verifying it by depending on the exposure of the pre-understandings that the interpretation grounds on.

6.2. Falsification: Simon (1996) defines problem-solving as a search through a vast maze, that is, the environment of possibilities, and what makes a problem-solving activity successful is its inclusion of selectivity and reduction of it into manageable proportions. Similarly, according to Schleiermacher (1998), hermeneutics is the art of avoiding misunderstandings. Hence, one must be eager to commit oneself to the possibility of misunderstandings. According to Davey (2006), the opposition of philosophical hermeneutics to the ambition of method reveals philosophical hermeneutics as 'negative hermeneutics.' The result of negative hermeneutics in both Gadamer and Ricoeur is that interpretation is an ongoing process. The eternity of hermeneutical reading in Gadamer consists of the possibility, even necessity, of continual new interpretations. In this sense, although the methods of interpretation do not give objective meaning, they make it possible to overcome the wrong meanings. Therefore, the aim should be the disposal of the prejudices that may lead to erroneous interpretation. Eco, with the help of Popper's theory of science, comes up with the conclusion that it is possible to say that a specific interpretation is a bad one, and at least somewhere, some criteria may limit the interpretation (Gorman & Gracia, 1994). Eco suggests that there is a criterion by which one can distinguish excessive interpretation of a text. Even if this criterion does not determine any interpretation to be regarded as the best one, a Popperian principle may determine which comment is the bad one. According to this principle, the experiments that must be done to verify a universal proposition are limitless, and the theory can only be abandoned if this proposition can be falsified. In sum, Eco proposes determining whether an interpretation is a good or a bad one based on falsifiability. Hence, when any evaluator tries to validate their interpretations, they can support their interpretation by depending on how that interpretation is concluded by falsifying others. Moles (2018) similarly state that the error creates concern, and it is the continuous verification process; to know the truth is to know the wrong since it is a heuristic of the truth.

7.Conclusion: The multiplicity of interpretations does not refer to any problematic situation since each evaluator brings different pre-understandings to their interpretations. On the contrary, a multiplicity of interpretations provides a better understanding of the overall situation since the multiplicity has the potential to uncover what implicitly exists — as Venturi (1977) notes, trying to reconcile similarities and differences simultaneously is helpful in most cases. Rittel and Webber (1973) similarly

assert, while dealing with wicked problems such as in designing, because of the problem's inherent uniqueness, the techniques of reasoning allowed in an interpretation are far more diverse than those permitted in scientific discourse. Therefore, hermeneutics is founded on the polarized connection between familiarity and foreignness. According to Gadamer, the core of hermeneutic understanding is asking questions that do not necessarily conclude with the acceptance of other interpretations. Hence, evaluators have a chance to re-evaluate their interpretations in the light of other interpretations and come up with an overall interpretation to conclude the act of evaluation. In sum, as Snodgrass and Coyne (1977) argue, since interpretations are not visible to others, the best one can do is ground their interpretations and refer them to other interpretations to support or expand them. It should be feasible to choose the 'best' interpretation when alternative meanings are considered.

On the other hand, Lawson (2005) adopts an approach to the limits of interpretation by stating that, in order to solve a design problem, one needs to ask how to find an end to a design problem since it is possible to get involved in more and more detail, and states that there is not a defined end to the design process. Designers mostly stop designing either when their time is over or by depending on their judgment that shows it is not worth pursuing further. For Lawson (2005), one of the skills in the act of design is knowing when to stop since there seems to be no natural substitute for experience in developing this judgment. Since words do not have a single and fixed lexical meaning but are constructed within the situation in which it is encountered, there is always the possibility of a dispute about the 'correct interpretation'. On the other hand, when the concern is about to conclude with one single evaluation, which is needed in practical research, such as in the evaluation of a design, after the evaluation of each interpretation of different evaluators by depending on their assertions to validate their interpretation, the consensus could be achieved with the assistance of tacit understandings as well, that will be discussed in Section 3.3. In order to understand the existence of tacit understanding to limit any interpretative process, the objectivity and subjectivity dichotomy should be overcome.

3.2 Co-existence of Objectivity and Subjectivity in the Design Process

According to Coyne (1991), understandings of the design processes are principally polarized around two exclusive positions: design as an objective inquiry and design as

a self-expression activity. The first understanding focuses on the idea that designers are objective experts who stand apart from life in order to make decisions, and neglects the ‘being person’ situation of designers that lead to an understanding of the designer much as a scientist who is often characterized as the objective expert outside the community. On the other hand, the latter approach considers designers as creative geniuses who use the design as an object of self-expression. Ideas such as 'using objective criteria for evaluation', ‘accepting the users' needs’, and 'making rational decisions' are often seen in design discourse, whereas their actual presence. In contrast, their process cannot find any correspondence. In order to regard design evaluation as objective, there are at least two requirements that Snodgrass (1996) indicates, that is, the need for the ‘unambiguously defined criteria’ and their ‘application with strict procedural rules. If an evaluation does not fulfill these requirements, that evaluation is considered subjective and therefore arbitrary. The objectivist account of evaluation considers an embedded value of the design that does not include any interpretative property. The task of the evaluator is to uncover the value.

In contrast, the role of the rules is to be followed to establish how the evaluator can uncover the real value of the design in the evaluation process. This approach assumes that the design carries a single and fixed value independent from the interpretative evaluation process. Hence, the evaluation can be revealed in two ways. One is the objective way that the evaluator finds and reveals the real value of the design. Second, the evaluator arbitrarily interprets the design according to their own tastes, the subjective and undesirable approach. Snodgrass (1996) argues that objectivity in any design evaluation is unattainable. This is first because of the selection of ‘unambiguously defined criteria’ that assumes the list of properties of the design to be expected to display the process of judgment in itself, and hence cannot be regarded as objective, since to assert that ‘this is the criteria’ is a value judgment in its peculiarity. Secondly, because the ‘procedural application rules’ of the criteria cannot be specified, in other words, asserting how to apply the rules again involves judgments. Derek et al. (2003) state that the quality of a product evaluates how adequately its features or attributes meet the needs and an evaluation of quality can be achieved mechanically since it is an evaluation of facts that does not cover the judgments or interpretations of an individual.

On the other hand, as discussed, since the needs are also the result of judgments and interpretations of individuals, the evaluation process cannot be thought of without considering personal judgments and interpretations. Kuhn (1973) similarly states that individual virtues are imprecise. Individuals might reasonably disagree on applying them to specific situations and define five characteristics a theory should fulfill: accuracy, consistency, scope, simplicity, and fruitfulness. These are considered by Kuhn (1973) as standard criteria to evaluate the adequacy of a theory. What is critical is that when taken individually, these criteria are ambiguous since individuals may differ in the way they apply these criteria to concrete situations.

In summary, Kuhn (1973) demonstrates that when two scientists are faced with the task of choosing between conflicting theories, even if they are entirely devoted to the same set of criteria, they may reach different results. This might be because they have different interpretations of the requirements, have different views about the scope of domains in which a specific criterion must be met, or agree on certain things but disagree on the relative weights. Similarly, according to Kuhn (1973), each individual's decision between competing theories is based on a combination of objective and subjective elements or standard and distinctive criteria.

On the other hand, as it is generally accepted, the unattainability of objectivity does not necessarily lead to subjectivity. This way of approaching the issue is a result of the Cartesian Anxiety, that is described by Bernstein (2009) as the idea that, in the end, the feasible options are either a type of objectivism, foundationalism, the ultimate base of knowledge, or the presence of a kind of relativism, skepticism, historicism, and nihilism. This excluding and irreconcilable assumption of objectivity and subjectivity depends on the object-subject dichotomy that takes its roots from Descartes. Bernstein (2009) asserts that addressing the problem by using this polarized continuum obscures the areas where there lie other types of knowledge beyond objectivism and relativism. Besides, Bernstein (2009) continues that the most critical issue in Gadamer is how he begins to form a way of thinking that extends beyond objectivism and relativism through the questioning of hermeneutic phenomena, exploring and revealing a completely different notion of knowledge and truth. Gadamer and Rorty show that understanding the nature of knowledge through a demarcation from the objective and subjective basis for guaranteeing knowledge about the world is a misleading effort

(Boland, 1989). Therefore, to accept the unattainability of objectivity does not necessarily mean that it does not follow any norms and/or criteria.

The evaluation depends on the evaluators' preconceptions, tacit understandings, experiences, and anticipations, which corresponds to the rules and criteria discussed in Section 3.3. These preconceptions, tacit understandings, experiences, and anticipations depend not on idiosyncratic tastes but the shared training and practices within a hermeneutical community. At this point, it is fruitful to mention the demarcation of Kuhn (1973) between types of subjective interpretations. Kuhn (1973) demarcates the use of the word 'subjective' into two categories. The first is the one that opposes 'objective', and the other opposes 'judgmental'. In the first meaning of subjectivity, the interpretation depends on judgments instead of tastes; therefore, it is open to discussion and may conclude with other interpretations. In the second meaning of 'subjective', there is a dependence on tastes and hence are not discussable. Therefore, the word 'subjective' in the second sense prevents further discussion about the interpretation, which is neither fruitful nor desirable in the design evaluation process. Hence, in the scope of the thesis, the word 'subjective' should be understood as in the first meaning of the word. Therefore, the subjective attitude does not mean that evaluators make their choices according to their tastes, but to assert and support their judgments and create a space within the hermeneutical community for discussion carries the design evaluation beyond objectivism and subjectivism. Feyerabend (1993) similarly states that "Neither science nor rationality are universal measures of excellence" (p. 7). Therefore, the design evaluation cannot be considered objective or subjective but depends on the tacit criteria shared by a hermeneutical community. Snodgrass (1966) revealed that the rules and criteria might not seem to include subjective interpretations of the design, but actually, they are the product of and subject to subjectivity. As Gadamer (2009) states, the understanding can only achieve its full potential when the preconceptions are not arbitrary. Therefore, firstly there is a need to examine the source and the validity of the fore-meanings since prejudices can be either enabling or disabling; that is to say, there are 'blind prejudices' and 'prejudices that illuminate'. According to Darke (1979), the difference between novice and experienced designers is the sophistication level of their prejudices. The most fruitful direction to any design research is to find different ways to examine what is happening in the designer's head to explore subjectivity. This emergence of prejudices depends

on how they opened themselves to understanding. Snodgrass (1991) states that interpretations cannot be considered according to their truth or falsity but instead can be regarded by their fitness to a specific context. Therefore, objectivity and subjectivity need not be considered as Boolean conditions since some things can be more or less objective or more or less subjective. By depending on previously mentioned explanations, approaching design as an interpretative and hermeneutical event opens different ways to understand what designers have in their minds.

Lawson (2005) characterizes the design problems with their three characteristics. The first is, design problems cannot be thoroughly addressed; that is to say, when creating a design process map, it is impossible to ensure that all parts of the problem have been addressed since many components of the design problems may not appear until any attempt to be made to generate solutions. The more implications of solutions emerge, the more objectives and priorities may open themselves to change. In each particular stage of design, new purposes may emerge, and problems can be re-defined, and priorities can be re-ordered. As a result, the evaluator should not anticipate a complete and static articulation of design issues but should consider the problems in continuous tension with design solutions. The second characteristic of design problems is, they mostly require subjective interpretation. This is not merely because designers devise different solutions to a specific problem but because they also perceive problems differently depending on their pre-understandings or tacit knowledge. In this way, design problems, like design solutions, are a matter of subjective interpretation. However, as discussed previously in the current chapter, this subjectivity does not depend on personal tastes, since it has a judgmental characteristic that is validated by grounding the judgments in either affirmations or falsifications. Therefore, one should not anticipate an entirely objective formula for a design problem. The third characteristic is, there may be an endless number of different coverings, and design problems have no optimum solutions since the design process inevitably includes compromises. Sometimes, defined objectives may conflict with each other, and the designer rarely optimizes a requirement without losing it from elsewhere. These trade-offs and compromises are matters of professional judgment. The designer needs to consult one's pre-understanding, tacit knowledge, personal expertise, and the dialogue within the hermeneutical community. Derek et al. (2003) similarly emphasize the importance of dialogue during the design process. It provides a shared understanding

of what constitutes quality and value, enabling a common language within the hermeneutical community and developing means of framing to design activity.

To sum up, as Snodgrass (1996) points out, the design evaluation is neither objective nor subjective since it does not progress by referencing fixed criteria but still does not depend on personal tastes. Instead, design activity proceeds with tacit understandings that are gained from professional training and specific applications. Taylor (1971) similarly states that the common meanings are not merely in the mind of the interpreters, but are in practices which are not solely a sum of individual actions but embedded in social relations and mutual understanding, that recalls the understanding of the whole transcends the sum of the parts. Interpreters bring their pre-understanding to negotiations, and the meanings of these pre-understandings are also constitutive elements of the negotiations. Since these meanings of pre-understandings are the results of shared experiences, they are not merely subjective. However, they are intersubjective and the constitutive elements of the dialogue within the hermeneutical community. Thus, the intersubjective meanings are embedded in mutual practices of negotiating. This does not mean that the criteria and procedural rules are wholly neglected. Instead, the hermeneutical community still follows them as general principles and/or as heuristic devices and can only be understood in the practical application situation; hence, the application is a constitutive moment. The meaning does not reveal by first thinking and then throwing the thought into an external object. Instead, it constitutes itself at the moment of understanding. Therefore, the meaning of a rule or criteria should be understood within its context; otherwise, there would be no meaning, or the meaning would not refer to what it aims to correspond.

According to Habermas, as Hesse (1972) narrates, while the interest of the natural sciences is technical control that requires skills in the inquiry of nature, the concern in the human sciences is social consensus and mutual communication that requires personal understanding. Therefore, the guarantee of objectivity in human sciences is participating in a dialogue between the investigator and what is investigated, which reciprocal interaction reveals. So, the failure can be seen as the breakdown of the communication. Even though the dialogue model as a form of objectivity is not familiar to empiricist acceptances, it is one of the few practical alternatives to the natural science model in dealing with human sciences.

To sum up, design activity, specifically the evaluation process, can be considered a stage that includes both objectivism and subjectivism. The process can be regarded as not a combination of these two but beyond these two. This approach aims to frame design evaluation not just by degrading into either objectivism or subjectivism but rather by accepting the existence of both objectivism, subjectivism, and beyond. One way to consider how these debates intertwine and contribute to the explanation of each other is to view them from a hermeneutical perspective.

3.3 The Role of Different Types of Knowledge in Design Activity

Design is dependent on modes of cognition and ways of knowing that have yet to be fully defined and understood (Cross et al., 1981). Therefore, one task for design research should be the informal knowledge that cannot be made explicit yet. The knowledge that is conveyed by explicit definitions is called 'knowing-how'. The demarcation between 'knowing-how' and 'knowing-that' is made by Ryle (1949) in his book 'The Concept of Mind'. The notion of 'knowing-that' corresponds to knowledge that can be made explicit and formulated. For instance, the knowledge of an architect of how many square meters of space is needed for a parking area or how many meters a cycling road should be considered can be shown as examples of knowing-that. On the other hand, the knowledge that comes from 'knowing-how' lies at the core of the design activity. As Cross et al. (1981) exemplifies, historically, design has evolved from crafting, and it encompasses a wide range of skills and embodiments of knowing-how. Hence, design activity should be seen so that it includes both implicit and explicit knowledge. In the study of meaning, both the process of making and critical reflection are included. Although design activity should and does involve knowing-that and knowing-how together, it should include knowing why and the purpose. The knowledge that comes from knowing-how derives its roots from previous experiences of designing, planning, etc., while discovering the implicit tactics within the rules. This kind of knowledge is quite similar to what Cross (1982) called 'designerly ways of knowing.' Archer (2005) asserts a similar concept to 'designerly ways of knowing' by adopting the term 'design awareness' to signify the ability to understand ideas that are expressed through the medium of doing and making. This kind of knowledge cannot be conveyed through books or guiding references due to its non-verbal essence. Another strongly related terminology is narrated by Dreyfus

(1980) about the Heideggerian understanding of the hermeneutical circle. Heidegger distinguishes three features that any explicit understanding involves. This threefold demarcation includes the account of theoretical holism that data are always theory-laden but goes beyond it. The threefold includes:

- Vorhabe (fore-having): the whole realm of cultural practices that determines what one finds intelligible. It can be thought of as similar to what Kuhn calls the 'disciplinary matrix', that is, the skills a student acquires as a scientist that enables them to determine which facts are relevant to science. The disciplinary matrix includes research groups that influence each other that share common problems and goals.

- Vorsicht (fore-sight): the vocabulary or conceptual framework with which one approaches a problem. In science, Vorsicht refers to that which is thought to be significant to the problem's dimensions.

- Vorgriff (fore-conception): a particular hypothesis can be confirmed or refuted by the data.

Hence, by examining the threefold of Heidegger, the theoretical activity of framing and conforming hypothesis does not take place by just relying on explicit or implicit assumptions, but also involves Vorhabe, the background practices that cannot be incorporated as particular presuppositions of the theory but can nevertheless be used to describe what constitutes confirmation. Hence, all knowledge that one has is always shaped by what Heidegger calls the implicit ontology. This ontology is indwelled in all practices of oneself, not just in their mind as background assumptions. To Heidegger, Vorhabe is not a concept to overcome since there would be no theories without it. Heidegger further claims that there is a level of Vorhabe (everyday practice) beneath all Vorsicht (theoretical presuppositions and assumptions). Simon (1996) similarly states that the boundary between knowledge and skill is subtle. While memory is mostly regarded with its relation to a body of data, professionals possess skills and knowledge. These skills are not solely about recognizing situations or providing information about them but also acquiring special skills for dealing with situations as one encounters them.

Polanyi (1962a) adopts another term that embraces the concept of 'knowing-how', that is, 'tacit knowledge', which refers to the impossibility of 'attending to' all the details of skill by the person who reveals the activity. He further states that some things can

be known but cannot be told and only can be known by ‘relying on’. This is notably valid for knowledge of skills. For instance, one can claim that they know how to swim, but this does not imply that they can explain how they stay afloat. It is generally unattainable to identify what specific details one is aware of while attending to. Polanyi (1962a) asserts that two kinds of knowledge enter into any act of knowing to comprehend an entity. The first is knowing a thing by attending to it, and secondly, knowing a thing by depending on its awareness for the intention of attending to an entity to which it contributes. Polanyi (1962a) calls for the latter tacit, as the particulars cannot be told, calls ‘knowing by attending to’ as focal knowing, and ‘knowing by relying on’ as subsidiary knowing. He extends his labels as, when one knows the particulars of a whole subsidiarily, these particulars cannot be understood in themselves. However, they can be understood concerning their contribution to the whole. Therefore, the integration of ‘subsidiarily knowing’ and ‘focal knowing’ constitutes the ‘tacit knowledge’, seen in Figure 3.2.

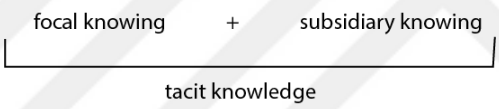

Figure 3.2 : The constitution of tacit knowledge.

Polanyi (1962a) supports the assertion by showing other forms of tacit knowledge similar to that of knowing a skill. For example, the diagnostic ability of a practitioner improves with more practical experience, or only years of professional practice allow a taxonomist to become an expert. Simon (1996) similarly states that one of the sources of selectivity in problem-solving is previous experience. This ability corresponds to the ability to recognize a characteristic appearance of indistinguishable particulars. A similar situation is called ‘family resemblance’ by Wittgenstein (1958); that is, the members of the same category do not need to share all defined features. He gives an example of a leaf and notes:

> I get an idea of the shape of a leaf, a picture of it in my mind. But what does the picture of a leaf look like when it does not show any particular shape, but what is common to all shapes of leaf? (p. 35).

In the definition of Wittgenstein of family resemblance, there are members of a family that do not have a standard and single feature but instead an indefinite number of

detectable features. The concept of family resemblance is conceptualized with other terms by different authors according to the context. For example, Otto Neurath used the word Ballungen by influencing from Weber (1949), and the fuzzy concepts are used by Lotfi Zateh in his seminal paper in 1965 on fuzzy sets, which later was adopted by Cartwright, Bradburn, and Fuller (2016) as Ballung concepts to define fuzzy-like or family resemblance-like situations. All these recognitions show that things can be discriminated against from a complex pattern of things without being able to identify by depending on what features it is discriminated against. Furthermore, there appears a situation that unspecifiable particulars can be comprehended only by depending on its total comprehension, such as how the hermeneutical circle progresses. To reveal the relationship between tacit understanding and hermeneutical circle, an example of Polanyi can be given. A person first recognizes another person, then discovers what that person does, then again realizes what the subsequent motives might be, and later reconsider their conception of the personality that is under-recognition.

The comprehended aspect is the integration of elementary particulars, in turn, becomes a clue to a complete entity that recalls the circular acting in the hermeneutical circle. A similar kind of acknowledgment has been realized by Hirst (2010), by considering the initiation of students into varied disciplines. It asserts that "all knowledge involves using symbols and making judgments in ways that cannot be expressed in words and can only be learned in a tradition" (p. 34). Kuhn (2018) advocates the use of historical examples of crucial experiments to teach science to students to make students comprehend how science is done instead of referencing explicit rules that can barely teach the same thing. This assertion of Kuhn calls for the role of tacit knowledge in the learning processes. Abel (1981) suggests that the same need for tacit knowledge is valid for architectural education, where the rules or principles of architectural design can barely be made explicit. However, students still come up with sufficient knowledge and skills to contribute to the architectural practice. Abel (1981) shows the role of tacit knowledge in architectural education through an example that they had practiced in one of their design studios. In the first phase of the project, students are required to research a style that they have chosen that either refers to an individual architect or an anonymous architectural style and asks to reveal the underlying rules and principles in the chosen style. Abel (1981) continues that, in none of the presentations, the styles were explicitly or clearly transferred enough to make other

students comprehend and produce imitations of any of those styles. In the latter stage, students are required to take the role of their chosen architect or the builder of the chosen anonymous style, and this approach helps the students to achieve their tasks. When this practice is put into the context of Polanyi's term 'tacit knowledge', instead of directing the architectural research on the misconception that tacit knowledge will eventually be made transparent or will lose its ambiguity, it is proposed to recognize the tacit knowledge in the design process. Wittgenstein (1958) similarly states that what one acquires in a language learning process is not a method; one learns to make correct judgments. Some rules do not constitute a system and can only be experienced by people to employ them suitable, unlike calculation rules. As Snodgrass (1991) narrates, Gadamer's application philosophy means that design education involves teaching design rules and the skills of interpreting, understanding, and applying rules. Snodgrass (1991) further argues that judgments are not conveyed by way of a formal doctrine or embodied in prescriptive formulae but instead can be learned 'by' and 'in' practice, hence, by applying general application rules that previously learned in particular situations. One learns to make correct judgments in the act of application. Snodgrass (1991) similarly continues that design activity involves the exercise of tacit knowledge that discloses itself in the experience but still cannot be formulated and hence cannot be codified in the form of rules. Different evaluators may perceive a design and its value differently, and even the same evaluator may evaluate the same design differently in different circumstances. Hence, the design does not have a single and fixed value but myriad constructions of value depending on private preconceptions (Snodgrass, 1996).

The hermeneutic approach acknowledges that knowledge is not guaranteed by a method that distinguishes the objective from the subjective to penetrate to the 'laws' of reality. Furthermore, neither objectivity nor subjectivity can stand alone as a domain of study, and there is a need for an appreciation of the union experience of both, where these two are accounting. Boland (1989) exemplifies this situation through a metaphor of photography. The photograph as a form of 'objective reality' of the natural world is grounded in the intentions of the one who takes it, and it captures the world of objects with defined meanings. Similarly, theory cannot stand apart from acting as the objective; but instead, they are inevitably bound to each other. In sum, as Cross (1982), Archer (2005), Polanyi (1962a), Abel (1981), Wittgenstein (1958), and many others

have shown, a kind of knowledge that does not include any tacit knowing is unattainable, which will be supported in the upcoming chapter with its relation with hermeneutics. As Abel (1981) states, in all of the studies into how current design processes might be improved, explicit knowledge in design has never been questioned as a required, attainable, or desirable goal. As tacit knowledge is an essential part of the heuristic methods of knowledge production in design, it also holds a solid potential to absorb and respond to change. Besides, it has largely abandoned efforts to measure, analyze, and regulate every aspect of the design process to recognize the role of tacit knowledge in qualified designs (Polanyi, 1962b). Hence, an adaptive-rational approach that does not obscure the existence of the tacit knowledge but lets it emerge in the measurement process can be considered a fruitful approach. According to Ayıran (2005), design knowledge bases on a type of knowing-how that develops within a hermeneutical circle and in a peculiar design situation. Therefore, the acceptance of different types of knowledge is necessary for each design situation. Besides, the acceptance of the tacit knowledge in the design process provides designers a highly relevant approach for dealing with constantly changing circumstances and a set of complex and seemingly contradictory requirements that is one of the constitutive attributes of the design process.

Moreover, Polanyi (1962b) states that the paradigm of tacit knowledge enables a seamless bridge from natural sciences to humanities research. One way to consider how these debates intertwine and contribute to the explanation of each other is to consider them from a hermeneutical perspective in the design process. Therefore, the projection of the hermeneutical circle into the design process requires further explanation in detail.

3.4 Design Evaluation Process as a Hermeneutical Process

According to Taylor (1971), there is a need for a hermeneutical approach when self-definitions partially constitute the subject of the field. Taylor (1971) further exemplifies physics and states that the lack of sufficient brute data can put a theory in doubt. However, in the fields where hermeneutical processes are needed, the failure arises from grasping meanings. Hence, to exclude the hermeneutical process in the design evaluation to arrive at objectivity means ignoring the essence of any design process since there are types of knowledge that do not ground on brute data. In order

to reveal this relation, the atomistic language model is examined. The atomistic language is a frequently used model derived from language theory for codifying, describing, and explaining what is seen to be the logical sequence of the design process. Even though in the short term, it has seemed like a successful approach, Snodgrass and Coyne (1977) argue that the model fundamentally misunderstands the essence of the design process. Relying on the research of philosophical hermeneutics, especially the works of Gadamer, it is asserted that design activities are carried out in a hermeneutical cycle that involves a dialogical structure. Under the role of understanding and interpretation, design activity should be considered more concerning the human sciences with its relation with hermeneutics instead of the natural sciences. Mitchell (1990) describes the atomistic language model by claiming that the design process can be described to create a critical language. Therefore, design worlds are composed of graphic tokens such as words that can be manipulated following certain grammatical rules. The model of Mitchell (1990) covers a design process similar to the process of language use, that can be described according to primary tokens such as geometric shapes that are equal to the words, and these primary shapes or units can be manipulated per grammatical rules in order to build structures. This structuring process is similar to the rules of logic to form meaningful sentences. In the atomic language model, the verbal atoms, which are the words, correspond to the objects in the real world. They are combined to construct larger information segments, like sentences. The structure-building process of this model must follow the rules of formal logic to be meaningful. Snodgrass and Coyne (1977) reveal the limitations of this model. The first limitation depends on the radical objection of Wittgenstein to the atomic model of language, which is based on the assertion that words do not acquire their meanings from logical calculus since the meaning of a word constantly changes by the situation it emerges in. Therefore, context is what creates and gives meaning to the words, that means, the meaning of a word is in its use, that is to say, if words are used in isolation such as in the atomic language model, because they are not regarded within a context, the meaning cannot be revealed just by using rules of formal logic. The second assertion that supports the objection is, it is the people who construct and define terms. Hence, rules of grammar do not reveal themselves but are the construction of people. The model of Mitchell (1990) takes its roots from the positivist theory of science, which is later discredited, as discussed in detail in Section 2. Snodgrass (1996) instead offers that design evaluation is similar to interpreting the

meaning of a word; it is not fixed or precise but depends on the context in which it is used. Such as words only have value or meaning in the context, the value of the design similarly only exists in the interpretative interaction of the evaluators and the design situation. Therefore, the value is not stable but changes when the interpretation, and therefore the evaluation progresses. Thus, the design evaluation process should be thought of as an interpretation of a text, therefore as an interpretative activity, instead of problem-solving activity. Similarly, Snodgrass and Coyne (1992) assert that the 'hermeneutic circle' is a more suitable metaphor for design activity than the prevailing metaphor, 'design as a problem-solving activity'. According to Schön (1983), the practical situations are not the problem to be solved, but the problematic situation in which one is involved, which has the characteristics of uncertainty, disorder, and uncertainty. The hermeneutic circle is also the metaphor that Schön (1983) references when using the concept of 'reflective practitioner'. Rittel and Webber (1973) similarly define design as a process of 'wicked problem solving', and define its characteristics. In the scope of the thesis, three of them will be emphasized. Firstly, in the process of wicked problem solving, there cannot be found a definitive formulation. Secondly, there are no stopping rules in the search for solutions to wicked problems, and thirdly, solutions to wicked problems cannot be considered according to their truth or falsity but can be regarded as good or bad. As Lawson (2004) similarly emphasized, what designers deal with are not well-formulated problems but instead ill-structured, open-ended, and frequently referred to as 'wicked'. According to Finkelstein (2003), the wicked problems are subjected to 'weakly defined measurement', or simply, soft measurement. Finkelstein (2003) defines weakly defined measurements with their characteristics based on ill-defined concepts of quality, and there are uncertainties in the empirical relational systems that it represents. Rittel and Webber (1973) define wicked problems as problems that cannot be understood without knowing the context in which they occurred. One cannot effectively search for information without first understanding the solution concept's direction; that is to say, one does not first understand and then solve since these two processes are interwoven. Coyne (2005) similarly states that the formulation of wicked problems is based on the knowledge of those who present them rather than being presented objectively. In other words, there is no final test of the validity of a wicked problem solution, and solution testing might be exposed in a practical context.

Any design problem is defined by Gasparski (1993) as a suitable mapping of design objects in a design language, and this mapping of a design object consists of two procedures: identification and interpretation. Since researchers such as Rittel and Webber (1973), Schön (1983), Lawson (2004), Coyne (2005), and many others indicate, design problems are not well-defined problems to be solved, but rather the initial condition of a design situation is characterized with ill-defined problems, that is, with the lack of adequate information for the designer to come up with conclusions directly. Therefore, an interpretative approach to an ill-defined situation should be employed for the design evaluation process instead of a well-defined problem-solving activity. Designers begin any design activity with their pre-understandings, and when they progress 'by' and 'with' their interpretations, their understanding expands following the interpretation of the parts and the whole, which in return can be modified and clarified. This dialogical rather than prepositional approach enables further questioning for the situation since when the process is codified as definitive, it closes further questioning. Accepting the hermeneutical circle's position in design activity rather than denying it to reach a kind of 'objectivity' thus has the potential to clarify the nature of the design process. Snodgrass and Coyne (1997) argue that designing is a hermeneutical activity rather than an epistemological event since in the hermeneutical process, the application is interwoven with the interpretation and understanding; hence they do not stand apart. On the contrary, in an epistemological event, knowledge and its application are separate and sequential entities; that is to say, knowledge prioritizes its application.

Now, there is a need to clarify the relationship between understanding, interpretation, and application. In the early traditions of hermeneutics, three elements were differentiated: subtilitas intelligendi (understanding), subtilitas explicandi (interpretation), and subtilitas applicandi (application). On the other hand, Gadamer (2009) argues that hermeneutics does not have three separate components; on the contrary, they are inherently related since every act of understanding involves interpretation, and all interpretation involves application. Only when the fore-meanings are not used arbitrarily can understanding reach its full potential (Gadamer, 2009). According to Gadamer (1973), the interpreter must not depend on the fore-meanings as they appear but must instead evaluate the origin and validity of the fore-meanings provided openly, which refers to the demarcation of 'blind prejudices' and

‘prejudices to illuminate’. As Ricoeur (1971) states, by engaging in a dialectic of guessing and validation, one can determine the validity of interpretations. This can be achieved through a dialogic exchange of questions and answers that needs more examination since it is directly related to the dynamics of the design process. The hermeneutical circle proceeds with a question-answer structure, and the question posits an initial way of seeing. Hence, the experience of hermeneutics is dialogical. An openness to what the other is expressing is required to reveal a true dialogue to test one’s understanding and pre-understandings by asking questions since a question is constantly directional and has an intentional character (Snodgrass & Coyne, 1997). What characterizes the human sciences and the hermeneutic sciences is the inquiry that comes from the question-answer dialogue. According to Snodgrass (1996), the tacit understanding that guides constitutes, and limits a design's evaluation is the ultimate authority within the hermeneutical community. Tacit knowledge often arises from the personal experience of making and thinking and hence connects intellectual and practical work. It provides knowledge embedded in a community labeled as the hermeneutical community by Snodgrass (1996). The members of the community share a common training and experience, hence not just relying on individual sources. They belong to design culture and share a common language of design. The individuals of the hermeneutical community share modes of interpretation that are called tacit understanding that corresponds to learned knowledge from examples in specific situations instead of knowledge coming from rules or by following formulae. They similarly share a practical understanding that is acquired from learning by doing. Therefore, this practical knowledge is not embedded in any formulae but rather should be considered an indwelled ‘know-how’. This tacit understanding within the hermeneutical community includes the tacit understanding of norms and evaluative practices as well. Hence, the evaluator does not arbitrarily choose the norms and criteria but follows the limits of the tacit understanding of the hermeneutical community, which comprises a complex set of tacit norms, processes, criteria, and procedural rules that form the practical know-how. Therefore, there is no need for explicit rules to evaluate a design since the rules are internalized and indwelled and became an integral part of the understanding within the hermeneutical community. The hermeneutical metaphor, therefore, negates the dichotomy of objectivity and subjectivity. According to Bernstein (2009), it is clear that many of the contemporary debates still lie at the traditional extremes, which addresses the problem in a polarized

way and hence obscures the areas where there lies a meaningful movement beyond objectivism and relativism. Snodgrass (1996) similarly asserts, this problem is not embedded in the evaluation process itself but rather is embedded in the use of an object-subject model to describe the activity of evaluation. Like every descriptive model, the object-subject model to describe the design evaluation process is a metaphor, and each metaphor reveals some aspects of its referent while obscuring other parts. However, the object-subject metaphor obscures more than it reveals (Snodgrass, 1996). Instead, a metaphor of a text and its reader can be proposed to reveal the hermeneutical process that exists in every act if understanding and interpretative activity, so in the design evaluation process as well. This is because the object-subject metaphor assumes that design is the object that stands apart from the evaluator as an isolated and contextless entity. On the contrary, in the hermeneutical metaphor, the evaluator and the design do not stand apart but interact within a specific context. The reader-text metaphor, instead of object-subject metaphor, leads to another fruitful situation, that is, when two evaluators disagree on the value of the design, the hermeneutical theory does not come up with the idea that one of the evaluators have misread the situation for two evaluators are probably reading the situations through different circumstances, with different pre-understandings, and with different horizons of anticipation. Hence, the value of the design is not regarded according to its truth or falsity. However, the meaning of the design depends on the situation with the preconceptions of the evaluator. Therefore, the hermeneutical metaphor dismantles the assumption that design possesses value in itself. However, the value arises in the interpretation situation, so it is not before the evaluation. Snodgrass (1996) explains this situation as neither the meaning of design nor the preconceptions of the evaluators are pre-given absolutes. However, instead, value arises in the complex interactions of these two in the interpretational situation. Evaluators that refuse to open their evaluations up for questioning lose their right to speak on behalf of the hermeneutical community since questioning reveals the unseen aspects of the evaluation and opens the way of new paths of seeing and interpreting. A better understanding of the tacit understandings within the hermeneutical community provides a fruitful base for the validity of the evaluation.

To put question-answer structure within hermeneutical circle into the context of the design activity, hermeneutics asserts that its process is primordial and universal; that

is to say, it does not only operate to understand languages or text, but it reveals itself in each act of understanding. As expressed before but to emphasize, the hermeneutical circle is not about acquiring a method by deciding, but rather, it is embedded in the process of understanding. To apply these findings to design activity, by following Schön (1983), the design process works according to the dynamics of the hermeneutical circle by using a dialogical exchange with design situations constantly, and Schön (1983) further describes design activity as a reflective conversation with the situation. Schön (1983) points out that the principle is that one works contemporaneously from the part to the whole, and next goes in cycles back and forth, back and forth, that is what is done several times stutteringly. Schön (1983) has suggested that designers 'have a conversation with the situation'; while designers are drawing and reacting to their drawings, drawings speak back to them, and further steps can emerge at that moment, or as he states, "The principle is that you work simultaneously from the unit and the total and then go in cycles—back and forth, back and forth…" (p. 92). Initially, Schön did not develop this understanding to characterize the design activity, but rather for the activities he called 'reflective practice'. According to this view, designers first begin the design task by shaping the situation according to an initial appraisal. Then, the situation talks back to the designer, and the designer responds to the situation's back-talk by reflecting-in-action on the construction of the problem. The process then develops in a circle, such as back and forth, back and forth. What Schön (1983) describes in this dialogue with the situation is the working of the hermeneutical circle. The designer advances by inter-referencing a 'projected whole' into parts that make up the whole, i.e., the design situation. In the design process, the meaning of the whole is projected into parts, and after working out these implications, parts project themselves to the whole. Snodgrass and Coyne (1997) sum this situation up as "an interpretation evokes new interpretations" (p. 31). Hence, a sketch to be accepted as an output of a design process can be accepted as an evocative element of other interpretations, and other sketches can be made according to these newly output interpretations that may again evoke new interpretations.

As Snodgrass (1991) claims, the design process does not proceed in such a way that is waiting to be discovered and formulated by the design scientist and does not proceed by reference to underlying and unchanging structures. Instead, it proceeds through a dialogical flow of ideas, shaping and reshaping the parts and the whole in a

hermeneutical cycle of everchanging interreflections. Archer (1979) similarly states that the design activity is a communicative process. The designer's attention constantly fluctuates between the emerging requirements and developing provisions to overcome the misfit between both sides. Hence, data cannot be understood without context, which themselves are dependent on the relations of data and the context. Wittgenstein (1974) similarly states that "Only propositions have sense; only in the nexus of a proposition does a name have meaning" (p. 16) and "An expression has meaning only in a proposition. All variables can be construed as propositional variables" (p. 17). These quotes can be interpreted as meaning that constitutes itself in a context. Therefore, like in the design evaluation, there cannot be mentioned eternal and external rules and criteria to apply to all design evaluations, but there can be methodologies that will be explicitly constituted for each design evaluation process in its own regard. Like Frege and Wittgenstein, Snodgrass and Coyne emphasize that words do not carry a single and stable lexical meaning but have meanings constituted with the condition it has encountered; rules also have the same kind of attribute that varies with the context. Therefore, a disagreement over a 'correct' interpretation is constantly possible. Snodgrass and Coyne continue that rules are not given from an uncanny power but rather are formulated by humans since formulation includes interpretation, and rules are constituted within these interpretations. On the other hand, rules and criteria do not prevent subjective interpretations of the design since they are themselves products of and subjects of subjectivity (Snodgrass & Coyne, 1996). Even though design evaluation cannot be considered an entirely objective process, evaluations are made correspondingly to tacit criteria shared by a hermeneutical community (Snodgrass, 1996).

It is commonly acknowledged that the design problems are characterized by being ill-defined by many respected researchers such as Ritter and Webber (1973), Schön (1983), Lawson (2004), Coyne (2005), and many others as discussed. An ill-defined problem is characterized by insufficient information to allow the designer to arrive at conclusions that correspond to the requirements since requirements cannot be defined explicitly. The lack of detailed requirements gives rise to the need for the practical use of the tacit-knowledge. Archer (1979) indicates that, first of all, 'the problem' should be recognized. The design problem does not correspond to the statement of requirements nor the solution area in itself. What creates the problematic part is the

misfit between the requirements and the provisions, in other words, the potential misfit requirement/provision match. Ambiguous facts and uncertain relationships are found in systems in which correlations between quantitative variables are weak, but a weak correlation is still something other than a lack of correlation and is the subject of science (Moles, 2018). The use of statistics in scientific inquiry can be given as an example of ambiguous situations but still considered worth investigating. Moles (2018) distinguish between three types of ambiguity by depending on their wherefrom. For the first category, some phenomena are ambiguous because of the possibility of error in their definitions or frameworks. They are ambiguous because they can appear in different images according to the situation, so that it should be known why the characteristics of those phenomena differ. Secondly, many facts remain uncertain because of the lack of proper measurement techniques. In this case, the task is to make a conceptual effort to fit them into some possible measure. Thirdly, some phenomena are inherently ambiguous; that is, the concepts to be used to express them are ambiguous or inappropriate; therefore, they should be examined depending on what is known. In the scope of the thesis, design evaluation is considered ambiguous in the third category of Moles. However, when the history of proposed design processes is examined in Section 2., it is seen that the design process is mainly considered under the second category. The design process is ambiguous since there is not yet 'discovered' a process to make it not-ambiguous.

In sum, defining a design process as a form of problem-solving activity is a definition that is based on the terminology of normal science; hence this definition is imported from an entirely different tradition and lacks reflecting the natural characteristics of design activity. Hence, design activity should be identified by being an interpretative and hermeneutical event since it seems much more convenient to its nature (Ayıran, 2005). As it is seen, Simon (1996) characterizes the field of design with its focus on 'how things ought to be'. Hence, the definition of Simon supports the interpretative characteristics of design as well. Ayıran (2005) emphasizes the importance of interpretation by stating that the primary goal of concept studies, which are required of students at the start of the design process in the design studios, is to ensure that students' primary interpretation of the subject may be utilized as a trigger for the design process. Whether the interpreter is an experienced designer or a novice student, it is essential that such an interpretation would be based on their prior knowledge. After a

comprehensive literature review on historically proposed design methodologies, the conclusion is that designers continuously switch between general and detail, function and form, problem and solution, aims and means.

Design, according to Foque (1982), entails coping with messages carrying extremely detailed information. As a result, it is critical to understand how information is transmitted and appropriately processed meaningfully and efficiently. Hence, there is a need for an epistemology (rules for reaching the truth), metrology (measurement techniques and sciences of the uncertain), and a methodology (knowledge of the methods that will enable the human to understand the uncertain things) to understand how the design evaluation process can be thought of.

As Stöckli (1992) narrates, Louis Kahn begins his design process with 'the unmeasurable', where there are all expectations, thoughts, wishes, ideas. As the process progresses, sketches transform into the 'measurable', and it needs transformations that involve myriads of steps at this stage. In the end, the building itself is again 'unmeasurable'. This process can be ordered such as:

- The idea (immeasurable)
- The building (measurable)
- Transcendence from the building (immeasurable)

Therefore, Kahn's approach consists of two categories that progress from the immeasurable to the measurable and immeasurable again, from the world of ideas to the world of tangibles and the transcendence from the building. Hence, Kahn seeks to coexist the immeasurable moving to measurable and vice versa in the design process. To put the approach of Louis Kahn into the context of the thesis, a design product comprises both measurable and immeasurable parts. By trying to find the components of the immeasurable attributes, the immeasurable uncovers itself through measurable parts. For that stage of 'uncovering' of the immeasurable parts, terminologies of measurement science convey high potential since there are similar concerns to be shared. Considering that measurement is undoubtedly one of the essential elements of scientific thought. Therefore, to develop design decisions, measurement science may bring highly fruitful understandings since, after all, design decisions depend on evaluation and measurement.

4. MEASUREMENT AS QUANTIFICATION, OR EVALUATION

In the 21st century, it can be asserted that measurement is considered as the basis of all experimental and theoretical research, including the social sciences and the natural sciences, and is mainly regarded as the source of trustworthy and reliable knowledge that includes a wide range of human activities, and primarily used to support decision-making processes. Besides, as Sydenham (2003) asserts, measurement, knowledge generation, and advancement are complementary activities, and the evidence grounds on the various sources spanning humanity's lengthy history and further exists in the early writings of the Ancient Greeks. Even though Ellis (1966) states that measurement should be the central concern of philosophy and science, it has not attracted attention as it is supposed to be throughout the twentieth century. Until today, philosophers of science have given a great deal of attention to what science is and what makes science distinct from other human activities. A more local question than the first one is of what measurement has also received significant attention, specifically in light of the measurability of psychological and social properties. In the natural sciences, the properties being measured are generally grounds on a well-defined body of knowledge.

On the contrary, in the social sciences, quantitative knowledge is less developed, and hence measurement activity first requires the characterization of the properties of interest to modify them so that quantitative information can be obtained. The measurability of properties that are not found in the form of quantity as it appears and is at the focus on sub-disciplines of social sciences such as psychometrics and econometrics (Mari et al., 2019). The multiplicity of sub-disciplines demonstrates the differences caused by measurability in different disciplines, even though they still share a common concern of the measurability of non-quantified elements within the discipline.

Since measurement activity has a powerful dependency on the nature of the subject matter, its application, and the context, the measurement should be performed to make its definition explicit and satisfactory, which is remarkably difficult. Some proposed definitions of measurement include the process of 'quantification' as compulsory to call the activity 'measurement', or even in some definitions, quantification is regarded

as equal to measurement. For example, Suppes (2002) defines the aim of measurement as "… to show in a precise fashion how to pass from qualitative observations to the quantitative assertions needed for more elaborate theoretical stages of science" (p. 4). The International Vocabulary of Metrology (2007) defines measurement as: "… process of experimentally obtaining one or more quantity values that can reasonably be attributed to a quantity" (p. 44). Alternatively, as Michell (1999) asserts, "… measurement is just the process of discovering or estimating the measure of some magnitude of a quantitative attribute relative to a given unit" (p. 14).

The importance of quantification or direct existence of any quantity is hence related to the term 'measurement'. Moreover, Piotrowski (1992) defines measurement as a 'quantitative observation' and limits the discussion to the purpose of quantitative output. As Ferris (2006) narrates, Piotrowski introduces a theory that consists of two domains. First is the actual object domain, and second is the representative abstraction, and what constitutes the measurement process is the transformation from the actual world domain to the domain of abstraction. Hence, measurement is considered by Piotrowski as the process of converting reality into a model that can be represented abstractly and quantitatively.

The identification of measurements by quantity can be traced back to the tradition of Euclid. On the other hand, as Mari et al. (2017) asserted, for measuring activity, quantification is neither a required nor sufficient requirement since it is too restrictive to be helpful in current scientific, technical, and social understandings of measurement, and it ignores other precise, accurate, and reliable bodies of information on non-quantitative elements of the world. Besides, the assertion that only quantities are regarded as measurable grounds on the historical convention instead of a logical necessity. Mari et al. (2017) further ask to clarify the relation of measurement and quantification:

- Is the property to be evaluated a quantity?
- Is it evaluated as a quantity?

The first question is ontological, whereas the second one is operational. The first question concerns the inputs of an evaluation process following its feature of 'being a quantity'. Ellis (1966) states that quantities are thought to be 'properties' of objects, that things must possess to a specific degree, even if there is no way of measuring the

degree. Hence, a quantity is usually regarded as a kind of property, and therefore quantities, like qualities, are regarded as inherent to the objects with a possession relationship and accorded a kind of ontological status. On the contrary, the latter question is whether being 'quantifiable' is sufficient or necessary of measurement that interests the outputs of an evaluation process, per the categorical feature of 'being the result of a measurement. The transformation from the first question to the latter one can be regarded as the process of quantification. If the property to be evaluated is not a quantity, it is still evaluated as a quantity; therefore, there is the knowledge that gets obscure in this transformation. Besides, not all quantitative evaluations can be considered as measurements. Gallagher (2004) asks what does 'scientific' imply. The often given answer is the 'appealing to the objectivity of scientific procedure'. Hence, if it is impossible to achieve any level of objectivity concerning the subject matter, it cannot be the topic of any scientific investigation. Alternatively, according to some other answers, quantitative accounts are the only ones allowed in science; hence if something is not quantifiable, it is not suitable for a scientific study. Gallagher (2004) states that there are things that have meaning but cannot be quantified or objectified without loss of their meanings and hence falls into the domain of hermeneutics. To deny the actuality of these facts is what is unscientific. Hofmann (1983) expands the definition of measurement as: "Measuring in a narrow sense (measurement) is the experimental comparison of a measured quantity with a metrological standard. Measuring in a wider broad (classification) is the experimental comparison of a measured object with a particular standard (pattern)".

The multiplicity of definitions of 'measurement' reveals that measurement is a many-faceted activity, which is somehow irreducible. Therefore, in the context of the thesis, measurement is considered in one of its most general use, as 'acquiring meaningful knowledge about the phenomena', or as Ferris (1994) states, a process to reveal the meaning of the data, similar to the definition of Sacerdoti et al. (1991), that is, measurement is about to construct a dialogue with the external world in order to broaden one's knowledge. Hence, measurement is considered equal to quantification, but by not limiting the area of knowledge that includes not-quantifiable entities with pragmatic measurement. These accepted definitions differ from the previously mentioned definitions since it considers measurement with its relation to the measurer and emphasizes that measurement results are in relation with the observed entity with

its relation to the understanding of the measurer on what is measured. Therefore, the definition of measurement offered by Ferris (2004) can also be accepted as the one the thesis supports: “Measurement is an empirical process, using an instrument, effecting a rigorous and objective mapping of an observable into a category in a model of the observable that meaningfully distinguishes the manifestation from other possible and distinguishable manifestations” (p. 107).

In the case of the design evaluation, the instrument is the judgments of the evaluators of the design team or the hermeneutical community. The words ‘measurer’ and ‘evaluator’ will be used interchangeably since measurement can be considered an informative evaluation that aims to acquire and convey information about what is in the interest of the empirical world. Even though the background assumption, that is, measurement is a specific type of evaluation, is relatively very generic, it is still a fruitful assumption to reveal the fundamental characteristics that measurement and evaluation share (Mari et al., 2012). Therefore, in the scope of the thesis, measurement is considered as a specific form of evaluation, that is to say, acquiring meaningful data in an interpretative way that signifies subjective components of measurement as well, by considering the inevitable presence of the judgment of the measurer, or the evaluator. Therefore, the term measurement is used to indicate all processes of the extraction of meaning from observations, models, and experiments. The assertion of the measurement is an evaluation that abstractly defines the measurement based on a black-box model as the process of achieving the functional transition from the input object to the output object that is the result of the measurement. A dependent relationship defined assumes a causality principle between input and output of the measurement process; that is to say, outputs are effects of inputs (Mari et al., 2012). This is particularly the conceptual ground for the developments related to measurement-uncertainty-evaluation techniques.

The International Vocabulary of Metrology (VIM) defines metrology as the "science of measurement and application". Even though VIM realizes this definition, it is still discussed if measurement science can be portrayed as an independent science or considered a sub-constituent of specific fields. As Witkovský and Frollo (2020) narrate, many reputable scientific journals publish the results of many fundamental and practical research fields focused on developing measuring methods and analyzing measurement data, indicating that measurement science is a mature, independent, and

unique scientific subject. On the other hand, measurement science can be considered according to its function in specific contexts without portraying its scientificity. To provide a single example, Mari and Petri (2014) consider measurement science as a bridge between reality and knowledge and address the function of measurement as a bridge connecting the empirical world and the information world. In this present study, measurement science is used for the clarification of a hermeneutical approach to the design evaluation process, and it is aimed to create an expansion of the design evaluation process with a flexible framework by deriving approaches from measurement science since as Simon (1996) emphasizes that the quality of design is grounded heavily on the quality of the data available. Therefore, in order to be able to evaluate any data, there is a need for a metric system in which the measurement activity to be performed.

According to Mari (1997), the current measurement paradigm is characterized by replacing the objective notion of truth with the subjective criteria of consensus. Correspondingly, measuring systems are unique mediators between objects and symbols, providing an intermediate state between objectivity and subjectivity's empirical and symbolic domains. Therefore, measurement becomes a kind of decision-making process, gives rise to the importance of the epistemic status of evaluation, and eliminates the traditional condition that necessitates the pre-existence of a valid value. While offering an expansion for the design evaluation process with the understanding of measurement science, a background assumption presumes a connection between design evaluation and measurement activities. To reveal this assertion, the etymology of the term 'measurement' is examined. The word 'measure' is derived from the Latin word 'mensura', the abstract form that comes from mensus, past participle of the verb 'metiri' derived from 'mitis'. The term meant wisdom, which is a measure in a psychological sense.

On the other hand, 'metrein', the Greek word, conveys measurement as an evaluation and judgment. It can be considered that measurement in this meaning is then a wise and subjective evaluation. Since measurement includes evaluation inherently, a continuous evaluation reveals the connection between the measurement and design process. According to Collins, as narrated by Goldschmidt (1992), evaluation and criticism are inherent activities of the design process, which is also a limitation for scientific architectural research. Hence, understanding of measurement does not need

to be limited with properties to be evaluated as a quantity because there are different contexts in which measurement can be applied while maintaining its accuracy and dependability to reveal knowledge. Thus, measurement can be accepted as a process that aims to acquire information about the properties of empirical entities. By depending on this, it is crucial to consider a historical perspective firstly in order to clarify the understanding of how the idea of measuring has evolved throughout time and came to an understanding which the thesis uses in the context, and to reveal that the problem of measurability has profound influences on the development of measurement science, and therefore clarify the wide range of use in a different context, and how it increases the value to different human activities.

4.1 Overview

Throughout history, many practitioners have contributed to the theory of measurement. Physical sciences and engineering are the main disciplinary foundation of contributors to the theory of measurements, such as Helmholtz, Campbell, Bridgeman, Finkelstein, and others. In the social sciences, specifically in psychology, Stevens, Suppes, Tversky, Krantz, and Luce are the main contributors to the field. Finally, in mathematics, Roberts, Pfanzagl, and philosophy, Ellis, Kyburg, and others can be regarded as the main contributors. The theory of measurement has attracted practitioners from various disciplines is the role of measurement as an actual a posteriori epistemic procedure for coping with real-world knowledge. Because the subject matter of interest is based on natural states, the understanding of reality is required in several fields (Ferris, 2006). To reveal the epistemic role of measurement in which practitioners know the world, a brief overview of the history of measurement is examined.

Hand (2016) asserts that the need for a precise measurement has been exposed in the very early times in human civilization, and alternative systems for measurement have been developed throughout history. Measurement is a primeval concept, and it seems unlikely that people have ever lived without it (Morley & Renfrew, 2010). When the origins of measurement date back to antiquity, it is encountered in Solomon's Book of Wisdom, written that "Omnia in mensura et numero et pondere disposuisti" a Latin phrase dated to mid-first century BC, meaning that all things are ordered in measure, number, and weight. In Ancient Greece, the philosophical foundations of measurement

are investigated. Socrates had considered that Protagoras was claiming the equivalence of knowledge to sensation, that is to say, what makes things known is the perception of things, and by following this meaning, it can be concluded that measurement is simply the synonym of evaluation which includes estimations and personal judgments as well (Mari, 2003). Protagoras, the Greek philosopher, has stated that "man is the measure of all things" in the mid-third century BC. While Pythagoreans dealt with the explanation of the world with arithmetical comprehension, the Platonic Academy adopted a geometrical conception and developed the theory of magnitudes. In addition to that, the first critical demarcation between notions of number (arithmos) and magnitude (megethos) is realized by depending on the differentiation of arithmetic and geometry in Greek mathematics (Berka, 1983). At that time, the knowledge about measurement was based on the assumption that numbers exist in the world and hence can be discovered by correct empirical operations. It can be seen that the roots of the understanding of 'things' by depending on a 'measurement' procedure can be followed till antiquity. Afterward, Galileo established a program of the physical world by putting mathematics in the center of physics and asserted in 1610 that "count what is countable, measure what is measurable, and what is not measurable, make measurable." Thorndike (1914) similarly asserted that "If a thing exists, it exists in some amount; and if it exists in some amount, it can be measured."

To approach a nearer history to relate with the scope of the thesis, the factual basis of the modern measurement is considered to laid by Helmholtz with a paper published in 1887, Zahlen und Messen, which is translated in English as Counting and Measuring, and then with Campbell (1920) in his book Physics, the Elements. Helmholtz dealt with measurability by investigating the objective meaning of the facts that are expressed as quantities and under what conditions it is allowed to do so (Finkelstein, 2003). Helmholtz explicitly investigated the objective meaning of the fact expressed as quantities and established an analogy between measuring and counting. In most cases, the assertion is that the characteristics to be measured are 'quantities,' hence the amount of something, and thought of as the summation of several elementary components. In these cases, the measurement is considered equal to the count of these units. As Ferris (2006) narrates, Helmholtz covered the measurement theory based on Euclidean geometry, asserting that in observable things, there are dimensions, and a number may represent each dimension.

On the other hand, each number can only represent one dimension. This assertion can be concluded that entities cannot be diminished to a single number, so the entity can only be compared regarding a specific dimension, not as a whole. The work of Helmholtz is considered the first formal discussion of measurement. After that, Campbell, like Helmholtz, dealt with 'what is the difference between the attributes that determine whether an entity can be measured or not?' or 'why can we measure certain properties of bodies but cannot measure others?' (Rossi, 2007). Campbell's (1920) concept of measurement is widely regarded as the first formal definition of measuring, that is: "Measurement is the process of assigning numbers to represent qualities: the object of measurement is to enable the powerful weapon of mathematical analysis to be applied to the subject matter of science" (p. 267-268).

According to Ferris (2004), the definition of Campbell is obviously based on Kelvin's dictum of four decades earlier. The statement of Lord Kelvin in 1883 is narrated by Sydenham (2003) as follows:

> In physical science, the first essential step in learning any subject is to find principles of numerical reckoning and methods for practicably measuring some quality connected to it. We often say that when we can measure what we are speaking about and express it in numbers, we know something about it; when we cannot measure it, when we cannot express it in numbers, our knowledge is of a meager and unsatisfactory kind: it may be the beginning of the knowledge, but we scarcely, in our thoughts, advanced to the stage of science, whatever the matter may be.

Both Helmholtz and Campbell dealt with the physical measurements based on additive quantities, and quantities deduced from them. During the 1930s, the British Association for the Advancement of Science committee, chaired by Campbell, had investigated whether measurement can be applied to sensory events, such as perceived loudness of sounds, and whether these scales can be used as a scale for measurement. These questions raised concerns about measuring quantities that are not additive and the properties that do not have quantities, such as measuring hardness or colors. Colors cannot be measured as weight can be measured since it is impossible to use a number to represent the color of an object. The committee then concluded with an agreement that rejects the idea of a scale of sensory perception "until a meaning can be given to the concept of addition as applied to sensation" (Stevens, 1946, p. 677). With the increasing developments in social and behavioral sciences regarding measurability problems, the rigid position of classical measurement theory was broken. We obtained

from previous discussions the need for a more general theory of measurement and not to limit the definition of measurement with a restricted class of empirical operations. In psychology, S. S. Stevens (1946) proposed hierarchical scale types that include ratio, interval, ordinal and nominal scales to expand the scope of measurement and make measurement applicable for physical and non-physical procedures while pioneering a psychological measurement understanding that will be discussed in Section 4.2.1. The re-definition of Stevens that considers measurement beyond referencing them to empirical facts breaks the necessity of additivity condition for measurement since the social sciences do not fit additivity condition; therefore, measurement was considered to exceed the domain of the natural sciences. At that time, the understanding of measurement that was based on the assertion that numbers are in the world, and to measure is to discover them, replaced with a different and more pragmatic understanding, such as asserted by Stevens (1951): “Mathematics is a human invention, like language, or like chess, and human not only play the game, they also make the rules.” Alternatively, again by Stevens (1959): "Measurement is the assignment of numerals to objects or events according to rule, any rule” (p. 19).

Or by Finkelstein (1975a):

> Measurement is defined as an empirical operational procedure that assigns numbers to members of a class of entities in such a way as to describe them, which is meant that relations between these numbers correspond to empirical relations between the entities to which they are assigned (p. 105).

Alternatively, again by Finkelstein (1990): “Measurement is the assignment of numbers or other symbols by an objective, empirical process to attributes of objects or events of the real world in such a way as to describe them” (p. 5). These definitions expose the shift of the emphasis on the quantitative nature of the measurement to the information-gathering nature of measurement. Mari (1997) states that with this new interpretation of the concept of measurement, there is nothing to justify the often asserted hypothesis that measurement is an empirical process that produces objective results, hence the demarcation between measurement and evaluation has disappeared, since when the accordance to Stevens’s ‘any rule’ is the necessity to characterize measurement, therefore the results of measurement inform one from the view of the measurer, not on the state of the thing itself. On the other hand, Stevens' work led to the development of the representational theory of measurements. This approach

incorporates a mathematical description of the relations within the observed entities and the numbers representing the empirical relations into the numerical system. Researchers of diverse disciplinary backgrounds have extended representational measurement theory. Since the 1970s, Finkelstein has been one of the pioneers who discuss the current role of measurability. His well-known definition of measurement is that measurement is a process of empirically and objectively assigning symbols to the attributes of objects in the physical world to represent them, which provides the keys of the representational approach. Finkelstein (2003) also made a demarcation between strongly and weakly defined measurement, where the former is the paradigm of the physical sciences, the latter is mainly considered as being the paradigm of the behavioral sciences, but can appear in natural sciences as well, such as in the case of measurement of hardness of minerals. The main difference between strongly and weakly defined measurement, according to Finkelstein (2003), is that the former is supported primarily by the theory that provides the basis for the quantitative empirical relations on which the measurement will be based.

The overview of measurement science and consideration of measurement as a specific kind of evaluation reveals that measurability was a current concern in both the natural sciences and the social sciences. Measurement is a process designed, planned, and carried out in order to achieve a purpose. Therefore, in the quest of proposing a framework for the design evaluation process, a pragmatic standpoint of measurement science may be appropriately adopted by concentrating on the epistemic features expected from the terminologies of measurement science. Therefore, some related terminologies from measurement science are chosen to be used in the design evaluation process to widen the domain of knowledge and practices in design evaluation by depending on related disciplines that share common concerns, such as measurability.

4.2 Concepts from Measurement Science to be used in Design Evaluation

A systematic review of the outcome of an activity to determine the degree to which the original objectives have been met is known as design evaluation. Although evaluation is often done after the activity, it is possible to maintain progress by doing intermediate or stage evaluations, especially when anticipated intermediate stage successes (BSI, 1994). The term evaluation is generally accepted as a synonym and

follows with assessment and measurement. According to Binder (2009), the measurement specifies the identification of what to count, the selection of relative quantitative units, and the collection of data conveyed within these units. Objective evaluation criteria should be determined at the end of the design process and throughout the life cycle of the process. The design evaluation process is about making data-driven decisions. Decisions can be arbitrary if there are no data on which to base them. Taking the time to monitor, measure, analyze, and incorporate the findings into the decision-making process will result in better decision-making. In order to obtain data to be based, terminology of measurement science might be fruitful to integrate with the design evaluation process since they share similar challenges to overcome.

4.2.1 Scales of Stevens

As discussed in Section 4.1, the more the domain of measurability widens, the more a need for a general theory of measurement grows. Therefore, Stevens (1946) proposed a categorization for building mathematical structures without reference to empirical facts. By considering Stevens's re-definition of measurement, it is argued that measurement is no longer seen as a precondition for scientific theorization but rather an integral component of the theory and experimentation (Leplege, 2003). In sum, Stevens proposed to overcome the severe limitation of measurability by expanding the domain of numbers and offered four types of scale: ratio, interval, ordinal and nominal (Table 4.1).

Table 4.2 : Classification of measurement scales, adapted (Stevens, 1946).

Scale	Empirical operations	True zero	Equal intervals	Order	Category	Examples
Ratio	Determination of the equality of ratios	Yes	Yes	Yes	Yes	Length, mass, density
Interval	Determination of the equality of differences	No	Yes	Yes	Yes	Time, position
Ordinal	Determination of being greater or less	No	No	Yes	Yes	Hardness of minerals
Nominal	Determination of quality	No	No	No	Yes	Pattern recognition techniques

Ratio scales are quantitative scales in which the difference between the two variables is equal, and there is an order between each variable. For example, 2 meters is a duplicated form of 1 meter. Someone at the age of 20 is two times older than someone who is 10 years old. If something does not have any length, it is considered 0 meters or someone with no age is regarded as 0 years old. Therefore, there is a true zero in the ratio scale that can be taken as a reference. To give another example, ratio scale emerges when switching into scales in architectural plans. In technical drawings, a 1/200 scale plan shows two times more extended area in the same size paper than a 1/100 scale plan. The main distinction between ratio and interval scales is that the empirical concatenation relation does not apply; for example, dates cannot be concatenated directly. How can one figure out how many 4 July 1776s add up to give 17 May 1814? Hence, the magnitudes of dates cannot be directly assessed since the ratio of dates does not correspond to an empirical operation and is thus meaningless (Houle et al., 2011).

To sum up, it cannot be said that year 2000 is two times more than the year 1000 since the defined year 0 is a common era, which is the incarnation of Jesus that cannot be accepted as a true zero because of its arbitrary nature. This kind of scaling is called the interval scale. The Celsius and Fahrenheit temperature scales are also instances of interval scales. All temperature scales based on arbitrary numerical assignments of two states, such as the freezing and boiling points of water, are interval scales, regardless of the unit of temperature used; however, once a unit of temperature is chosen, there is a scale on which units are essential to the interpretation of the numbers. For example,

When Celsius is examined, 80 degrees cannot be considered two times more than 40 degrees. While the Celsius scale has 100 degrees between the freezing point and boiling point of water, in the Fahrenheit scale, there are 180 degrees. So, there is a need to transform from Celsius to Fahrenheit to adjust the different sizes of degrees and baselines. If the transformation from Celsius to Fahrenheit is applied with the formula C = 5/9 x (F-32), the Fahrenheit values will not be two times higher/lower than each other. Hence, interval scales are quantitative measurement scales, where there is an ordering relationship, and the difference between two variables is equal.

On the other hand, there are not equal intervals in the ordinal scales, differently from the interval scales, but the relationship represents the order. Hence, while the ranking of variables is to be counted, the difference between variables is not. For example, if such a question asked "how is your satisfaction with your experience?", and people are asked to score their experience of satisfaction on a Likert scale from 1 to 5, a person who scored 4 does not refer to he or she satisfied two times more than someone who scored 2, since the intervals are not equal. Hence, on such scales, the numerals both serve as distinguishing marks, and additionally, they indicate an order. Mohs scale of hardness can be given as an example of ordinal scales, where numerals are assigned to substances according to their stretching potential to other elements. Hence, in the Mohs scale of hardness, hardness is defined in a way that, if substance X stretches the substance Y, then substance X is regarded as harder than substance Y. Therefore, in the ordinal scale, there are not any numerical value but an ordering relationship according to the defined practical purpose. Lawson (2005) notes that ordinal scales are commonly used when the evaluation depends on many factors or is not easy to define. They contribute sufficient information regarding the order of choices, such as in a customer satisfaction survey, when the distance between variables cannot be calculated. A quotation of Saaty (2008) can be used to explain ordinal scales in more detail:

> Long before measurement scales were invented, people had no direct way to measure because they had no scales and had to compare things with each other or against a standard to determine their relative order. People still have that ability, and it is still critically necessary to make comparisons much of the time, especially when they cannot measure things. Ancient people used their judgment to order things. The way they did it was to compare two things to determine which was the larger or more preferred. By repeating the process, they obtained a total ordering

> of the objects without assigning them numerical values. After being ordered, they could rank them: first, second, and so on (p. 255).

On the other hand, nominal scales can only be used to indicate sameness or difference. Nominal is derived from ‘nomalis,’ a Latin word that means ‘related to names’ and indicates categorical differences. For example, colors are considered on the nominal scale; one cannot say that ‘green’ is higher than ‘yellow’. The scales of Stevens, specifically the nominal scales, raised reactions since there was an ambiguity if classification can be considered as measurement. Stevens argued that classification should be considered a measurement since classification is the first step in all measurements and the basis of all kinds of categorizations and conceptualizations. The approach of Stevens can be summarized as it frames the question of what measurement is and is not as a gradient rather as a Boolean categorization. Carnap (1966) asserts that the reveal of scales is evolutionary, therefore, has a hierarchical structure. In the early stages, one learns to categorize things according to their properties, the nominal scale. Later, with the enrichment of the knowledge about the attribute itself, one learns how to order them, that is, the ordinal scale. In the end, one may find a way to define the meaningful metric among things following the same attribute; therefore, interval or in the higher degree, ratio scale appears. Brinberg et al. (1981) similarly state that researchers do not have to choose between the polar-extreme paradigms labeled ‘qualitative’ and ‘quantitative’ but might combine features from both paradigms best to meet the demands of the research topic at hand. Hence, there appears to be no need to select between qualitative and quantitative approaches as well. There would seem to be, then, no reason to choose between qualitative and quantitative methods either. Regardless of the method's traditional associations, evaluators should employ the most suited methods to their research objectives.

Furthermore, according to Kelle and Erzberger (2004), there is a strong tendency between qualitative and quantitative methods in such a way that they are generally handled as incompatible ways of thinking. However, the borderline between qualitative and quantitative research does not necessarily need to be regarded as impenetrable. On the contrary, the unity of qualitative and quantitative data can shed light on the same entity from different perspectives and give a more comprehensive and valid picture about it.

As Ellis (1966) narrates, according to S. S. Stevens, measurement is the assignment of numerals to objects or events according to rule, any rule. Since each measurement must be grounded on a scale, this assertion includes that there are also rules to make numerical assignments, and so a scale of measurement. Hence, by following the definition of Stevens, one has a scale of measurement if and only if one grounds on a rule for making numerical assignment, that is to say, according to Stevens, a scale of measurement equals having a rule. On the other hand, this definition is not that satisfactory if there are no restrictions on deciding the rules' nature. To clarify, one can state that 'I will assign numbers to weights of importance according to the order it is written', and then one can assign numbers by following this rule, but this rule does not have any correspondence to provide a meaningful evaluation of the aim. Hence, there are not many questions to make one able to check if it was a measurement, which means although the numerical assignment followed a rule, it does not necessarily represent the result of the measurement. Hence, there is a need for criteria when designating the rule to be followed as well. After Stevens, in the second half of the 20th century, there was a considerable amount of fruitful results in the theory of measurement, and then there appeared a need for systematization that is considered as achieved by representational measurement theory.

4.2.2 Representational measurement theory

The main body of studies on the foundations of measurement in the 20th century is the representational measurement theory. Since measurement results represent empirical relations, the term is 'representational.' The representational measurement theory is a mapping of the exciting property of an object and its relations into an empirically defined numerical system, hence ensuring the representation to be possible. Representational measurement theory initially proposed by Scott and Suppes (1958) but found its more extensive improvements with Kranz et al. (1971). According to these theoreticians, measurement is a kind of construction of representing an empirical relational system to a numerical relational system (Figure 4.1). Thus, for example, the results of a site surveying can be tangibly represented with a mapping of features of the physical world to a numerical system by use of point cloud surveys, photogrammetry, lidar, etc.

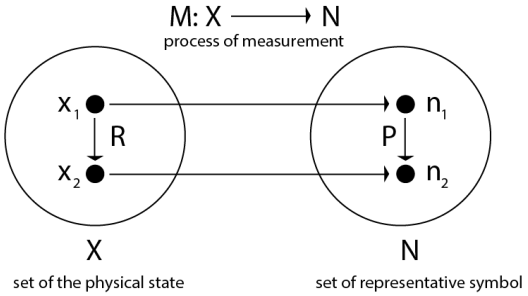

Figure 4.1 : An abstraction of the representational measurement theory

The representational measurement theory will not be used alone in the proposed framework for the design evaluation since assuming representability is a sufficient condition for evaluating a design process alone is not fruitful. Hence, representability alone cannot characterize the design evaluation process without specifying any other conditions.

4.2.3 Pragmatic measurement theory

In some cases, contrary to the representational measurement, there is not an attribute or property to be represented, or even sometimes a hypothesized attribute does not even exist as it is seen in Section 4.1., in the cases such as the measurement of hardness, the debates resulted with the insufficiency of representational measurement theory. Some extreme assertions against the representational measurement theory have come from operationalists, like Bridgman (1927). According to this extreme view, representation is a kind of illusion, and measurement is just what the measurement process captures; in other words, 'the concept is synonymous with the corresponding set of operations'. Hence, what is being measured is defined solely by the questions themselves. IQ tests are examples of specified situations since intelligence is defined as what intelligence tests are measured. Since operationalism defines the attribute to be measured and specifies how to measure it, it is closely related to pragmatic measurement theory, which Hand defines. Hand (2016) defines pragmatic measurement as when one constructs a measure that includes the sort of properties for the intended use. Therefore, pragmatic measurement simultaneously defines and measures what it defines.

Even though it is not a direct correspondence of pragmatic measurement, an example can be given from temperature measurement. In order to measure temperature, one needs to be able to measure pressure, volume, electrical resistance, or any of many

other thermometric properties. Hence, the measurement of temperature can only be performed through the measurement of one other quantity. When the measurement of volume is investigated, to measure temperature, a linear relationship between the temperature and the height of the mercury column is needed to be assumed. In this case, the temperature is defined as a property that gives rise to the height of the column in a mercury thermometer. What makes this example not a very clear example of pragmatic measurement is, even though an instrument reveals the measurement procedure –in this case, mercury thermometer- the temperature is not defined by its relation with the instrument since there are other ways to measure temperature, such as by considering the widening of metal under specific conditions. This latter way can be used as another way to measure temperature by using different scale types. The example of measurement of temperature is more related to the demarcation of the observable and unobservable properties. While observable entities do not necessarily belong to the representational measurement, similarly unobservable entities need not be considered a pragmatic measurement. For instance, the temperature can be inferred only indirectly, that is to say, by revealing its effect into an instrument, and by reading the result, and supposing that there is a link between the instrument and the entity aimed to be measured. On the other hand, in the more extreme uses of the pragmatic measurement, nothing in the real world corresponds to what to be measured; such happens when measuring sustainability. Thus, the main difference between the representational and pragmatic measurement relies on the question of 'is there a real quantity in the physical world (representational measurement), or is it just a name one uses for a specific purpose (pragmatic measurement)?'

Miyake (2013) describes a similar phenomenon as 'black-box measurement'; there are problems when it aims to measure properties that are not directly accessible, but by revealing the measurement based upon its accessible parts. Miyake (2013) exemplifies the situation such as; seismologists try to find out the properties of the deep parts of the earth by observing seismic waves at the surface by assuming that seismic waves are the indicators of the properties of the deep parts of the earth. Therefore, when there is a system that one aims to acquire knowledge about the inaccessible parts, by depending on the accessible parts and their relationship, a 'black-box measurement' with terms of Miyake (2013) or pragmatic measurement with terms of Hand (2016) can be revealed. In sum, to find out the properties and relations of the inaccessible

parts, one must rely on what is known about the accessible parts. One of the most central problems of 'black-box measurement' is how the assumption that presumes the accessible parts and their interrelationship indicates the overall property of the system can be justified. Chang (2004) describes this problem as 'the problem of nomic measurement'. In other terms, there should be a presupposition that there is a kind of relation between the accessible and inaccessible parts to claim that by depending on the properties of the accessible parts, it can be concluded with the properties of the overall system. Hence, to carry out a black box measurement, one must assert assumptions about:

- the nomic relations between the accessible and the inaccessible properties, and;

- the way the system's effects interact with one another

An important question here is the justification of these assumptions. Miyake (2013) offers a strategy for the justification process, that is, converging measurement. If one supposes a system, such as represented in Figure 4.2, it is seen that node X is connected to node Y with relation a and is connected to node Z with relation b. Y and Z are considered the accessible properties of node X; hence their measurement can be revealed confidently, but there is not enough information about how the relations a and b are constructed. Miyake (2013) asserts that in this step, there is a way to measure X. A way is to use the observation of Y by using relation a, and through the observation of Z using relation b, and if the measurer performs both measurement procedures, and if they are approximately the same result, it means that they converge, which shows a qualified measurement is revealed. In other words, if one inaccessible property aims to be measured by depending on the measurement of accessible parts, and if different measurements of accessible parts confirm each other, it can be concluded that the result represents the correct measurement of the overall system.

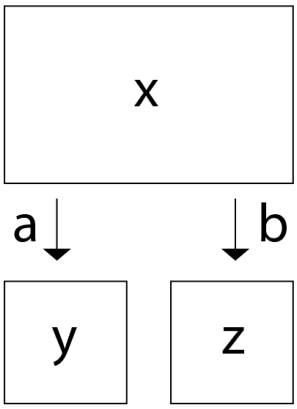

Figure 4.2 : An example of the justification process, adapted (Miyake, 2013).

Rossi (2007) similarly proposes that one can consider different sets of empirical operations to measure the same property. For example, in the Mohs scale of hardness, one may consider the indentation as the indicator of the hardness instead of scratching. In these cases, checking the agreement of different empirical operations of the same attribute can be fruitful for validation. Another similar term is the 'problem of nomic measurement', named by Chang (2004). To explain the term through an example, in order to measure the 'user-friendliness (X)' of a building, which is not directly measurable, a directly observable feature (Y) should be chosen, and a function between them (X = f(Y)) should be constituted, but the problem arises here that, how it can be known if directly observable features (such as making a questionnaire to the users of the building) represent the not directly observable feature (user-friendliness of the building), and if the function works correctly? According to Chang and Cartwright (2008), there are two ways to exceed this problem. One is determining the X values by another measurement method, which postpones the problem since the problem of nomic measurement will emerge again with another measurement procedure because X is still not directly observable. The second proposed way is deriving the function 'f' from a more general theory, which will not be straightforward again, since if the theory was empirically justified will not be known as well. So, Chang and Carwright (2008) define nomic measurement under a more general problem of the theory-ladenness of observation. If this example is put in the context of the design evaluation and aforementioned hermeneutical context, theory-ladenness of an evaluation will not be considered as a 'problem', since as it is seen, theory-ladenness corresponds to all the pre-understandings and tacit knowledge of the evaluator, which is necessary in order to make an evaluation, hence a measurement. Besides, many design-related concepts

are value-laden, and also many of them are defined, valued, or measured with value-relevant consequences. Since all measurement and evaluation processes are designed for their specific purpose, reaching a not-'theory-laden' approach is neither attainable nor desirable. Ferris (1994) similarly showed that the significance of data is something that data conveys about the world, but that significance is something the evaluator assigns to the data based on their concepts of the nature of the thing they investigate. Therefore, specifically in pragmatic measurement, the data from the measurement is only meaningful if it revealed our purpose and intention. The purpose and intention include how the evaluator interprets the data, and only after the interpretation process can the measurement result be used as meaningful input.

Representational and pragmatic measurements can be considered two extremes of a continuum, and most of the processes include both the representational and the pragmatic measurements (Hand, 2016). To give a single example, if it aims to measure sustainability outcomes, site information and spatial requirements can be investigated, which can be measured within representational measurements since there are elements in the physical world that can be represented numerically. However, combining and interpreting these numeric values is a part of the pragmatic measurement, since all criteria that will be included to measure the sustainability outcomes may not carry the same importance weight independent from the evaluator; hence, how to combine these numerical values depends on the evaluator.

5. AN INTEGRATED FRAMEWORK

Zellner (2013) affirms that architecture results from composite relationships between material, space, context, and the individual. In its physicality, architecture involves more than the measurable object in virtue of its references that is intangible, unmeasurable, and ephemeral. Holm (2010) similarly stated that in architecture, what is being sought is the relations and the encounters that relations reveal, not the objects themselves. Therefore, any design 'structure' has unmeasurable components, and in order to make them measurable, there is a need for reasoning that hermeneutics and measurement science may guide. Since there is not an instrument that can be calibrated in order to measure a design structure, these instruments have to be constructed and developed specifically for each design process itself due to the context-dependency of each design process.

The thesis asserts that designing involves practical knowledge that acquires rules that are not universal in their application but somewhat change according to the particular context they are applied. This argument is based on the interpretation of the juridical understanding of Gadamer used to describe laws since laws do not remain unchanged in the changing situations but change in the act of their application. According to Gadamer (2009), a good judge does not directly take the pre-given laws and 'apply' them to all situations in the same way, but instead interprets them in the light of precedents, since each pertains to a unique case. Therefore, the judge holds the general laws to act in their light but applies it differently according to the situations since the understanding of the law involves its application and its modification according to the situations. A judge's interpretation can neither be understood as objective or subjective since there is a complementary relationship between the law and the way the judge understands it in its application. Therefore, the meaning of the law changes in its application with the judge's understanding since laws are general by definition and cannot include all possible complexities that can be found in each case. Any assessment about a correct judgment cannot be determined apart from its application to individual cases since the case itself partly determines what a correct judgment is. This is why Gadamer (2009) asserts that interpretation, understanding, and application

are not three divergent processes of the hermeneutical event, but they are interwoven. Thus, the proposed framework aimed to be considered a flexible base that can guide the evaluators in the design evaluation process and evaluate the design product. Therefore, the framework is not proposed to be directly used as it is, but since the application re-creates the needed conditions, the proposed framework can be thought of as a 'tool for thinking'. There is nothing untouchable in the proposed framework for the design evaluation; all is changeable and changing, renewable and even eliminable, since designing is a context-dependent activity, and context does not take its roots from an unambiguous set of rules. Gadamer (1973) similarly narrates that according to Aristotle, the notion of a single fixed method, a method that could be determined before the penetration of a thing, is a pretty dangerous abstraction since the object itself should determine the method in its peculiarity.

Moreover, Gadamer (2009) narrates Hegel's assertion that each method is linked to the object itself. As Snodgrass (1991) asserts, design methods that assert their application are universal have a misunderstanding of the nature of practical design knowledge. Therefore, each design process has unique qualities that are difficult to generalize since each design product is diverse and provides a wide range of occupancies and purposes, and by considering these, any attempt to create a single system to describe and grade building performance would not be fruitful. Hence, each design process and product should be understood in its own singularity and uniqueness. Design decisions and actions can be understood in the application since they involve interpreting myriad factors that constitute the total design environment. Depending on this, designers do not generally come up with design decisions that are deducted from general rules but instead by understanding the rules in the light of the peculiarities of the design situation. Hence, judgments that concern design actions cannot be described as concrete rules but instead can be prescribed as flexible rules that are based on the interaction between general design rules and the understanding of the characteristics of the particular situation. Since design activity does not fall in the scope of deductive logic as discussed in Section 2, deductive logic cannot codify it. Therefore, the proposed framework should be considered pragmatically and can and should be modified in its applications, since if the theory is taken in isolation, it cannot stipulate 'how' to apply the rules, considering it is a matter of judgment that does not

belong to the epistemic knowledge but instead belongs to a hermeneutical understanding where there are not any unchanging formulations.

Before starting the proposed framework for the design evaluation, there is a need to clarify the practical nature of the measurement and design process. The exact measurement can be considered helpful for some purposes and useless for some other purposes. Hence, objectivity is not considered a realm that is always desired since if it does not correspond to the reality aimed to be attained knowledge about, it is useless in that situation. This pragmatic approach emphasizes the operative use of sufficient objectivity and sufficient subjectivity. To provide reasonableness, even though objectivity and subjectivity are valid, they are not sufficient, and a more general condition must be identified. Hence, to reveal a design evaluation, there must be a clear picture about what is to be evaluated so as not to distract the context-dependency of the design evaluation.

5.1 Design Measurability and Evaluation

Evaluation and measurement are found almost in every design activity. Most of the concerns on what to do and what decisions to make in architectural activity involve measurement and evaluation in one kind or another. The design evaluation aims to determine to what extent total and partial solutions satisfy the requirements set in advance. Hence, evaluation is the determination of a value or establishment of the worth of something. As Voord and Wegen (2005) claim, the term ‘evaluation’ originally came from the financial world, where evaluation corresponds to calculating an exchange rate or determining the money value. In architecture, evaluation primarily concerns establishing the value of all or parts of the architectural entity (evaluation of product) or the construction and management process (evaluation of process).

Alexander (1964) considers the design process an error reduction or an error-correcting process with a Popperian approach that depends on falsification in his book Notes on the Synthesis of Form. On the other hand, the decision of what to reduce, what to falsify, or correct includes personal judgments. Therefore, Alexander (1964) claims that the set that includes the misfit variables cannot be objective, and further emphasizes the role of the weights of importance of the variables, since they are results of highly subjective decisions, whereas to decide whether including a variable or not is a less subjective decision since stress that misfit causes can be objectively

observable (Alexander, 1964). Another example of an approach to design evaluation is narrated by Lawson (2005), who states that one of the most notable cases of confusion between scales of measurement is constructed by Bruce Archer. Archer admitted that at least some part of design evaluation must be subjective, but he sets up an extremely organized system to measure satisfaction in the design. Archer promoted the use of ratio scales and argued that a scale from 1 to 100 could be used for a subjective evaluation, and the data taken from the scale can be treated as if they were on an accurate ratio scale, even though they are ordinal scales. Archer lays down several conditions to do this, firstly, evaluators should be chosen correctly, and judgment conditions should be controlled appropriately. By doing so, this kind of scaling could be considered to have an absolute zero and constant intervals like ratio scale (Lawson, 2005). In other words, what Archer offered is to act ordinal scales as if they were on ratio scales; thereby, a subjective result can be regarded as an objective result. This approach has some similarities with what had happened in the history of science when social sciences adopted the methods of natural sciences since it was accepted as the only way to gain objective knowledge. The same kind of effort is found in the proposal of Archer since he proposed to find a standard scale for design evaluation to be accepted as an objective evaluation.

On the other hand, as Lawson (2005) points out, in the design process, there are so many parameters that cannot be measured on the same scale; besides, reducing all the criteria to a standard scale is a common mistake in the design evaluation. What is more, quantity is not a single concept as well, such as qualities. Regularly, quantities are measured and represented by way of a numerical system, which assumes that all numbers act in the same way, which is not correct as seen in Stevens's scaling system, and the arbitrary use of scales may have catastrophic consequences.

In order to conclude with a framework to be used in design evaluation, firstly, a literature review has been visited. For example, The Working Party on Assessment Criteria for Design Disciplines and the Advisory Board for Technological Policy at the Delft University of Technology listed criteria for assessing if a design is scientifically sound and the criteria defined as (Voord & Wegen, 2005):

- Originality (the design must contain novelty)

- Utility (a feasible solution to a specific problem)

- Efficiency (ability to perform its function over a long period)

- The standard criteria applicable for any scientific endeavor: reliability, verifiability, and a systemic approach with a sufficient level of objective validity or substantiated subjective validity

- Applicability (can be implemented in a variety of different settings or contexts)

In recent years, the scope of evaluations in building performance evaluation or overall building performance evaluation has been expanded. Voord and Wegen (2005) categorized the factors into four categories, which is very much in line with the traditional three-way division of Vitruvius, which is one of the first proposed frameworks to be used to evaluate architectural design quality, that includes utilitas, venustas, and firmitas but by adding costs, legislation and regulation.

- functional

- aesthetic

- technical

- economic and legal

The multifaceted nature of design has been acknowledged since the late Antiquity when Vitruvius described the design in firmitas, utilitas, and venustas, translated by Sir Henry Wotton (1968) as commodity firmness and delight. Theorists of modern architecture continue to investigate and identify design characteristics and their interrelationships (Gann et al., 2003). According to current literature, architectural design quality in the built environment may be divided into three headings: build quality, functionality, and impact, which can be thought of as a modern interpretation of the Vitruvian principles (Harputlugil et al., 2014).

Another evaluation format can be exemplified by CABE (Commission for Architecture and the Built Environment). CABE listed the value drivers as functionality, impact, and building quality that each impacts design individually. Therefore, the intersection of two is considered the area of the ‘added value, and the intersection of three is the ideal area, that is, the ‘excellence,’ that can be seen in Figure 5.1, and regarded as the achievement of architectural design quality.

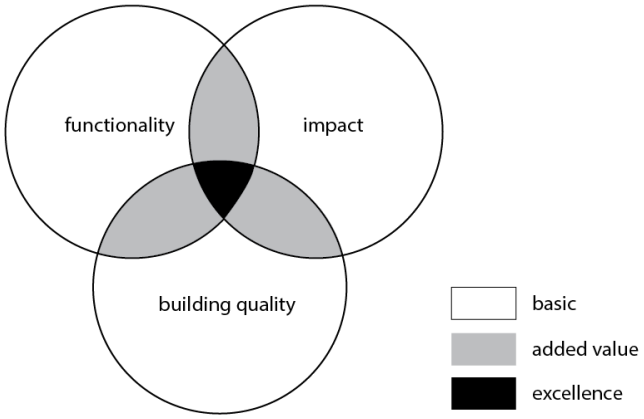

Figure 5.1 : Architectural Design Quality Value Drivers, adapted (CABE, 2004).

When examining all criteria to evaluate a design product, there is nothing found on how to apply these criteria, and as it is argued in Section 5., application of criteria is what characterizes the process of evaluation. Since each design problem is unique in virtue of its context-dependency, the framework for the design evaluation process has to be flexible enough in terms of the choice of the specific fitness criteria, in the examination of the ramifications of various sets of fitness criteria, and the selection of the more relevant aspects for each specific condition. Since ill-defined problems cannot be solved by traditional analyses, such as by reductionist methods, there is a need for a cross-disciplinary approach to deal with ill-defined concepts and benefit from their findings.

Matchett (1968) defines the optimum solution for a design activity as the sum of the actual needs of a particular set of circumstances. Lawson (2005), however, asks whether it is meaningful to talk about ‘optimum solutions’ or ‘true needs in terms of design. Matchett’s ‘optimum’ suggests that the design product can be measured against criteria of success. On the other hand, Lawson (2005) indicates that this may be a case for engineering design such as a machine, where the outputs can be quantified, but cannot be adopted to design situations. Dewulf and Van Meel (2004) state that scientific thought is not able to grasp the concept of design quality in order to make it operational. On the other hand, the thesis asserts that design results also can be quantified with a process of operationalizing, since in design evaluation, most of the criteria, such as sustainability, are not definite before one makes an operation in order to define it. Coyne (2005), depending on the perspective of Deleuze and Guattari,

asserts that operationalization includes expansion of discourse and opens a space for revealing what designers bring to the situation. Besides, as Rittel and Webber (1973) point out, there is no definitive formulation of a wicked problem.

Hence, the information needed to understand any problem grounds on the idea of one in order to consequently understand and solve a problem are inextricably linked; that is, the process of formulating the problem and bringing solutions are identical. Simon (1996) similarly points out that efforts to solve a problem must be guided by efforts to understand it. Besides, as Lawson (2004) emphasizes, design solutions have a somewhat mysterious and complicated relationship with design problems and noted that the way that goes from problem to solution is neither direct nor simple. Rittel and Webber (1973) assert another characteristic of wicked problems, that is they do not have any stopping rule, namely, when one solves a mathematical equation, the problem-solver knows when the deal to be finished, since there are explicit criteria that show when 'the' or 'a' solution has been found. On the other hand, in the case of wicked problems, solving a problem is identical to understanding the problem since there are no explicit criteria to check its correspondence. Besides, in wicked problems, additional effort may increase the chance to find 'better' solutions. The problem-solver of the wicked problem concludes with a solution, not for reasons inherent in the 'logic' of the problem, but when external considerations are regarded, such as when one runs out of time, money, or patience (Rittel & Webber, 1973). Thirdly, wicked problems are characterized by not being true or false but by being better or worse. Hence, it can be concluded that design is as much about identifying problems as solving them.

Many researchers have attempted to map out the process of design from beginning to end. All of these 'maps' of the design process are widely accepted to comprise a succession of diverse and recognizable actions that occur in a logically identifiable order. Since the thesis aims not to focus on how the design processes progress but rather to focus on the design evaluation through its measurability, Figure 5.2 shows the ongoing role of evaluation through the design process. It is argued that finding solutions and solving them is reciprocal, like in the hermeneutical circle. When one finds a specific problem, the solutions primarily affect one bit of a problem but influence a more general picture. Each design solution is usually a comprehensive answer to a series of problems, and it is hard to map a bit of solution to a bit of problem. Therefore, there is no optimal solution for the design problem but a wide range of

acceptable solutions, each of which provides more or less desirable solutions in a different way or under different circumstances. Making such design decisions requires judgments, which is why solutions are appraised and evaluated. Hence, one looks to general to understand the effects of the solution in the overall situation, and in return comes back with other problems and solutions. Therefore, as Lawson (2005) notes, design problems and solutions are inevitably interdependent since one cannot study solutions without reference to problems, and the reverse is equally fruitless. In any design process, the problem involves certain characteristics of the solution, and these solutions, in turn, will produce new and different problems because design problems are often multidimensional and highly interactive, and any part of a design solution principally serves more than one purpose.

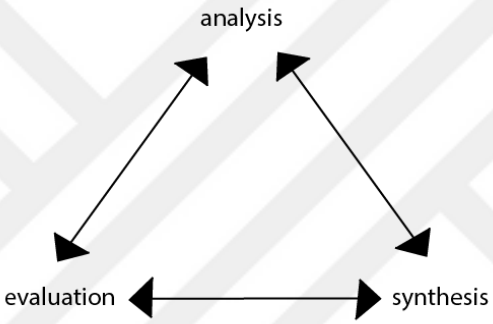

Figure 5.2 : Relation between analysis, synthesis, and evaluation

According to Jones (1962), who is one of the significant figures in the systematic design methods movement, the design process can be split into three main stages: analysis, synthesis, and evaluation. This conceptualization assumes that design is a linear process and synthesizes components obtained via theoretical analysis based on logic. Ayıran (2005) states that this conceptualization is still the focus of most design studios. Even though many explanations of the design process are based on an analysis-synthesis paradigm, it does not relate to the actual design process. As Schulz (1966) asserts, the design process cannot be viewed as synthesizing components obtained through logic-based theoretical study. This design process paradigm, which seeks to encompass design inside the usual science paradigm framework, disregards designers' primary concern with ‘how things ought to be’ and adopts the scientists' interest in ‘how things are’ (Ayıran, 2005). Darke (1979) supports this idea while stating that designers mostly start their design process by depending on a ‘primary

generator', without having studied a list that outlines all of the elements. Hence, the designer's interpretation of these external aspects is influenced by prior experiences and can be regarded as prejudicial. Accordingly, Darke (1979) concludes that the analysis-synthesis paradigm is no longer a viable strategy, and a value judgment is used as a trigger of the design process rather than rationality.

On the other hand, according to the assertions of hermeneutics, understanding evolves circularly, and never reaches a definitive end, since it always opens up new interpretations. It is also clear that the model that separates the design process into phases like analysis – synthesis and variants on that theme has missed this point. Sebastian (2003) asserts a similar approach by stating that design activity is not a linear-running process but an iterative process that progresses through analyzing through synthesizing. The essence of this description is that designing is an interpretive and hermeneutical event rather than a form of problem-solving activity that relies on analysis and synthesis.

In the design evaluation process, there are both directly measurable entities, such as site surveying, and not directly measured entities, such as the sustainability of a design product. Hence, there is a need for a process of operationalization to make measurable the unmeasurable properties. For example, to measure sustainability, firstly, a theoretical context should be defined, whether the aimed sustainability is in the context of economic, environmental, social, etc. Then, to measure the not directly measured entities, there is a need for some indicators. According to the Merriam-Webster dictionary, an indicator is a sign that shows the condition or existence of something. Hence, the indicators of sustainability should be decided, that is to say, by depending on what observable entities one can come up with the knowledge of the unobservable entity. Later, which attribute of the indicator should be considered needs to be decided. For example, if the waste generation of a design product is considered as the indicator of sustainability, what property of the waste will be examined, whether the mass of the waste will be examined, or the weight of the waste, or the production of the CO2 of the waste, etc. This is because the same attribute can be associated with different empirical relational structures according to what attributes it is focused on in the specific context. This process of defining what properties to be regarded is because most of the indicators of unobservable entities are cluster concepts. Later, there is a need to define an empirical relational structure into a numerical relational structure,

that is, the act of measuring itself, as shown in Figure 5.3. In order to do this, there is a need for a stage of representation to decide under what scale the act of measurement will be revealed. At the final stage, the procedures should be revealed to designate the measurement activity's accuracy and precision.

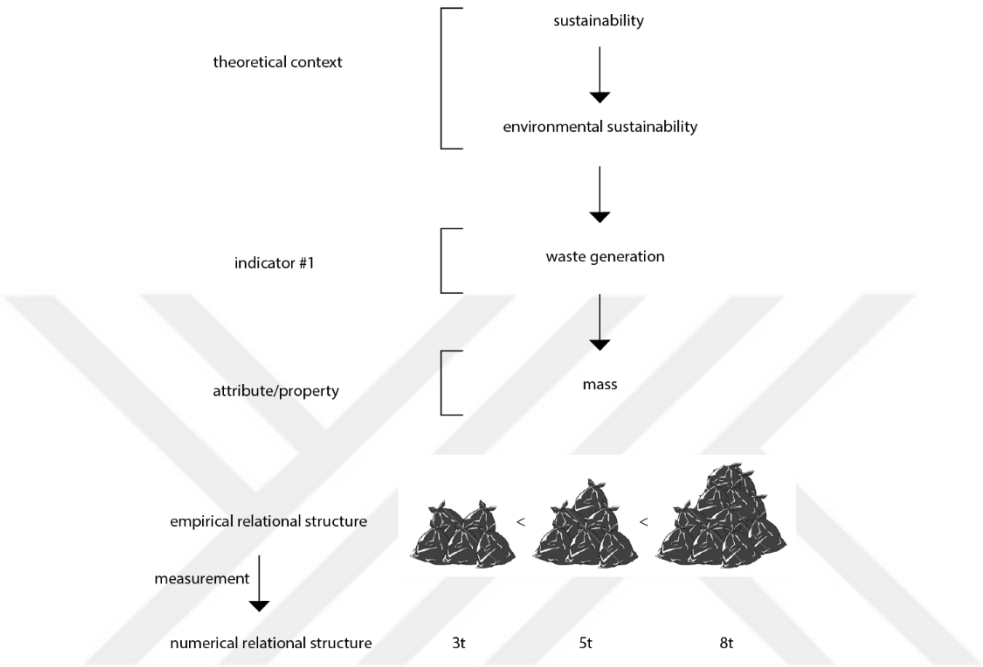

Figure 5.3 : Operationalization process of the attribute under measurement.

Gann et al. (2003) emphasize the difficulty of quantifying the quality of architectural design considering both tangible and intangible facts and the existence of objective and subjective components. Harputlugil et al. (2014) introduce the Analytic Hierarchy Process (AHP) to evaluate architectural design processes. Initially, The Analytic Hierarchy Process (AHP) is a multi-criteria decision-making (MCDM) approach that Saaty introduced. The approach aims to gather and categorize different perspectives to improve architectural design quality. However, Chen (1996) states that AHP includes some shortcomings, such as it is mainly utilized in non-fuzzy decision-making applications, and it both produces and manages with an imbalanced scale of judgments. The main problem of adapting AHP to the design evaluation process is, the ambiguity of mapping one's judgment to a number is not taken into consideration by AHP, even though the subjective judgments of the evaluators have a significant impact on the design evaluation. Besides, AHP does not include a strategy for validating judgments,

such as the thesis proposed in Section 3.1. On the other hand, some proposed approaches focus on the measurement of the value of architectural design. For example, Fowler (2005) recognized that a product must fulfill the need of users to be accepted as having a value and defined the relationship as (5.1):

$$value = worth \div cost$$

Later, Fowler realized the difficulty of objectively assess worth and developed an alternate equation with a more subjective component (5.2):

$$value = (user's\ initial\ impression + satisfaction\ in\ use) \div (first\ cost + follow\ on\ costs)$$

Alternatively, in construction, Dell'Isola (1997) reflected an equation for value, that is (5.3):

$$value = (function + quality) \div cost$$

On the other hand, Derek et al. (2003) define value as (5.4):

$$value = benefits\ (what\ one\ gets\ in) \div sacrifices\ (what\ one\ puts\ in)$$

Again, even though Fowler (2005) realized the problem of measuring the worth objectively and proposed an alternative, the problem still resides. The problem is the use of ratio scale, even though it is not suitable for measuring described concepts without making any operationalization, since an evaluation requires appropriate units of measurement to be accepted as measurement. Another issue is the desire to establish objective and universal quality standards. This may be achievable for fundamental features like lighting and air quality, but it becomes more complex when considering socio-psychological issues like privacy and territoriality. Many studies have confirmed that architects, other professionals, and the public have different views and preferences on quality (Brown & Gifford, 2001). Therefore, there is a need for a consistent language of the discussed terms and a framework to attain a fruitful interpretation discourse between individuals of the hermeneutical community, that is to say, between the individuals of the design team.

Even though existing quantitative or 'positivistic' studies have significant relevance for scientific practice, they fail to address the comparatively 'soft' and intangible components of quality, which have drawn much attention from academics and practitioners over the last decades (Dewulf & Van Meel, 2004). On the other hand,

another attempt is associated with the design quality evaluation, which is the Design Quality Indicator (DQI). The Design Quality Indicator (DQI), developed by the Construction Industry Council (CIC) in the UK, focuses on three quality fields; namely, functionality (how good the facility is to achieve its purpose), build quality (performance of the completed facility), and impact (the extent to which the facility creates a sense of place) for measuring the quality of design by using the feedbacks of all stakeholders involved in the production and use of the buildings. The tool is based on an approach that combines measurements of 'hard' physical properties with 'soft' perceptual perspectives on building performance with design decisions. In the DQI, the respondents are asked to assign the importance of each aspect in the range of 'strongly disagree' to 'strongly agree', the scaling known as the Likert Scale. As Dewulf and Van Meel (2004) state, contrary to previously mentioned approaches, the DQI acknowledges that quality is subjective since it recognizes design quality's multifaceted and complex nature by using only subjective measures. Differently from other approaches again, the DQI attempts to understand the intangible components of any design by asking questions such as 'Is this building inspirational for you?'. Even though such statements may seem vague and unscientific, at least the DQI sheds light on qualities that may otherwise go unnoticed by conventional approaches. On the other hand, the DQI has some drawbacks as well. Eley (2004) explains that using the DQI as the calculation of scores is based on the aggregation of a set of individual opinions obtained by the people involved in the questionnaire. This aggregation depends on either a negotiated agreement amongst individuals to establish a consensus 'opinion', or on taking an 'average' using the built-in algorithm in the computerized program. Gann et al. (2003) state that, even though the DQI was developed for targeting, mapping, measuring, and managing performance development in construction, it is not intended to assess the design process but instead focuses on the measurement of the quality of design embodied in the design product. Giddings et al. (2010) state that there are three limitations of DQI:

1) Do not provide knowledge for the enhancement of design process,

2) there is a lack of recognition of hierarchy considering the quality evaluation,

3) its weighting system for evaluation is based on Likert Scaling, which barely relates to design quality.

Dewulf and Van Meel (2004) adds one more limitation to the previously mentioned ones, that is:

Everything is based on subjective measurement. For example, users are requested to rate a building's 'feel' or 'inspirational' qualities and its lighting, air quality, and wheelchair accessibility. However, it is debatable whether these topics should be decided based on views rather than facts.

Cardellino et al. (2009) similarly define the DQI as an architecturally biased tool since it undervalues the measurement of intangible components of design and warns that the tool has the potential to become a 'tick the box' exercise. Although the DQI is one of the pioneers of the current tools for design quality evaluation, it has some limitations, as stated above. Hence, no quality evaluation tool in the current literature is widely accepted. From a general point of view, the models used for decision-making in architecture are primarily used to select building products, construction systems, and technologies with the evaluation of measurable factors such as statics, mechanics, topography, etc. On the other hand, they cannot be used in the evaluation of intangible elements such as space, environment, character, aesthetic dimension (Palabıyık & Çolakoğlu, 2012). Gann et al. (2003) similarly point out that measuring the quality of design includes some major conceptual and practical problems, such as some features of the built environment have physical parameters. For example, the level of light in a room can be measured in lux.

On the other hand, some parameters are more perceptual and subjective, like the feeling of warmth emanating from a heat source. The thesis asserts that this problem originates from the lack of a framework that emphasizes the qualitative aspects of a design process and product as well as the quantitative aspects. For this reason, it is of great importance that the developed framework is effective in evaluating qualitative data and quantitative data to guide the decision-making process. As mentioned before, the proposed flexible framework should be regarded as a guide to be acted in its light, but its application depends on the context and should be evaluated critically within the hermeneutical process. The main objective of the thesis is to provide a possible evaluation approach for architectural design to improve the design process. As Gann and Whyte (2003) assert, much of the current performance improvement agenda has been focused on measuring and providing higher quality processes. Measuring and evaluating the design quality has become a significant challenge for designers,

construction professionals, and clients, and hence reveals the need for the aim of the thesis. In order to overcome the deficiencies mentioned earlier and be able to reflect the actual way of human thinking, measurement science and hermeneutics are combined to provide realistic and consistent results.

5.2 Characteristics of the Proposed Framework

The proposed framework can be thought of as a link between the theoretical and empirical worlds and proposed to be used as a guide for clarification of the design evaluation process, which does not assert that being 'the one and absolute method to use in design evaluation without considering the context, but rather, it aims to clarify some characteristics of the nature of the design evaluation, that are, its singularity and uniqueness. In other words, each design evaluation process should be understood in itself and should not be presented to the measures of an external rule set which is possibly extrinsic to its own access. Thus, it cannot be said for design evaluation that any external, general, and abstract rule set that asserts which criteria are acceptable and which are not can ever exist to evaluate a design since there are no 'acceptability' criteria 'in themselves', that exists independently from what that specific situation of the design evaluation requires. Snodgrass (1991) explains the conventional assumption that theory precedes practice as the first one knows the general laws that govern object behavior and then uses those principles to manipulate and control them. This assumption is based on the idea that laws have universal validity in the same way in every situation. This accords with the orthodox epistemological tradition, which, from Plato through Descartes to logical positivism, insists that authentic and valid knowledge may only be obtained by understanding the hard-and-fast rules or principles. Knowledge can only be of the unchanging rules, not of what changes. According to Dilthey (1999), no scientific process basically regulates or prioritizes the internal state of life and experience; since science cannot prioritize living, it is itself the product of life. With the same approach, an external rule-set to be adopted to any design evaluation cannot prioritize the evaluation process since it is a product of a judgment that includes other circumstances and excludes the context-dependent nature of any design. What may be critical about the use of the same rule-set on not homomorphic structures is that when general explanations are made through homomorphism; singular processes, their specificities, and distinctions between them

are ignored, or at best condition, these specificities and distinctions are accepted only as insignificant and straightforward appearances and projections of homomorphism and reject the uniqueness of each design evaluation process.

The proposed framework is intended to be utilized in all stages of the design process, starting from pre-design to final design. It is well acknowledged that the consequences of early design decisions play a significant role in assuring the quality of the final product. However, most information required for design assessment is gathered later in the design process (Harputlugil et al., 2014). Finding ways to test and assess the design to manage its quality from the start is a difficult task in this circumstance. Volker (2010) states that tools established to collect data on architectural design quality are mainly utilized for post-occupancy evaluation (POE), and their contribution to the design process is limited.

On the other hand, the data obtained from POE can only be helpful for future designs. Hence, POE does not assist in the current design, except in the case of renovation. When the subject matter is architectural design quality, researchers mainly deal with the post-occupancy evaluation, while it is mainly limited to design confirmation. Besides, comprehensive research on quantifying design quality cannot be found before the design process begins (Harputlugil & Gültekin, 2009). Scriven (1991) defines evaluation as "the process of determining the merit, worth, and value of things". Even though various types of evaluation methods can be applied to quantifying the results after the process is finalized, the proposed framework is to be used during the design process as well; hence, the feedback in return can modify the design process. Besides, Harputlugil et al. (2011) assert that there is no standard definition of quality, and the means to be used to evaluate design quality should be based on a flexible and adaptive system for the selection of criteria. In the scope of the thesis, evaluation is not solely focused on the end product but also accepted as a 'tool for thinking'.

The design quality is difficult to assess since it includes both objective and subjective elements. The essential subject of defining the main criteria for architectural design quality dates back to ancient times. Every architect since Vitruvius has had varied opinions on what the requirements should be. Criteria and their sub-criteria have been defined differently throughout the history of architecture, depending on the era, technology, culture, and society (Harputlugil & Gültekin, 2009). To deal with the complexity of the design process, a common language within the hermeneutical

community is of great importance. Derek et al. (2003) define project values as the guiding principle of negotiation and sharing followed by all stakeholders and define objectives as precise goals representing the project values. Hence, the evaluators within the hermeneutical community are the design team that shares common project values. Therefore, it aims to clarify the evaluators' unambiguous ideas and translate them into design knowledge on the quality of architectural design quality to be evaluated numerically. Even though Saaty (2008) asserts that intangible criteria cannot be evaluated numerically, by performing an operationalization process, and by depending on the previously mentioned assertion in Section 5.1., that reveals that quantity, like quality, is not a single concept, the thesis asserts that by using different scales such as the ones offered by Stevens (1946), intangible criteria can be evaluated numerically. According to Nelson (2006), quality is the extent to which a collection of intrinsic qualities meets expressed, inferred, or mandatory demands or expectations. Nelson (2006) continues that, quality in the realm of architecture is defined as the degree to which design meets needs and expectations. Besides, the measurement of intangible components can be accepted as invitations to dialogue. Instead of avoiding intangible components that every design comprises, the hermeneutical community needs to work on the extension of the dialogue, which can uncover formerly unseen information.

Before detailing the framework to be used in the design evaluation, it is fruitful to clarify the thesis's grounded acceptances and show how the proposed framework corresponds to them.

- Use of different scales and weights of importance: Often, multiple criteria with different measurement units are effective in the success of the design product. Therefore, the use of different scales -such as the ones proposed by Stevens (1946)- in evaluation and decision-making provides a reliable ground to ensure that the value judgments obtained as a result of the evaluation are sound. Besides, determining the weights of importance of the criteria is of great importance since not all criteria have the same importance in the success of the design process and product. On the other hand, quantities are not inherent properties of the physical objects but can be assigned according to the practical purpose. Hence, it is necessary to distinguish different concepts labeled as ‘quantity’, and the different properties of numbers should be

recognized. Similarly, there are no ‘perceived connections’ between items before measurement, and the assessment findings can only be confirmed a posteriori.

- Importance of in-process evaluation: In-process evaluations are as crucial as POE for the design process since early decisions made throughout the design process play a significant impact on the final product's quality. As seen; in the hermeneutical circle, parts and whole are always in a reciprocal relationship, and the sole use of POE neglects the dialogical character of the design evaluation and prevents the use of new recognitions within the design process. Hence, the proposed framework is to be used for all stages of the design processes, starting from the pre-design to the final design.

- Transcendence of object-subject dichotomy: Most of the time, to reach a kind of objectivity since it is mainly equated to the source of accurate and valid knowledge, the knowledge that does not fulfill the commonly accepted objectivity criteria is neglected. This negligence limits the area of knowledge and can be accepted as one of the most crucial obstacles in enhancement. Hence, the traditional object-subject dichotomy should be abandoned so as not to limit the area of knowledge.

- The complexity and the context-dependency of design: Value is not an inherent characteristic of any design product but is constructed by the evaluators. In other words, value is in the eye of the beholder. Hence, the role of the evaluator should not be the exposure of the value, but to assign a value by considering the context and by grounding it through validation. Therefore, any architectural evaluation, like interpretation, cannot be considered according to its truth or falsity since architectural values cannot be judged as scientifically correct or incorrect. There is no actual evidence to back up such claims. On the other hand, well-founded and reasonable judgments about what is suitable for some (designers, clients, end-users) in a specific situation are undoubtedly achievable. Therefore, there is a need for an adaptable approach instead of a proposal of universal definitions and criteria. Criteria should be reviewed on a project-specific level that grounds the evaluators' judgments in the hermeneutical community. Besides, there is a need for a comprehensive approach by transforming any uncertainties into a format that can be evaluated within the same language. Design activity involves intuitive, measurable, unmeasurable, ambiguous, concrete, tangible, intangible, observed, unobserved, direct, indirect, etc. Due to the complexity of quantifying design quality, the framework aims to quantify needed aspects with less loss of information during the quantification process. A common

language and criteria to be evaluated must be agreed upon among the design team or the hermeneutical community.

- A multi-evaluator framework: To provide a ‘tool for thinking’, rather than an absolute measure to foster the use of learned knowledge from current design for strategic future use is of great importance. Hence, the framework aims to supplement existing examination mechanisms, provide feedback, and gather diverse perceptions of design's worth within the hermeneutical community. The multiplicity of the interpretations of evaluators should not be seen as there are some misunderstandings since the multiplicity allows the evaluators to compare and contrast different interpretations and may conclude with new interpretations that include unseen parts as well. Besides, any assessment about a correct judgment cannot be determined apart from its application to individual cases since the case itself partly determines what a correct judgment is.

5.3 Proposed Framework for the Design Evaluation

According to Cartwright et al. (2016), measurement is not merely assigning values or numbers but instead assigning them in a systematic and grounded manner that necessitates applying some well-grounded metric and then making expressions following the defined metric. Therefore, Cartwright et al. (2016) categorize three conditions that any measurement process should involve:

- Characterization (identification of the boundaries of the identity)
- Representation (construction of the metrical system that represents the category)
- Procedures (construction of the rules to apply to produce measurement result)

Mari (1977), on the other hand, states other conditions in order to accept an evaluation as a measurement. The first requirement is, the measuring standard to be used must be well-defined and should be independent of any particular measurer. The second requirement is that the procedure for comparing the object to be measured with the standard (directly or indirectly) should be fully specified and performed independently of any specific measurer. Hence, while the first requirement is about being understood by each evaluator in the same way, the second is about being applied by each evaluator in the same way. On the contrary, Mari (1977) also recognizes that the subjectivity of the measurer is inescapable in evaluating the quality of measurement findings, as a

result, in deciding which result should be regarded as significant. As discussed earlier in detail, the thesis supports that neither is possible due to the understanding of hermeneutics that acknowledges the role of pre-understandings in every act of understanding and interpretation.

According to Ellis (1966), in all formal systems, the application must be made to let the system tell anything about the world. Hence, although these steps are characterized as divergent steps to analyze any measurement process, each stage affects the other. For example, after taking the representation results, one may return to the first step to re-characterize it, or after the procedures are considered, the representation may be needed to revisit. The proposed approach is chosen to gain a comprehensive and rational framework to structure a decision problem, represent it, and quantify its tangible and intangible elements to clarify the design evaluation. The proposed base for design evaluation comprises Cartwright, Bradburn, and Fuller (2016) as sub-stages, but with an extension with other stages to be adapted to the design evaluation. The proposed framework thus comprises the stages as follows:

- Definitions: what to consider?
- Quantification: how to measure?
- Re-thinking definitions: how to interpret?

In the process of definitions, criteria to evaluate the design and organization of the criteria should be decided, and the indicators of each criterion should be characterized. Hence, this process is about ‘what to consider?’. Later, in the quantification process, the weights of importance of each criterion and the weights of importance of each indicator to define the criterion are decided, and the decision of which scale these indicators are represented should be made. Therefore, the quantification process is about ‘how to measure?’. Then, in the process of re-thinking definitions, the indicators' accuracy and precision are re-examined to see if they correspond to the criteria. Then, by deciding the thresholds, the quantification results are interpreted within the hermeneutical community by way of the process in Figure 3.1. Hence, the last step considers the question ‘how to interpret?’.

5.3.1 Definitions

In the design process, the definitions at the start are often open-ended characterizations that are context-sensitive, which constitutes what Finkelstein called ‘weakly defined

measurement', or simply, soft measurement. According to Finkelstein (2003), "strongly defined measurement is based on the mapping of an empirical relational system into a well-defined theory in mathematical language" which can be interpreted as it corresponds to the representational measurement theory (p. 44). Finkelstein (2003) further states that weakly defined measurements have characteristics such as they are based on ill-defined concepts of quality, and there are uncertainties in the empirical relational systems that they represent. The relational system, which is symbolic, has limited relations defined on it. Hence, the definitions' importance is that sometimes the theoretical context and the measurement performed may not be matched since, in the design evaluation, the categories are based on loosely interconnected characteristics. The concept of sensitive dependence on initial conditions means that a slight change in a system that uses its outputs as inputs can dramatically change the course of the system. The design process is that kind of process since the problem's definition can be continuously updated with the emerging inputs in other stages of the design process. Therefore, the process of definitions to evaluate any design product is crucial since the measurement procedures should measure what it aims to measure. Measurement is a purposeful process; hence the first phase should be to describe the property intended to be measured, potentially together with additional information on the existing resources and limitations to be considered. This necessitates the object being measured as well as the type of the property being measured. Typically, the object being measured is modeled as an object in a certain state. Another importance of the definition process is, it provides the ability to cope with the current 'evolving needs', since new challenges require new definitions. A crucial point to be emphasized is that the aim of definitions is not to produce absolute knowledge but to make operational definitions according to the purpose of the measurement. Monod (2012) similarly states that specific schemes, whatever they may be, make sense to the extent that they are part of a more general scheme. Hence, the process of definitions should be thought of with its relation to the quantification processes, and the reciprocal relationship between all these steps should continuously be considered. Therefore, the more explicit the definitions, the more probable the concept is to be designated in terms of its measuring procedures, and it is crucial for measurement procedures to measure the concepts it is aimed to be measured, so the criticality of definition cannot be overemphasized (Cartwright et al., 2016).

Architectural design can be thought of as a collaborative effort involving various members of the design team. Depending on their perspectives and roles, each member may have their criteria and weightings. As a result, design may be thought of as a multi-criteria decision-making process (MCDM) (Harputlugil et al., 2011). Besides, each design has its priorities. For example, while social sustainability may be a priority for a design project of an atelier, it may not be a criterion for a design of a factory. Thus, when the criteria are determined, there should also be an investigation of the weights of importance of the criteria. Hence, the first step should be the decision-making of criteria to be evaluated later on. The importance of this stage to be done at the beginning of any design process can be exemplified with the term 'falsification' of Popper. According to Popper, as Lakatos (2014) narrates, intellectual honesty consists in stating precisely the circumstances under which one should stop defending a claim, rather than trying to secure or impose a claim by proving (or showing that it is probable). Hence, asserting the criteria to be later evaluated clarifies the priorities of the design and provides consistency in the evaluation process. Besides, the previously defined criteria can be used as a guide with which the process works in relation to the design process. For example, suppose one aims to measure the flexibility of an architectural entity. In that case, one may define flexibility as 'the extent to which the entity allows changes without a need for breaking its walls', and thus the next step would be to establish the parameters or indicators relevant to this definition of 'flexibility'. In this way, flexibility may become measurable with a precise characterization of it as much as possible by considering the practical purpose and revealing which indicators serve the defined concept to measure it. As another example, there is no single metric for architectural sustainability. Hence, to measure sustainability, first, the indicators of sustainability should be decided within the context of the project. The use of sustainability indicators can be different according to the context of each project. Because each design problem is unique, the design assessment process's framework must be adaptable in selecting specific indicators. Since there are several issues to be considered when describing the sustainability of a design, the selection of the set of indicators should reflect the concerns of the overall evaluation goal since the indicators have a direct relationship with the overall evaluation goal. Figure. 5.4 aims to reveal a more straightforward definition of the process of operationalization.

description	characterization	indicators
sustainability	economic sustainability	maintenance costs...
	social sustainability	access to services, correspondance to user needs...
	environmental sustainability	use of renewrable and non-renewable resources, waste generation...
	...	
safety	structural stability	resistance loadings, wheather, earthquakes...
	fire safety	means of escape, resistance to fire loadings, topography...
	...	
comfort	acoustic comfort	sound pressure level, audibility, isolation...
	thermal comfort	humidity, vapour pressure, air velocity...
	visual comfort	illumination level, daylight factor, visibility...
	...	

Figure 5.4 : Process of operationalization through description, characterization, and indicators.

Hence, fuzzy-like or ill-defined concepts need a more precise operational definition with peculiar characteristics to be considered a concept to be measured. These kinds of concepts do not require objective verification for their validity. On the other hand, in mathematics, even though the validity does not come from any objective verification, it comes from a theoretical deductive system, whereas in an ill-defined term, such as flexibility, it does not. Since they are unique concepts, and their meaning changes according to their use, a pragmatic and operational characterization is needed to progress the measurement. Definitions include a range of formulations to eliminate and reduce ambiguities about the concept. Most concepts in the design evaluation are loosely defined at the start, that is to say, ill-defined.

Moreover, the definitions of the concepts are primarily dependent on their use. Therefore, the choice of criteria should be assessed depending on the purpose of the evaluation. Hence, when the criteria are clearly assessed, there is a need for a decision on how to evaluate these criteria if they correspond to the aimed result or not, and this process will be addressed with measurement. Therefore, one of the designer's tasks is to translate vaguely descriptive terms into a more precise design classification system. To the designer, statements such as ‘X building has a high quality’ or ‘Y building is sustainable’ present problems in definition, since what is meant by ‘high-quality building’ or ‘sustainable building’ is unclear and may correspond to different means for every evaluator. Thus, the necessity for such a precise definition becomes explicit in the hermeneutical community, that is to say, in the design team. When disagreements appear on how to classify the concerned design process or product, the design team may have difficulties specifying the parameters of the bases of their characterization. To reach an agreement, the design team is forced to tighten the loose characterizations and determine more precise definitions of what is meant. According to Suchman (1950), one of the fundamental challenges and the difficulty of scale creation is shifting from a loose characterization to a more rigorous one. Lundberg (1942) states that there are two leading parts of scale construction. First is about how to choose the aspects of a property which is assumed significant and thus to be regarded in the scale, and secondly, how to establish the relative weights of importance to each aspect included. These two considerations occupy central positions in scale construction. Suchman (1950) thus distinguishes between terms of itemized and non-

itemized. In the non-itemized rating, building X can be attempted to settle on an agreement by asking a group of people to describe building X as sustainable or not. This kind of classification is called non-itemized. The second approach attempts to settle the agreement by clarifying what is meant by 'sustainability'. Hence, there is a need for signifying specific characteristics of the building to reveal the presence or absence of 'sustainability'. The categorization of 'sustainable' should be extended with the addition of assertions such as 'Building X generates x unit of grey water' or 'Building X has x unit of negative impact on the environment. The more specific definitions are added, the more precise the meaning appears since the second assertion causes more problems such as 'what is meant by a negative impact on the environment?'. Hence, by defining the criteria more concretely, the 'sustainable' building can be distinguished from the 'unsustainable' ones. This kind of classification is called 'itemized classification'. The use of itemized classification brings a solution to the problem of a meaningful definition for the variable. This process of itemized classification is called definitions. The process of definitions grounds the basis for a rigorous system of measurement. Thus, structuring item characterization into coherent systems allows for the shift from a loose to a more accurate categorization (Suchman, 1950). The definitions should be performed by considering the practical purpose of the design at a project-specific level to be called operationalization. As Simon (1996) asks, how can one evaluate a design without well-defined criteria to compare it against, and how can the design process itself advance without such criteria to guide it?

According to Snodgrass (1966), a list of criteria may include technical factors, such as thermal performance, or aesthetic factors, such as visual unity. However, this list should also include a statement about how to measure or weigh these criteria, and it is also necessary to give unambiguous instructions on what constitutes an adequate level of performance or an adequate level of aesthetic acceptance. For instance, if one aims to measure flexibility, due to the concept 'flexibility' short description, it cannot be measured with a calibrated instrument to measure 'flexibility' such as one measures 'length'. These vague and intangible concepts should be more concrete by translating them into indicators that represent the concept to measure it. Hence, to attain information about them, the operationalization process should be performed by way of pragmatic measurement since design problems cannot be defined according to explicit rules or procedures to determine the 'correct' explanation of the problem due

to their ill-defined characteristics. There is a need for clarification; as Moles (2018) asserts, the goal should not be to transform the imprecise realms in precise forms since it is not their characteristics. Hence, trying to make definitions with excessive force means putting them in a series of contradictions and irrationalities. The aim of operationalizing is to utilize these concepts to arrive at a partial insight. After this demarcation is revealed, the measurement of fuzzy-like or ill-defined concepts can be accepted as more critical to solving its uncertainty, precision, and accuracy problems. The problem of nomic measurement emerges in this design evaluation stage since the non-directly observable features should also be included in the criteria. A function to connect directly observable and non-directly observable features should be developed for the specific purpose.

Similar to Wittgenstein's family resemblance, Gasking (1960) introduces the concept of 'clusters' that many characteristics can identify. For instance, while considering a concept of an individual, Le Corbusier. Most of the statements that can be given about Le Corbusier can be regarded as empirical; that he was born in Switzerland, he is mainly known for his contributions to the modernist movement, he died at the age of 77, and even that he is called 'Le Corbusier'. All of these statements are rectifiable. Any statement or any combination of these statements has a role in identifying Le Corbusier, who is the individual referred to, while none of the statements (or combination of statements) can be accepted as the definition of Le Corbusier. Therefore, the concept of an individual can be considered as a cluster concept. An example of a cluster concept is given through thermal comfort in Figure 5.5. This example recalls the assertion of Simon (1996) when he states that what determines the complexity or simplicity of a structure depends on how one describes it. Suchman (1950) similarly states that the number of indicators to characterize an attribute is unlimited, and there are no inherent reasons why any of these indicators are better than any other. This situation can be summarized simply as what is being measured is not the object under measurement but an 'attribute' or 'property' of the object. Therefore, an object can have many properties belonging to it, but the measurement result only shows what property is measured since the measurement is an operation that aims to acquire information on what is measured in accordance with an attribute. For example, 'sustainability' can be defined in various ways, and there are countless classificatory indicators to be used to differentiate 'sustainable' buildings from 'unsustainable'

buildings. Since an infinite number of indicators may be used to define a particular concept, any finite number of indicators to be used must be a selection from the infinite universe (Suchman, 1950). The question of whether an indication belongs to a certain universe or not is one that the hermeneutical community should negotiate and resolve by consensus, that is to say, design team, by considering the tacit understandings and pre-understandings, and within the interpretative process that is discussed in Section 3.1.

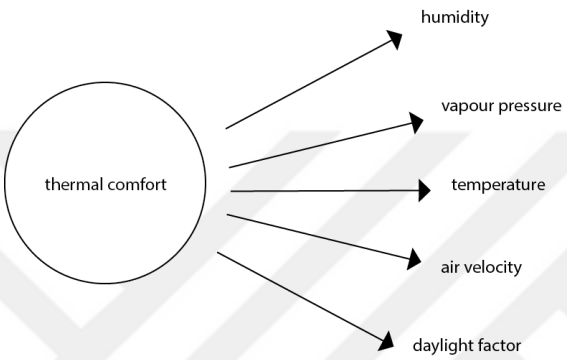

Figure 5.5 : Operationalization of thermal comfort by a set of formative indicators.

Hence, at the end of the process of definitions, the hermeneutical community is to be decided following outputs, that will be the inputs of the process of quantification:

- Looking at which criteria the design will be evaluated?
- What are the indicators of the criteria? In other words, by looking at which attributes of the criteria the measurement will be performed?

5.3.2 Quantification

It is acknowledged that there are numerous aspects to consider in the design problem, some of them are quantifiable, and others are 'subjective'. However, through research, non-quantifiable variables can eventually be transformed into quantifiable ones (Darke, 1979). Any measurement is constantly exposed to some degree of uncertainty, and for a correct understanding of the different types of uncertainty, definitions are crucial. As stated, the main goal of the process of definitions is to clarify what attributes of the criteria to be measured. Guttman (1944) defines quantitative values as numerical and qualitative values as non-numerical ones. In order to evaluate, that is to

say, measure a design, one needs to attain numerical values from non-numerical values by using a kind of quantification process through operationalizing. To accept a measurement result as meaningful, there is a need for retaining them connected to the theoretical and instrumental framework from whence they came. Since the measurement theory concerns the link between the measurement results and reality, the objective is to ensure that conclusions regarding measurement results accurately reflect the underlying reality. In the intangible aspects of an architectural product, the connection between concepts aimed to be measured and measurement results are often lost during operationalization. Besides, scientific representation of architectural realms extends the use of mathematical models to capture the relationship between architectural components since all components are not tangible, and hence there is a need for pragmatic measurement. Therefore, the fuzzy-like or ill-defined concepts and those that are well-defined and have explicit meanings cannot be considered under the same scale and cannot be exposed to the exact measurement procedure.

After the exposition of the indicators for each criterion in the process of definitions, there is a need for a scale to express the measurement results, or as Markus (2003) states, to evaluate something or evaluate its quality, it must be represented. Amarel (1966) similarly states that problem-solving is the formation of an appropriate problem representation; that is to say, solving a problem means representing it to make the solution area visible. A metric system with an underlying numerical structure is commonly used to represent well-defined and quantitative notions. Lawson (2005) states that quantities and qualities are not as different as it is thought since quantity is not a single concept as well. Usually, quantities are measured and expressed using a numerical system that creates a perception that there is only one way to use a numerical system.

On the other hand, it is commonly employed in several distinct ways, and numerical systems vary in the degree of application of the rules. Scales proposed by Stevens can be used as an example. Stevens (1946) introduced four kinds of representations: nominal, ordinal, interval, and ratio, as seen in Section 4.2.1. In the first step of evaluation, that is, definitions, the criteria to evaluate the design, and the indicators of the criteria are characterized, and in the stage of quantification, they are positioned under a scaling system, that is, the scaling system of Stevens. Even though the ratio scale may seem to belong to representational measurement and interval, ordinal and

nominal scales may seem to belong to pragmatic measurement, they can be combined context-dependently. The holistic and integrated nature of design indicates that in most cases, a single design function solves many parts of the problem at the same time, therefore in the evaluation process, the criteria evaluate not a single part of the solution, but since a solution corresponds to more than a single problem, criteria should be considered with the same approach as well. Therefore, different measurement procedures of the same criterion should be considered pragmatically. A proposal for representation of the evaluation process Cartwright et al. (2016) argue that even though the distinction between well-defined and ill-defined concepts may not be sharp, it is favorable to keep in mind the distinction while thinking about representation. For example, an interval or ratio scale would not be appropriate in a specific context for an ill-defined criterion. In the ordinal scale, as discussed in Section 4.2.1, there are not equal intervals between objects that are represented. Lawson noted that ordinal scales are mainly used when the evaluation depends on many factors or is not easily definable. They contribute with adequate information about the order of choices, like in a customer satisfaction survey when the distance between variables cannot be calculated and the intervals cannot be described (Lawson, 2005).

What is done in the stage of quantification can be likened to the transformation from data to information and knowledge, since before putting into the context, that is the scale system, the definitions alone can be considered as data that does not include any inherent meaning, that is to say, without context. Hence, the quantification process can be thought of as the representation process by putting the characterized properties into a scaling system. Sydenham (2003) defines data as raw symbols obtained from a measurement system, which do not have any assignment to be accepted as a significant component. Hence, data are just symbols, letters, icons, such as ‘5’ or ‘+’. They do not inherently have any meaning unless there is any assigned ‘code’.

On the other hand, information is that of data associated with a tag that provides some cognitive material to give meaning to data in a more specific way, or as Shannon’s theory of information defines, structured version of data, which gives the possibility to take it as knowledge. The designation of a tag provides cognitive meaning; for example, a distance unit of ‘m' offers valuable information from the data, as does a numerical symbol of ‘5.' Finally, knowledge is information that has been contextualized for a certain purpose. As Lawson (2005) noted, in the design process,

there are so many variables that cannot be measured on the same scale, and reducing all the criteria to a common scale is a common mistake in the design evaluation. In sum, measurands are generally assessed concerning a reference; therefore, the statement of the measurement must include a clear indication of what is being used as a reference. For example, if the symbol '9' is chosen, it considers different meanings relative to different references, whether it corresponds to meters or Kelvin degrees. Thus, the reference of the measurement establishes the meaning. Measurement references can be formalized as measurement scales. The most commonly known scale types are ratio, interval, ordinal, and nominal scales of Stevens' (1949). Any act of measuring necessitates a pre-defined measurement scale since the value of the measurand are grounded on their scale types, and the information can only get acquired by depending on this predefined scale (Mari, 1999). Hence, it can be concluded that there is a necessary classification of knowledge to meet the need of the design evaluation process since without being aware of how to use the knowledge, it cannot be considered as an evaluation activity. Each measurement and evaluation process is designed for a purpose. Hence, human cognition interprets data to convert it to knowledge by putting the characterized properties into a scale system. Fleck (1997) asserts that interpretation is always required to get meaning from data; therefore, knowledge is information that human experts give significance.

On the other hand, the design team needs to decide how much weight to assign to each indicator characterizing the concept since rank order cannot be determined without assigning weights of importance to each indicator. Besides, to put the cluster as mentioned earlier concepts into context, in the design evaluation process, some criteria are empirical, such as site surveying has its own measurement techniques or the usage of a specific material that has a certain kind of gravity that it is brown, that it is permeable, that it is durable to extreme heat conditions and so forth. However, none of these characteristics can be accepted as the overall definers of the specific material. Nevertheless, some of these characteristics have more weight of importance than others under the specific conditions, since in most cases, the evaluator does not perceive all factors as equally significant; consequently, certain ones weigh more heavily than others. Therefore, there is a need for a scaling system to designate the weights of importance within criteria as well. Since not all scales are designed to measure quantities, there is a need for stating necessary and sufficient conditions to

clarify that there is a scale of measurement and, secondly, there is a need for criteria to identify scales. To decide weights of importance of indicators, the process is judgmental, and therefore discussable and cannot be discarded as 'I prefer indicator A should have more weight than indicator B to define property T', but instead 'I prefer indicator A should have more weight of importance than indicator B in terms of X, Y and Z in order to define property T.' and 'X, Y and Z' have judgmental characteristics that will be discussed and defined within the hermeneutical community. In this sense, the word judgmental refers to how Kuhn uses it instead of 'depending on taste', so in the way of 'by being judgmental' as discussed in Section 3.2.

While combining different scales, according to Lawson (2005), only numbers on a ratio scale can be integrated meaningfully with other numbers on the same scale, whereas one cannot add together numbers from different ordinal scales. On the other hand, there are so many parameters in design evaluation that cannot be measured on the same scale. Therefore, value judgment seems inevitable and necessitates the interpretative activity of the evaluators within the hermeneutical community, which is discussed in Section 3. For example, when Figure 5.6 is investigated, an overall evaluation of thermal comfort can be obtained as the sum of the scores. Guttman (1944) defines a score as a value of a scale variable. What is crucial at this point is, by saying 'sum of the scores', it is not meant the addition of numbers, but it is indicated to accept the scales as inputs for the interpretative activity of the hermeneutical community. Besides, according to Achinstein (1965), to designate something like a model of (an) x is to indicate it as a way of representing x, which gives at least some approximation of what is modeled.

Additionally, it is also a suggestion that alternative representations can be helpful for different purposes. Therefore, a model can be valued by considering how well it serves its purposes. For example, in design evaluation, how well the indicators describe the criteria for establishing and the completeness and accuracy of the representation between indicators and criteria is crucial. Therefore, after the process of definitions, in the stage of representation, the property to be measured should be located on a scale according to a purpose-dependent way, as seen in Figure 5.6.

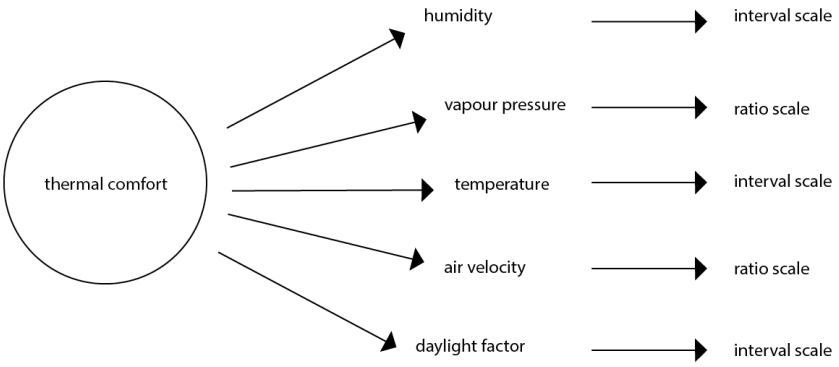

Figure 5.6 : Placing the indicators into scales

Hence, at the end of the process of quantification, the hermeneutical community is to be decided following outputs, that will be the inputs of the process of re-thinking definitions:

- What are the weights of importance of each criterion in order to evaluate the design?

- What are the weights of importance of each indicator to define the criterion in the most pragmatic way?

- On what scale should each indicator be represented?

5.3.3 Re-thinking definitions

The design team frequently does not entirely know the goal until they have attained it in the design process. Besides, to remember the hermeneutical circle, one understands the whole in terms of the parts, and in return, the parts in terms of the whole. Similarly, design is constantly re-determined by changes in pre-understandings; the designer's pre-understanding about the whole governs the designer's thinking about the parts. The continuous revision process thus helps to enhance understanding (Snodgrass & Coyne, 1997). Hence, after the process of quantification, there may be emerging definitions; therefore the aim of the current stage is to open a space to re-consider the definitions by following the hermeneutical circle. In re-thinking definitions, there is also a need to consider how evaluations should be carried out. Measurement is thought of as a set of procedures that apply a metric system to observe the phenomena.

In order to set up a measurement procedure, efforts should be concentrated on ensuring that the procedures revealed are both accurate and precise (Cartwright et al., 2016). To

clarify the difference between accuracy and precision, while accuracy refers to whether or not the measurement results correspond to the actual values, precision refers to the specific degree of the measurement result. When measuring a quantity, the observations are usually displayed by instruments such as rulers or thermometers, calibrated to the metric system that represents the quantity. Then, the observations can be translated into myriads of metrical systems by algorithms. In some cases, the instruments do not directly interact with the quantity but depend on a pre-established relation to the quantity aimed to be measured. In other cases, there are directly observable quantities through instruments, like in a mercury thermometer. The measurement of temperature is revealed by recording the height of the column of mercury that is assumed that changes linearly with the temperature. This leads to what Chang (2004) is called 'the problem of nomic measurement'. To ensure that the mercury thermometer measures temperature accurately, one must have a pre-supposition that assumes mercury expands uniformly with the temperature.

On the other hand, to establish this empirical law, an independent and accurate method of measuring temperature is needed. According to Cartwright et al. (2016), this justification problem is common in all measurements based on empirical laws. In this step, Campbell and Fiske (1959) have offered a multitrait-multimethod approach for validation, arguing that in order to be recognized as valid, the construct should be assessed using a variety of techniques and representations. They assert that the validation process receives particular interest in some points. One of them is that validation is typically convergent; that is to say, a confirmation by independent measurement procedures is needed, and independence of methods is a mutual denominator. Secondly, discriminant validations are needed, and convergent validations are needed to validate interpretations and establish a construct of validity. Another emphasis is that more than one trait and more than one method should be employed to examine the validity. In a hermeneutical community, the proposal of Campbell and Fiske for unobservable concepts is used inevitably, since each member of the hermeneutical community has their pre-understandings and tacit knowledge, and they should provide judgmental-subjective arguments in order to validate their interpretations. This 'opening a space' corresponds to what Campbell and Fiske (1959) call 'measuring by various methods', since each interpretation is the interpretation of the interpreter, and by overlapping all the judgments that are offered by distinctive

interpreters, so-called evaluators, the procedures can be done in a hermeneutical way that is beyond objectivism and subjectivism.

In the design evaluation process, if the criteria are considered under the representational measurement, investigating accuracy is relatively more apparent since what is represented corresponds to the physical world. It can be checked whether the representation corresponds to the fundamental world feature or not. The instruments can be used for tangible measurements in different ways, or different measurements can measure a tangible component, and by comparing the results, the accuracy can be satisfied. On the other hand, since in pragmatic measurement, there is not a 'true value' to be measured, but instead, the evaluator constitutes what to measure and how to measure for a specific purpose, accuracy is manifold. The interpretative processes in the hermeneutical community here validate the accuracy by gathering different interpretations, and by fusion of them, the accuracy of each evaluation can be revealed. This process is shown in Figure 3.1. In the measurement theory, measurement is considered a mapping of a property of the empirical world into a set of numbers. On the other hand, to attain meaning from these numbers, one needs to interpret them to transform them into knowledge.

On the other hand, precision can be considered more similar in representational and pragmatic measurement since it is about specificity. Both representational and pragmatic measurements can be detailed and specified. For the representational measurement, the bigger scales are used, the more precise numbers can be attained, and how to decide which instrument to be used for the needed precision is context-dependent. For example, 5 cm may not be crucial if it represents a tree trunk's diameter, but if 5 cm is thought under the construction of openness of a wall, it is then not negligible. So that, if 5 cm difference is under the threshold, which is 'sufficiently' convenient, is acceptable, and hence negligible, since it will not cause crucial changes in the design, but 5 cm difference in the openness at the wall will apparently be over the threshold, that is not 'sufficiently' convenient, and therefore cannot be neglected. Therefore, precision for the representational measurement procedures can be designated by investigating the characteristics of the criteria. The more precise the definitions are, the more 'correct' results can be attained for the pragmatic measurement. Precision in pragmatic measurement has a crucial role in the problem of nomic measurement since the evaluator constitutes what to measure according to a

specific aim, then has to specify what to measure as detailed as possible to decrease the effect of the problem of nomic measurement. In other words, precision plays a crucial role in pragmatic measurement since what to measure is constituted by the evaluator. It is possible to measure another attribute of the entity that is aimed to be measured; therefore, a narrower and more precise definition is required should be made to prevent interference. Therefore, while re-thinking definitions, it should be considered if what is aimed to be measured and what is 'really' being measured should be decided carefully in the process of definitions within the hermeneutical community, since they may not overlap, so that it should be controlled if two systems of knowledge can be mapped directly onto each other. To give an example, if it is aimed to measure the satisfaction of the users with an atelier building, the question should be relatively more specific compare to the question 'how is the resilience of this building to earthquakes?', since the conceptions of users for the term 'satisfaction' may not be the same, therefore what is measured may not correspond to what is aimed to be measured.

Hence, at the end of the process of re-thinking definitions, the hermeneutical community is to be decided following outputs:

- How accurate and precise the indicators correspond to the criteria?
- Interpretation of the quantification results

5.4 An Exemplar of the Proposed Framework through the Criteria of DQI

Since the proposed framework can be considered as a bridge between empirical and theoretical worlds, an exemplar is proposed as a base framework to act in its light as a tool for thinking. Since each design problem is unique, the expected outcomes and criteria should be decided on a project-specific level. The criteria of DQI are regarded as a starting point for the exemplar of the proposed framework. To recall, DQI defines three criteria in order to designate a quality of a design, that is:

- Functionality: the effectiveness of the facility to achieve its goal
- Build quality: the completed facility's performance
- Impact: the facility's ability to generate a sense of place

The first stage of the proposed framework is the definitions. DQI is accepted as a base for the model practice; hence the criteria are accepted as the ones DQI has accepted.

Typically, the thesis supports that all criteria should be decided within the hermeneutical community by considering the project-specific expectations, hence not from a universally asserted list of criteria. On the other hand, to clarify the proposed framework, the criteria of DQI are accepted as the base criteria to be followed in the exemplar.

The adaptations of questions to the DQI exemplar to be answered in the phase of definitions are as following:

- Looking at which criteria the design will be evaluated?

Since DQI is accepted as the base for the exemplar, the criteria of DQI are directly accepted as criteria to be followed: functionality, build quality, and impact.

- What are the indicators of the criteria? In other words, by looking at which attributes of the criteria the measurement will be performed?

Since the criteria are not measurable and there is a need for a pragmatic measurement, it can be defined as in Figure 5.7. Besides, because each criterion can be characterized with its different properties, as mentioned in Section 5.3.1, Gasking (1960) introduced the concepts of clusters as the concepts that many characteristics can identify. To adapt the cluster concepts into definitions, in the case of functionality, it should be checked if the product supports the required functions and it is performing as it should On the other hand, in the case of build quality, how well the product is examined, and in the case of impact, the influences are to be examined. To explore functionality indicators, the use, size and space, and access will be considered. In revealing the indicators of building quality, performance, engineering, and construction of the building can be examined. In the case of impact, the character and innovation, form and materials, and urban and social integration will be regarded (Figure 5.7).

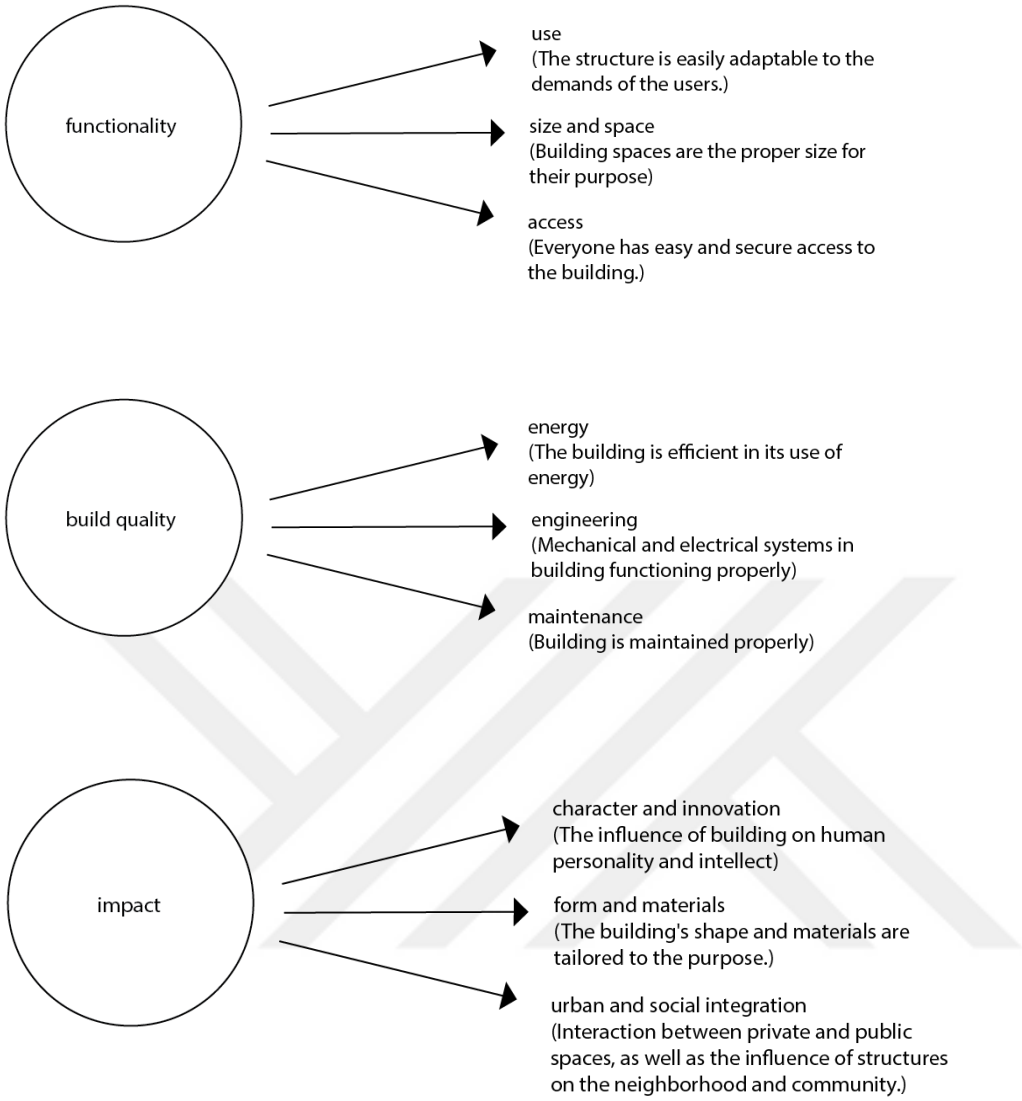

Figure 5.7 : Exploring the indicators of criteria of DQI

In the next step, which is quantification, the questions can be answered as follows:

- What are the weights of importance of each criterion in order to evaluate the design?

The decision of which criteria to be considered more important than others is up to the consensus or the average ratings of the members in the hermeneutical community. In the exemplar, the functionality and building quality can be regarded as more important than impact. If the consensus is aimed to be achieved, each member of the design team should present the origins of their interpretations to validate them with either affirmation or falsification; if consensus cannot be achieved, then the average rating

of the weighting of each member is to be considered. Therefore, in the situations that necessitate trade-offs between these criteria, the weighting should be kept in mind.

- What are the weights of importance of each indicator to define the criterion in the most pragmatic way?

The decision of which indicators define the aimed criteria more appropriately is again up to the consensus or the average ratings of the members in the hermeneutical community. For example, use, size, and space can be considered more critical indicators than access in order to examine the functionality of a building. This decision should be made on a project-specific level. In the case of an art gallery project, access can be considered as more important compared to a factory project. Therefore, the indicators should be designated according to the context of the project.

- On what scale should each indicator be represented?

According to Lawson (2005), numerous factors in the design process cannot be assessed on the same scale, and reducing all criteria to a single scale is a typical design evaluation issue. Furthermore, like qualities, quantity is not a single notion. Quantities are often measured and represented using a numerical system that implies that all numbers behave in the same way, which is incorrect, as evidenced by Stevens' scaling method introduced in Section 4.2.1. The indicators are decided in definitions are following:

- Functionality: use, size, and space, access
- Build quality: energy, engineering, maintenance
- Impact: character and innovation, form and materials, urban and social integration

While putting these indicators on scales, the number's acting should be considered depending on the context. For example, in the case of use, the members can either calculate the ratio of non-used areas to most commonly used areas and have a number on a ratio scale to be interpreted in later stages. Alternatively, comparing the use of one space to any other can be calculated on an ordinal scale to see the ordering relationships of the space use. Alternatively, can directly assess a classification as used/unused spaces to be considered on a nominal scale. Hence, according to the project's specific aim, on what scale to consider, the indicators should be determined.

In the case of re-thinking definitions, the decisions to be made can be as following:

- How accurate and precise the indicators correspond to the criteria?

To recall the demarcation between the terms 'accuracy' and 'precision', accuracy refers to whether or not the measurement results match the absolute values, while precision refers to the degree to specification. Therefore, while re-thinking the definitions, firstly, it should be checked if the indicators correspond to the criteria, in other words, if indicators are appropriate to represent the criteria. Since criteria cannot be measured inherently, indicators are the components to be measured to evaluate the criteria. Hence, the match of indicators and criteria correspondence to accuracy. Precision, on the other hand, about how specific indicators are chosen in order to represent criteria. The more specific indicators are considered, the more precise results can be attained. For example, when access is considered as an indicator of functionality, the term ‘access’ still cannot be measurable in its own right, so by increasing the degree of the term, such as ‘safe space’, the indicators can also be made more precise, and by progressing these specifications, a measurable last indicator can be obtained.

- Interpretation of the quantification results

In the design process, the design team mostly does not comprehensively know from the beginning what to be achieved until some degree of achievement has been attained. Moreover, to recall the hermeneutical circle, the whole is understood in terms of the parts, and the parts are understood in terms of the whole. Correspondingly, changes in preconceptions are continuously reshaping design; the designer's preconception about the whole influences the designer's thinking about the parts. As a result, the process of continuous revision aids in improving comprehension (Snodgrass & Coyne, 1997). Therefore, interpreting the quantification results is up to the process of the hermeneutical circle in the design team (Figure 3.1).

6. CONCLUSION

Many current architectural quality improvement programs focus on measurement to provide higher quality, which reveals that determining and evaluating design quality has become a significant problem. The question of how to define and measure value lies at the heart of this debate. The design quality is difficult to assess since it encompasses both objective and subjective factors. While certain design elements may be objectively quantified, some indicators are intangible and contain critical interpretations. Since prehistoric times, defining the main criteria for architectural design quality has been a significant issue. Many scholars and practitioners have developed notions about what the criterion should be since Vitruvius.

On the other hand, whether it is feasible to develop universal criteria that can be applied uniformly to all design products remains legitimate, given that its reliance on context and evaluator characterizes the design evaluation process. Making data-driven judgments is vital to the design evaluation process, and the data must be evaluated by the evaluator that inevitably entails interpretation. The fact that circumstances are marked by multiplicity (meaning layers) and a plurality (multiple meanings that lead each interpreter to develop divergent but still equitably valid meanings from the same situation) makes it more challenging to arrive at a final interpretation. Therefore, the thesis aimed to provide a framework for the design evaluation process by maintaining the context-dependent nature of the design process by considering both tangible and intangible components. Hence, the thesis is founded on the grounded theory methodology, which builds its hypotheses and theories based on data and analysis. In order to offer a framework for design evaluation, terminologies from measurement science and hermeneutics are taken, since there are common concerns in these fields that may extend the potential understandings of the design evaluation process. Besides, Snodgrass and Coyne (1992) pointed out that the hermeneutic metaphor does not establish such artificial limits since its boundaries are uncertain and vague, and this vagueness is its generative power. By considering these, the proposed framework includes three phases: definitions, quantification, and re-thinking. Since design

problems are highly context-dependent, the proposed framework can be regarded as a ‘tool for thinking’, instead of an absolute measure to be used uniformly in all design evaluation processes by considering the interwoven nature of understanding, interpretation, and application. Hence, the application of the framework into unique design cases depends on the certain circumstances of the design, and the framework should be considered a base to act in its light, and an exemplar is provided to reveal the applicability of the proposed framework.

Therefore, the thesis concludes with the following assertions:

- In most of the situations, use of multiple criteria with different measurement procedures are effective in the success of the design product. Correspondingly, the employment of various scales in assessment and decision-making, such as those provided by Stevens (1946), offers a solid foundation for establishing that the value judgements reached as a result of the evaluation are sound. Furthermore, defining the weights of importance of the criteria is critical, since not all criteria are equally important to the design process and product's success. Quantities, on the other hand, are not intrinsic qualities of physical things but may be ascribed to them according to their intended use. In other words, different conceptions labeled as ‘quantity’ must be distinguished, and distinct features of numbers must be identified. Similarly, there are no ‘perceived links’ between things prior to measurement, and assessment results may only be validated a posteriori.

- For the design process, in-process evaluations are just as important as POE since early decisions made throughout the design phase have a big influence on the end product's quality. As has been shown, parts and whole are constantly in a reciprocal connection in the hermeneutical circle, and relying solely on POE ignores the dialogical nature of design assessment and inhibits the application of new recognitions within the design process. Correspondingly, the suggested framework should be used to all stages of the design process, from pre-design through final design.

- Most of the time, in order to achieve a degree of objectivity, which is generally equated with the source of correct and true knowledge, knowledge that does not meet the widely recognized objectivity standards is ignored. This omission restricts the scope of knowledge and might be considered one of the most significant roadblocks

to progress. Resultantly, the conventional object-subject distinction should be disregarded.

- Value is not a built-in feature of any design product; rather, it is produced by the evaluators. To put it another way, value is determined by the individual. Therefore, the responsibility of the evaluator should be to assign a value by considering the context and grounding it by way of validation, rather than simply expose the value. As a result, any architectural evaluation, such as an interpretation, cannot be assessed on the basis of its truth or falsity, because architectural values cannot be classified as scientifically right or incorrect. Such statements are based on a lack of proof. On the other hand, making well-informed and reasonable decisions about what is appropriate for some (designers, customers, end-users) in a given circumstance is unquestionably possible. Correspondingly, rather than proposing uniform definitions and standards, an adaptive approach is required.

- It is of great importance to provide a 'tool for thinking' rather than an absolute measure to encourage the application of gained information from current design for strategic future usage. Resultantly, the framework intends to complement current assessment methods, give feedback, and gather various perspectives on the value of design within the hermeneutical community. The diversity of evaluators' interpretations should not be seen as an indication of misunderstanding, as it allows evaluators to compare and contrast different interpretations and come up with new ones that contain previously unseen components. Furthermore, any judgment regarding appropriateness can only be determined by applying it to specific instances.

6.1 Further Research

Discussions on the fundamentals of measurement science are continuously enriched due to the developments in different scientific fields. The research aims to show that the design process can be re-formulated with understanding measurement science and hermeneutics. Since it is the first attempt to bridge measurement science, hermeneutics, and the design evaluation process, further research may and should develop for more specific steps in design processes. It can be offered to use the terminology of measurement science such as derived and fundamental measurements, uncertainty, uniqueness problem, theory of error, validation, calibration, etc. can all be assigned for each step of the design process, as Snodgrass and Coyne (1996) states,

design activity cannot be considered in the field of natural sciences which -generally- works with the formal logistic rules. However, it is more related to understanding and interpretation, which makes the base of the design process in human sciences. The offered terminology is still open for discussion and still being discussed within the measurement in science, but to bring these discussions also to the design evaluation process may support the discussions in the design process since there are similar concerns between the design field and measurement science and by doing so, the potential of measurement science in the design process may be revealed.

On the other hand, the question of 'is there a value of a design that exists independently from the assessor' is more likely a question that belongs to axiology, a philosophical study of values, and the question can be a topic for another research.

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