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Exploring the AHP-AgileITS-ArchDesign: An AHP Model and Tool for Evaluating IT Service Architectural Agile Designs in SMBs

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Abstract

The design of IT services—including the architectural design—is considered a core activity to obtain a cost-effective IT service. Consequently, the main extant IT service frameworks and standards—rigorous and lightweight-agile types—aim to provide guidance for this purpose. However, some of them are reported at a coarse-grain conceptual level, and others are practically null. Consequently, their utilization—in the best case for large businesses—demands additional ad hoc organizational efforts. In the worst case, small and medium businesses (SMBs) are practically blocked from performing these relevant IT service activities by their limited resources. In this research, we are interested in supporting IT service design activities for SMBs, and thus introduce the AHP-AgileITS-ArchDesign model. This AHP-AgileITS-ArchDesign model was elaborated with a Design Science Research Methodology (DSRM), and aims to provide theoretically valid, systematic, agile and usable fine-grain guidance to support the design and evaluation of IT service architectural agile designs. The AHP-AgileITS-ArchDesign model uses a three-Layer AHP model derived from the main lightweight-agile IT service design literature, and its utilization is illustrated with an Academic Data Science Analytics Platform IT Service case. Then, its conceptual validity and its usability are evaluated, respectively, by a Panel of 16 Experts and an Exploratory Pilot Sample of 62 ITSM academics and practitioners. The evaluation results indicate that the AHP-AgileITS-ArchDesign model has a valid theoretical conceptualization and satisfactory usability, and thus can be used by practitioners and academics in SMBs.

Keywords: AHP-AgileITS-ArchDesign model; analytic hierarchical process (AHP); IT service architectural agile design; design science research methodology (DSRM); IT service management (ITSM) frameworks and standards; small and medium businesses (SMBs)



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1. Introduction

1.1. Research Background

The design of cost-effective IT services—including their architectural design—is a relevant engineering and managerial activity in the main IT Service Management (ITSM) frameworks [1–5] and standards [6–8]. Consequently, the main rigorous ITSM frameworks such as ITIL v2011 [1] and CMMI-SVC [2] and standards such as the ISO/IEC 20000 [6],

and lightweight-agile ones as the standard ISO/IEC 29110—through the complementary Technical Reports (TR) 29110-4-3 [7] and 29110-5-3 [8]—and ITIL v4 [3,4] and VeriSM [5], have included general IT service design guidance.

In the case of rigorous ITSM frameworks [1,2] and standards [6], due to the usual high cost and impact attributes of the planned and authorized IT services [9,10], the IT service design activity indicates the need of elaborating and evaluating two or more IT services architectural designs, and systematically evaluating two or more alternative architectural designs to select the most adequate one according to agreed IT service design criteria [11,12]. However, in the best of the cases—for ITIL v2011 [1] and CMMI-SVC [2] frameworks—the guidance provided for this aim is reported at a coarse-grain conceptual level, and for the case of the ISO/IEC 20000 [6] standard, such guidance is practically null. In the case of the main lightweight-agile ITSM frameworks and standards—i.e., the ISO/IEC 29110 standard through the Technical Reports (TR) 29110-4-3 [7] and 29110-5-3 [8], the ITIL v4 [3,4] and VeriSM [5] frameworks, and other less-reported lightweight-agile ITSM frameworks [13]—this situation worsens to minimal or null guidance.

Consequently, for both cases—rigorous and lightweight-agile ITSM frameworks and standards—the IT service design practitioners and academics face a problematic IT service design situation. Then, in both cases, they are pushed to add ad hoc guidance—in the case of large businesses—or practically perform nothing—in the case of small and medium businesses (SMBs)—to systematically design and evaluate alternative IT service architectural agile designs for the planned and authorized IT services.

1.2. Research Motivation and Problem Statement

As previously indicated, due to the relevance of performing IT service architectural design and evaluation of candidate solutions [1–13], and the availability of coarse-grain conceptual guidance in the best case, large businesses apply in-house developed systematic models and procedures to cope with this problematic situation. These kinds of organizations—because they count with adequate human, organizational, technical and financial resources—can realize these additional ad hoc organizational efforts. For instance, systematic decision-making techniques have been proposed in the domain of IT services for Cloud service selection [14], Cloud service composition [15], replacement decisions of virtual machines in Cloud Data Centers [16], energy optimization of virtual Data Centers [17], selection of IaaS Cloud services [18], evaluation of the IT service design, building and deploying workflow of the main ITSM frameworks and standards [19], and large-scale IT service design evaluations [20], among others.

In the worst case, in SMBs, this problematic situation is practically not addressed—but it is still existent—due to the partial or null utilization of ITSM frameworks and standards caused by limited organizational, technical, human and financial resources [21–24]. Consequently, SMBs are blocked from proceeding adequately with specific models and procedures on how to conduct such relevant activity.

In this research, we are interested in supporting IT service design practices for SMBs, and, consequently, we state the research problem as follows: *the lack of fine-grain decision-making guidance to support the design and evaluation of IT service architectural agile designs*. Furthermore, we consider important—for the context of SMBs—to add that the plausible solution proposed should be theoretically valid, systematic, agile and usable [25,26]. In this research, we refer to the theoretically valid attribute as built upon established theoretical sources; to the systematic one as its similar repeatable utilization; to the agile attribute as a lightweight model and its included procedure of utilization; and to the usable one as the satisfactory perception of usefulness, ease of use, compatibility, value and attitude

potential of use from the target user population—IT service academics and practitioners in the context of SBMs.

1.3. Research Overview

In this research, we conduct a design science research [27–29] effort for contributing to the literature on IT service architectural agile design as follows: (1) by providing theoretically valid, systematic, agile and usable decision-making models and tools—i.e., the designed artifact A AHP-AgileITS-ArchDesign model and its implemented artifact A* AHP-AgileITS-ArchDesign tool—for supporting the design and evaluation of IT service architectural agile designs; (2) by making available a free-access Electronic Process Guide (EPG) of AVS_FD_MVITS v3 workflow [30,31], which is an agile fine-grain guidance for designing IT services, which includes the new designed dual-artifact A/A*; and (3) by fostering the research stream on IT services architectural agile design.

Then, the remainder of this paper continues as follows. In Section 2, we report the theoretical bases used to support the design of the artifact A; Section 2.1 reviews the foundations on rigorous and lightweight-agile IT service architectural design guidance; Section 2.2 describes the classic Analytical Hierarchical Process (AHP) [32–38], which is used in the designed artifact A; and Section 2.3 reports cases on how the classic AHP method has been used in similar and related design problems in the domain of IT services, from a selective literature review for the 2010–2024 period. In Section 3, we report the research formulation including research methodology, research goal and research questions, and research hypotheses. In Section 4, we report the design, description and an illustrative case of application of the designed artifact A—i.e., the AHP-AgileITS-ArchDesign model—as well as its inclusion in the free AVS_FD_MVITS v3 workflow [30,31]. In Section 5, we report the two evaluations conducted. Section 5.1 refers to the Conceptual Validity Evaluation from a Panel of 16 Experts, and Section 5.2 to the Exploratory Usability Evaluation from a Pilot Sample of 62 academics and practitioners in the context of SMBs. In Section 6, we report a discussion of the results and the contributions to the knowledge and to the professional practice of this research, and, finally, in Section 7, we report the conclusions reached, the methodological limitations, and the recommendations for advancing this research.

2. Theoretical Background

In this Section 2, we report the theoretical foundation of (2.1) the extant rigorous and lightweight-agile IT service architectural design guidance; (2.2) the classic AHP method, and its three steps for elaborating an AHP decision-making model; and (2.3) how the AHP method has been used—alone or combined with other Multi-Attribute Decision-Making (MADM) methods—in the main literature on design of IT services during the 2010–2024 period, to provide evidence of the past and still current utilization of the AHP method.

2.1. Rigorous and Lightweight-Agile IT Service Architectural Design Guidance

2.1.1. IT Service Architectural Concepts

An IT service can be defined as a functionality enabled for IT users that delivers business value, and is provided by an IT service system composed of IT resources, IT processes and practices, and IT people [1–13]. Value is realized when the expected IT service utility—i.e., the fit for purpose proposition—and the IT service warranty—i.e., the fit for use proposition—are achieved. The utility of an IT service refers to what the service does that is valued by the customer—i.e., the tangible benefits and the reduction in service business risks. The warranty for an IT service refers to how well it is delivered—i.e., how

well the agreed levels of availability, capacity, continuity, security, cost and performance are achieved.

According to the core ITSM literature [1–13], for designing and building a cost-effective IT service, it is necessary to elaborate the following artifacts: architecture, main components, the procedures of deployment, operation and support, and complementary documentation on the required IT infrastructure to install the IT service. Figure 1 shows a typical architectural diagram of a generic IT service. This architectural diagram is presented hierarchically in three layers, the high-level components as well as their interrelationships [39].

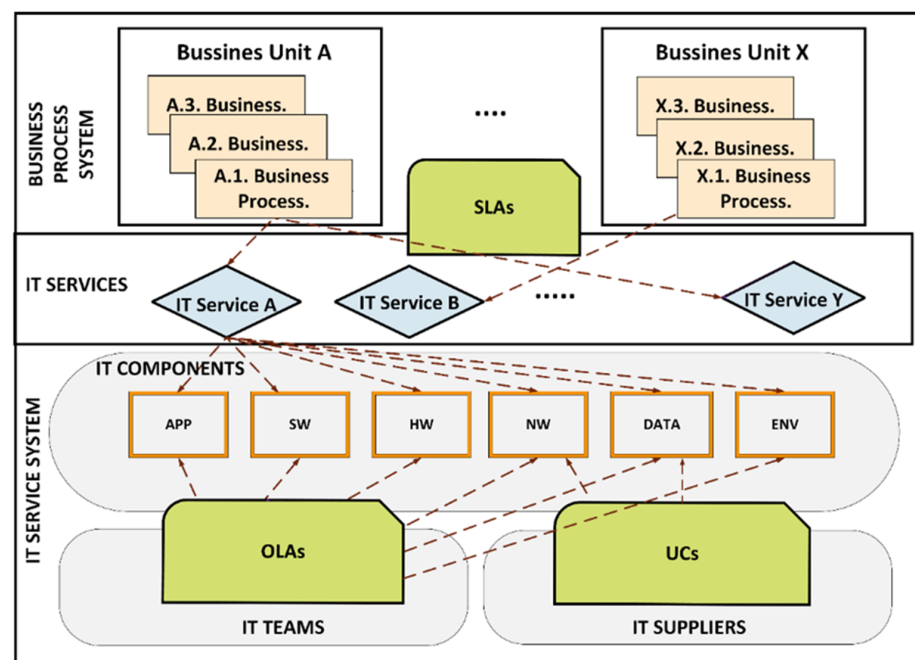


Figure 1. A generic IT service architecture design diagram.

The three layers shown in Figure 1 correspond to: (1) End-User Business Processes; (2) IT Services; and (3) IT Service System. Layer 1 refers to the business processes supported by the agreed IT services. The IT service agreements are documented in a Service Level Agreement (SLA) defining the range of planned warranty metrics (availability, capacity, continuity, security, performance, and costs). Layer 2 refers to the set of functionalities activated by the IT services provided by the IT Service System. End-Users can use a single or several IT services and these can serve a single or several End-Users. Layer 3 refers to the whole IT Service System that is responsible for generating the IT services for the End-Users. This Layer 3 can be divided into three internal sub-layers: (3.1) IT Service Components; (3.2) IT Teams; and (3.3) IT Suppliers. Sub-layer 3.1 includes the following IT components: (1) APP: End-User application software; (2) SW: system software; (3) HW: hardware and storage equipment; NW: network equipment; (4) DATA: physical data; and (5) ENV: environmental facilities. Sub-layer 3.2 accounts for the human resources required to operate and support the IT services. Finally, sub-layer 3.3 corresponds to external companies hired to supply external IT services that the organization cannot provide. IT Teams and IT Suppliers are tied, respectively, to the IT Components through Operational Level Agreements (OLAs) and Underlying Contracts (UCs).

The procedures of deployment, operation and support report all necessary steps for the acquisition, building, testing, integration, releasing, operation and support of all IT components selected to constitute the IT services. These procedures are considered mandatory in the main rigorous ITSM standards and frameworks [1–6], and, thus, the design of IT services includes both engineering and managerial sides.

2.1.2. Extant Rigorous IT Service Architectural Design Guidance

The ITSM literature reports rigorous IT service design workflows which are included in the ITIL v2011 [1] and CMMI-SVC [2] frameworks, and in the ISO/IEC 20000 [6] standard. These frameworks aim to provide guidance for designing and building IT services in the context of large businesses.

ITIL v2011 [1] reports in the Service Design overall phase the following high-level IT service design workflow: (1) Service Requirements Identification; (2) Business Requirements and Drivers Identification and Documentation; (3) Service Solution Design; (4) Alternative Solution Evaluation; (5) Selected Solution Procurement; and (6) Service Solution Development. Thus, it is expected to have several IT service designs and to use a systematic decision-making method to evaluate and select the highest-ranked IT service design. As ITIL v2011 [1] (p. 51) indicates: *“evaluating and costing alternative designs, highlighting advantages as well as disadvantages of the alternatives”*. However, ITIL v2011 focuses more on the economic–financial evaluation of the alternative IT service designs [11], rather than on architectural IT service attributes.

Similarly, the ITSM framework CMMI-SVC [2] includes an IT service design workflow—named Service System Development (SSD) process—to *“analyze, design, develop, integrate, verify, and validate service systems, including service system components, to satisfy existing or anticipated service agreements”* [2] (p. 437). The IT service design workflow in CMMI-SVC [2] is structured in three activities: (1) Development and Analysis of Stakeholder Requirements; (2) Development of Service Systems; and (3) Verification and Validation of Service Systems. In particular, activity (2) includes the sub-activity—called specific practice—(2.1) Selection of Service System Solutions. In this sub-activity 2.1: *“alternative solutions and their relative merits are considered in advance of selecting a solution”* [2] (p. 383). To support this sub-activity 2.1, CMMI-SVC [2] includes a full workflow called Decision Analysis and Resolution (DAR), which is used to *“analyze possible decisions using a formal evaluation process that evaluates identified alternatives against established criteria.”* However, despite the inclusion of this decision-making procedure, this guidance is generic and coarse-grained, and, thus, its practical utilization demands ad hoc additions on evaluation criteria, scales, and quantitative-based methods.

Surprisingly, in the standard ISO/IEC 20000 [6], whereas it includes a specific IT service design workflow—called Service Design and Transition—where *“the organization plans, designs, builds, and transitions services based on agreed service requirements”* [6] (p. 41), there are no explicit indications on the need to propose and evaluate different IT service designs. These results concur with previous thorough studies on the IT service design workflows in the main rigorous ITSM frameworks [11,12].

2.1.3. Extant Lightweight-Agile IT Service Architectural Design Guidance

Lightweight-Agile ITSM literature also reports IT service design workflows included in the lightweight ISO/IEC 29110 standard [7,8] and the agile frameworks ITIL v4 [3,4] and VeriSM [5]. These workflows also aim to provide guidance for designing and building IT services in the context of SMBs.

The lightweight ITSM standard ISO/IEC 29110—through the Technical Report (TR) 29110-4-3 [7]—provides an IT service design workflow in the Service Control (SC) process with the aim of supporting and controlling the design, building, and transition of new or changed services. This SC process includes three activities: (1) Management of the Change to Services; (2) Evaluation and Building the Service Change; and (3) Testing and Deployment of the approved Service Change. However, explicit indications to generate and evaluate IT service designs are not reported in this lightweight ITSM standard [7]. The unique reference for the utilization of a decision-making technique is reported in a comple-

mentary TR 29110-5-3 [8], which reports a single task SR.3.2 statement as follows: “*Make trade-offs among the different possible functional architectures relative to the requirements.*” [8] (p. 27), within the SR.3 activity of Systems Architectural Design.

Regarding the agile ITIL v4 framework [3,4], a specific IT service design workflow was not reported initially [3], so any organization should define its ad hoc IT service design workflow—called Value Stream. Later, complementary literature on ITIL v4 [4] proposed an exemplary IT service design workflow of six steps. These steps are: (1) an Engage step where the IT service requirements are recognized and documented; (2) a Plan step where the new potential IT service is financially authorized or canceled; (3) a Design and Transition step where the new authorized IT service is architecturally well-designed; (4) an Obtain and Build step where the required IT service components are procured; (5) a Design and Transition step where the IT service components are got ready for launching; and (6) a Deliver and Support step where the new IT service is released and supported. In this agile IT service design workflow, Step 2 refers to making the overall decision whether or not to invest in the asked IT service based on costs, benefits and risks. Thus, this step does not address the design and evaluation of several candidate IT service designs. Regarding step 3, there is no explicit indication of the same situation of proposing several IT service designs and the need to apply a decision-making technique for selecting the most appropriate one.

Similarly, the agile VeriSM [5] framework includes an agile IT service design workflow that corresponds to the Define stage. Its objective is to provide the activities and outcomes—i.e., artifacts—related to the IT service design. The Define stage contains the next four activities: (1) Identification of the Consumer Needs; (2) Definition of the Required Outcome; (3) Elaboration of the Solution; and (4) Design of the Service Blueprint. In activity 1, a request for a new or changed IT service is presented for its authorization or declination. In activity 2, the functional and non-functional IT service requirements are collected. In activity 3, a design plan is generated, which mainly specifies: service level attributes, IT service items for composing the service, and the deployment, operation and support procedures, the tools and the involved IT people. Finally, in activity 4, a more detailed document of the IT service design is reported. However, the core agile IT design steps 3 and 4 do not explicitly report the need to elaborate and evaluate IT service architectural designs to select the most appropriate. This lack of fine-grain guidance documents is also present in other less reported lightweight-agile ITSM frameworks and standards [13].

Hence, these rigorous and lightweight-agile IT service design workflows, which suggest several general guidelines to evaluate the design of an IT service—in the best of the cases—do not provide specific fine-grain models and procedures on how to conduct such evaluations.

2.2. The Analytical Hierarchical Process (AHP)

This research team selected the classic version of the AHP method [32–38] as a fundamental building block to design a plausible solution to the addressed research problem. We selected the AHP method based on the following rationale:

- The AHP method permits us to structure the criteria set through a hierarchy of independent attributes [32,33];
- The AHP method permits the combination of attributes ranked subjectively with others ranked objectively [32,33];
- The AHP method permits the assignment of crisp values or probability distribution functions for assessing each input in the bottom layer and analyzing ranking sensitivity through Monte Carlo simulation [34–36];
- The AHP method has an adequate balance between the complexity of calculations versus the validity and effectiveness of evaluations [37,38];

- The AHP method is highly intuitive for its utilization in the context of SMBs [37,38];
- The AHP method is one of the most used Multi-Attribute Decision-Making (MADM) methods [40–44] for similar and related IT service design problems (Section 2.3);
- The AHP method has proved its usability and effectiveness in a wide variety of domains of application such as: engineering design problems [45,46], business managerial decisions [47,48], and military evaluation scenarios [49,50] among other domains of applications [51], and, thus, provides adequate trust and acceptance in decision makers.

Additionally, if it were required to advance towards a more sophisticated plausible solution for this research problem, the AHP method has been generalized from a linear decisional hierarchy to a network decisional structure [52], and can be combined with other relevant MADM methods [53–56].

In summary, the AHP method provides powerful modeling capability to structure a hierarchy of criteria, effective decisional capacity, and demands less cognitive complexity from decision makers than other MADM methods [32,33].

A decisional situation can be structured as a decision value tree (DVT) model [57,58] in the AHP method. Essentially, a full DVT model has three layers: (1) a single goal top layer; (2) a layer (with sub-layers if required) of mutually excluding decision criteria used to conjointly assess the score of the single goal in the top layer; and (3) a bottom layer of the candidate decisions to be evaluated—at least two. An adequate DVT model should exhibit completeness, operationality, decomposability, non-redundancy and minimalism [57,58]. Completeness exists when the decision makers' concerns of interest are covered. Operationality refers to well-defined candidate decisions. Decomposability enables dividing an attribute into sub-attributes. Non-redundancy is satisfied when attributes are not conceptually overlapped. Finally, minimalism refers to avoiding the addition of unnecessary elements to the DVT model when the previous conditions have been satisfied.

Three principles support the AHP method [32,33]. These are: (1) the Principle of Decomposition; (2) the Principle of Comparative Judgments; and (3) the Principle of Priority Synthesis. The first principle—on Decomposition—states that a decision problem for the AHP method must be represented as a DVT. The second principle—on Comparative Judgments—asks for the decision maker's capability to conduct pairwise attribute comparison for all pairs in a layer regarding their contribution to their linked attributes in the next upper layer. This Comparative Judgment is conducted in the AHP method using a 9-point scale of crisp or probabilistic values, and produces eigenvectors of priority in each layer. This process can produce some preference order inconsistency, but the AHP method limits its value to 0.10 for adequate results. This value is called the Consistency Ratio (CR). Finally, the third principle—on Priority Synthesis—accounts for the final score calculations that integrate all previous ones.

Hence, the AHP method can be applied through the next three steps:

- **AHP Step 1. Elaboration of the AHP Decision Value Tree (DVT) Model** (top layer: goal; middle layers: criteria and sub-criteria attributes; and bottom layer: candidate decisions and assumptions elements).
- **AHP Step 2. Quantitative Procedures** (pairwise comparison matrices; derived local priority vectors; derived global priority vectors; and Consistency Ratios (CRs) for all criteria layers).
- **AHP Step 3. Evaluation and Reporting of Candidate Decisions and Assumptions** (results and further analysis—if required).

Further mathematical details on how to realize all calculations of the AHP method can be consulted in the AHP literature [32,33].

2.3. Selective Review on the Utilization of the AHP Method for Evaluating Architectural Design of IT Services

In this sub-section, we report a summarized view on how the AHP has been used directly or combined with other Multi-Attribute Decision-Making (MADM) methods to evaluate architectural designs of IT services reported in the main related literature on Software–Systems and Decision Science areas during the 2010–2024 period. This review aims to provide evidence of the permanent adequacy of using the AHP method, as well as to provide core concepts potentially to be used in the elaboration of the AHP decision value tree model—top goal, criteria and sub-criteria layers.

For this aim, a Systematic Selective Literature Review (SSLR) process was applied—adapted from [59,60]. This SSLR method was conducted following the next five steps: (1) formulation of the research goal and research questions; (2) definition of the research context; (3) collection and selection of the final studies; (4) review and synthesis of findings from the collected–selected studies; and (5) elaboration of the findings report.

Table 1 reports a high-level summary of findings from the 26 studies [19,40,61–84] that were selected from an initial set of 304 studies. Table 1 includes 22 studies [19,61–81] from the Software–Systems literature—from 7 relevant JCR-indexed journals—and four [40,82–84] from Decision Science—also from 7 relevant JCR-indexed journals—both during the 2010–2024 period. Table 1 reports the following columns: literature area, ID journal-article, type of AHP method utilization, year, and IT service design impact. Appendix A—Tables A1–A5—reports the details of how the SSLR method was applied in this research.

Table 1. Summary of findings from the SSLR on the topic of “architectural design of IT services using AHP” in the Software–Systems and Decision Science areas.

Area	ID Journal-Article	Type of AHP Utilization				Year	IT Service Design Impact	
		Classic AHP	Hybrid Classic AHP	Fuzzy AHP	AHP vs. Other MADM		IT Service Utility	IT Service Warranty
Software and Systems	TSE.01 [61]	✓				2019		✓
Software and Systems	IST.01 [62]	✓				2013		✓
Software and Systems	IST.02 [63]	✓				2013	✓	✓
Software and Systems	IST.03 [64]				✓	2014		✓
Software and Systems	IST.04 [65]				✓	2019		✓
Software and Systems	IST.05 [66]	✓				2019		✓
Software and Systems	IST.06 [67]			✓		2023		✓
Software and Systems	JSS.01 [68]				✓	2011	✓	✓
Software and Systems	JSS.02 [69]	✓				2010		✓
Software and Systems	JSS.03 [70]	✓				2012		✓
Software and Systems	JSS.04 [71]				✓	2017	✓	✓
Software and Systems	JSC.01 [72]	✓				2020		✓
Software and Systems	JSC.02 [73]		✓			2021		✓
Software and Systems	JSC.03 [74]		✓			2021		✓
Software and Systems	JSC.04 [75]	✓				2022	✓	✓
Software and Systems	JSC.05 [76]		✓			2022		✓
Software and Systems	JSC.06 [77]				✓	2023		✓
Software and Systems	JSC.07 [78]			✓		2023		✓
Software and Systems	JSC.08 [19]	✓				2023		✓
Software and Systems	SPE.01 [79]			✓		2018		✓
Software and Systems	SPE.02 [80]	✓				2021		✓
Software and Systems	SPE.03 [81]	✓				2022		✓
Decision Science	OME.01 [82]		✓			2015	✓	✓

Table 1. *Cont.*

Area	ID Journal-Article	Type of AHP Utilization				Year	IT Service Design Impact	
		Classic AHP	Hybrid Classic AHP	Fuzzy AHP	AHP vs. Other MADM		IT Service Utility	IT Service Warranty
Decision Science	EJOR.01 [83]		✓			2015	✓	✓
Decision Science	EJOR.02 [84]				✓	2023	✓	✓
Decision Science	OR.01 [40]				✓	2013	✓	✓

The summary of findings reported in Table 1 shows evidence of the permanent and still current utilization of the original AHP method, or its extension or combination with other MADM methods—such as Fuzzy AHP or TOPSIS—for addressing design problems of IT services or for some particular component of an IT service. This SSLR found that the new method proposed produced better results than the classic AHP method in only two [71,82] of the 26 studies [19,40,61–84]. Table 1 also shows that the most frequent impact found was on the IT service warranty dimension—i.e., on availability, capacity, continuity, security, cost and performance metrics.

We must remark that this SSLR did not filter documents by rigorous or lightweight-agile IT service Design Approaches, and, consequently, these 26 [19,40,61–84] documents could include any of these two approaches. Additionally, no study claimed explicitly to use an IT service architectural agile design. Consequently, this SSLR provides additional evidence of the knowledge gap addressed in this research.

3. Research Formulation

3.1. Research Methodology

A Design Science Research Methodology (DSRM)—based on the core literature [27–29]—was applied in this research. A DSRM is used for (1) generating a new conceptual or physical artifact through a scientific, systematic, repeatable and theoretically supported design process; and (2) designing and building artifacts that are explicitly non-trivial given their conceptual and physical complexity, but are useful and valuable for human activities. We consider that the addressed research problem regarding the lack of an agile, systematic, theoretically valid and usable decision-making model and procedure to support the design and evaluation of IT service architectural agile designs fits the use of the DSRM.

Essentially, the DSRM comprises the activities of Build and Evaluate [27]. The realization of the Build activity is expected to answer the next inquiry: is it feasible to produce an artifact A that exhibits a set of agreed Design Objectives (DOs) by applying a Design Approach (DA) and a set of Design Components (DCs)? In turn, the realization of the Evaluate activity must answer the next inquiry: does the generated artifact A fulfill the agreed set of Design Objectives (DOs)? An enhanced DSRM [28] was proposed with seven Design Principles: viable artifact, useful artifact, validated artifact, knowledge and praxis contributions, repeatable design, consideration of economic, technological and organizational constraints, and accessible findings for both scientific and practitioner audiences; four types of outcomes: a construct, a framework model, a methodology, or a system instance; and five modes of evaluation: empirical observation, analytical mathematical procedures, laboratory controlled experiment, empirical field test, and/or conceptual logical argumentation. Finally, in an additional study [29], a well-structured 6-Step DSRM was reported, and it was integrated with and complemented the initial DSRM literature [27,28].

The six steps of the DSRM applied in this research correspond to: (1) Design Research Initiation; (2) Design Research Formulation; (3) Design and Development of the Artifact; (4) Demonstration of the Artifact (Proof of Concept); (5) Evaluation of the Artifact; and (6) Communication of Research Results. Appendix B reports an essential description of these six steps complemented with additional theoretical support [85–90], and a summarized structure of the 6-Step DSRM in Table A6. Table A6 reports: steps, purpose, complementary research methods, and expected outcomes.

3.2. Research Goal and Questions

This research, thus, aims to achieve and answer, respectively, the following research goal and research questions:

- **General Research Goal**
 - **RG:** To design and computationally implement theoretically valid, systematic, agile and usable decision-making model and procedure—called the artifact A: AHP-AgileITS-ArchDesign model—to support the design and evaluation of IT service architectural agile designs that can be used for academics and practitioners in the context of SMBs.
- **Research Questions**
 - **RQ.1:** How can the artifact A—AHP-AgileITS-ArchDesign model be designed and computationally implemented?
 - **RQ.2:** What is the degree of achievement of the proposed Design Objectives (DOs) and the identified Design Restrictions (DRs) for the artifact A—AHP-AgileITS-ArchDesign model?
 - **RQ.3:** What is the degree of conceptual validity of the artifact A—AHP-AgileITS-ArchDesign model—from a Panel of Experts on ITSM and Agile Approach?
 - **RQ.4:** What is the degree of usability—i.e., usefulness, ease of use, compatibility, value and attitude potential of use—of the artifact A—AHP-AgileITS-ArchDesign model—compared with an alternative IT service architectural design Model Y, from an Exploratory Pilot Sample of ITSM academics and practitioners in the context of SMBs?

3.3. Research Hypotheses

Based on the previous research goal and research questions reported, and the theoretical background reviewed, we posed the following two hypotheses:

- **Research Hypotheses.**
 - **RH.1:** A theoretically valid, systematic, agile and usable decision-making model and procedure—AHP-AgileITS-ArchDesign model—to support the design and evaluation of IT service architectural agile designs can be designed, computationally implemented, and evaluated satisfactorily on Theoretical Validity by a Panel of Experts.
 - **RH.2:** The artifact A—AHP-AgileITS-ArchDesign model—can reach satisfactory usability levels from an evaluation by an Exploratory Pilot Sample of ITSM academics and practitioners in the context of SMBs.

4. Design, Implementation and Proof of Concept of the Artifact A: AHP-AgileITS-ArchDesign Model

In this section, we report the design of the artifact A, its implementation in the artifact A*, its Proof of Concept with an illustrative “Academic Data Science Analytics Platform IT

Service” case, and how it can be included in a full IT service design workflow—i.e., the AVS_FD_MVITS v3 workflow recently reported [30,31].

In this research, we define the concept of agile from an IT service perspective [25,26] rather than from the usual Software Engineering approach [91]. Then, an agile attribute refers to a process or practice with: speed to quickly deliver a usable IT service; leanness to deliver a usable IT service at minimal time-frames and development costs; and lightweight to provide reduced but useful practices from the original heavy-process ones [25,26].

The design of the artifact A includes the determination of the Design Approach (DA), the Design Objectives (DOs) and Design Restrictions (DRs), the Design Theoretical Sources (DTSs), and the selected Design Components (DCs), as well as the application of the AHP method (Step 1) to elaborate the artifact A. The implementation and Proof of Concept of the artifact A* uses the AHP method (Steps 2 and 3).

4.1. Design of the Artifact A: AHP-AgileITS-ArchDesign Model

4.1.1. Design Approach (DA)

The heuristic Design Approach (DA) [85] was used in this investigation to design the artifact A—AHP-AgileITS-ArchDesign model. The Analytic DA [86,87] and the Axiomatic DA [89] demand a valid mathematical or logical representation of the Design Objectives (DOs) and Design Restrictions (DRs) that can be automatically solved by the existing related methods. However, its complexity-value DA trade-off is not affordable for SMBs. Then, a Heuristic DA was used. A Heuristic DA refers to the iterative application of design heuristics agreed by the research design team for selecting adequate Design Components (DCs) from the Design Theoretical Sources (DTSs) and analyzing their impacts against the expected Design Objectives (DOs).

According to [85], a generic heuristic design can be pursued with the following steps: (1) state an initial designed artifact A0; (2) transform iteratively the initial artifact A0 in subsequent artifacts A1, A2, . . . Ak, applying design heuristics operators HOs; and (3) evaluate each modified artifact Ai against the level of conformance of the Design Objectives (DOs) and Design Restrictions (DRs). In this research, four design heuristic operators (HOs) based on the AHP decision-making literature [57,58] were agreed by the research team as follows:

- HO.1: Select a single concept as the first top-level decision-making objective.
- HO.2: Select a concept, in the current k-level, and state at least two sub-objectives in the k + 1 level that, conjointly, are useful to rate the selected concept in the k-level.
- HO.3: Review the overall unambiguity, comprehensiveness, directionality, operability and understandability of the set of concepts (also known as attributes) in the last level.
- HO.4: Review the overall completeness, operability, decomposability, lack of redundancy, and size of the current set of selected concepts.

4.1.2. Design Objectives (DOs) and Design Restrictions (DRs)

The expected Design Objectives (DOs), including their validation procedures, as well as the Design Restrictions (DRs) for the designed artifact A—AHP-AgileITS-ArchDesign model—were stated as follows:

- DO.1: The designed artifact A must use only Design Components (DCs) from relevant Design Theoretical Sources (DTSs). Validation is through logical argumentation.
- DO.2: The designed artifact A contains a Value Tree Hierarchy that is complete, operational, decomposable, non-redundant, and minimal. Validation is through logical argumentation.

- DO.3: The designed artifact A contains a set of attributes that are unambiguous, comprehensive, directional, operable, and understandable. Validation is through logical argumentation.
- DO.4: The designed artifact A is a theoretically valid, systematic and agile decision-making model. Validation is through the application of a Conceptual Validity Questionnaire to a Panel of Experts.
- DO.5: The designed artifact A is computationally implemented in an artifact A* using standard Information Technology. Validation is through the implementation of the Proof of Concept.
- DO.6: The A* artifact provides three core functionalities: DO.6.1, DO.6.2 and DO.6.3 (Table A7 in Appendix C).
- DO.7: The A* artifact has a satisfactory level of usefulness, ease of use, compatibility, value and attitude potential of use from an Exploratory Pilot Sample of ITSM academics and practitioners. Validation is through an empirical survey applied to the pilot sample.

Regarding the Design Restrictions (DRs), they were stated as follows:

- DR.1: The time-frame agreed for the design, computational implementation and evaluation of the designed artifact A is limited to a 2-year period (2024 for the Literature Review, and 2025 for the Design, Build, and Empirical Evaluation of the artifact).
- DR.2: The standard Information Technology used to computationally implement the designed artifact A must be very affordable for academic and small business settings.
- DR.3: The designed artifact A must be plausibly integrated (i.e., to be part of) into a full agile workflow for designing IT services in the context of small organizations.

4.1.3. Design Theoretical Sources (DTSs) and Design Components (DCs)

The Design Theoretical Sources (DTSs) are the key sources of the Design Components (DCs) that will be selected to elaborate the designed artifact A. These DTSs were proposed and agreed upon by the research team based on its conjoint knowledge and research findings on: (1) the main literature on rigorous and lightweight-agile IT service design; and (2) the Systematic Selective Literature Review (SSLR) conducted on the utilization of the AHP method—alone or combined—to the design of IT services for the period 2010–2024 (reported in Section 2.3).

Table 2 reports the two agreed DTSs used in this research. Table 3 presents the agreed 19 DCs taken from the two DTSs, and Table 4 reports the three scales proposed for measuring the DCs. Scale 1 is used only for the top goal DC.01, “Value Index of Agile Architectural Design of IT Services”. Scale 2 is used for all criteria and sub-criteria DCs. Scale 3 is used for all decision–assumption DCs. The three scales are from 0.000 to 1.000, but Scales 1 and 3 are reported in percentage format.

Table 2. Design Theoretical Sources (DTSs).

Id DTS	DTS	DTS Description
DTS.01	Classic, lightweight-agile IT service design literature.	This DTS.01 refers to the specific topics of IT service designs reported in the following IT service management standards and frameworks: ITIL v2011 [1,39,62–64]; CMMI-SVC v1.3 framework [2]; ISO/IEC 20000-2:2019 standard [6]; ITIL v4 framework [3,4]; VeriSM framework [5]; and ISO/IEC 29110 standard (TR 4-3 [7], and TR 5-3 [8]).
DTS.02	Systematic Selective Literature Review (SSLR) on AHP for IT service design.	This DTS.02 refers to the content located—26 research articles—through the applied SSLR on how the AHP method—alone or combined—has been used for the design of IT services as it is reported in the main literature on Computing (7 top JCR-indexed journals) and Decision Sciences (7 top JCR-indexed journals) areas for the 2010–2024 period.

Table 3. Design Components (DCs) (DCs 1–19).

Id DC	DC	DC Type	DC Scale	DTSs	DC Description
DC.01	Value Index of Agile Architectural Design of IT Services	Top design goal	Scale 1: Very Low, Low, Moderate, High, Very High.	DTS.01	DC.01: Value Index of Agile Architectural Design of IT Services refers to an index to measure the value of agile architectural design of IT services. The value of a service “is created by the combination of Utility and Warranty [39] (p. 441). Value is defined as “the perceived benefits, usefulness, and importance of something” [4] (p. 254).
DC.02	Utility	Design criteria layer	Scale 2: Very Low, Low, Moderate, High, Very High.	DTS.01	DC.0: Utility refers to “the functionality offered by a product or service to meet a particular need. Utility can be summarized as ‘what the service does’, and can be used to determine whether a service is able to meet its required outcomes, or is ‘fit for purpose’ [39] (p. 17).
DC.03	Warranty	Design criteria layer	Scale 2: Very Low, Low, Moderate, High, Very High.	DTS.01, DTS.02	DC.03: Warranty refers to “an assurance that a product or service will meet its agreed requirements” [39] (p. 18). Warranty can be summarized as ‘how the service is delivered’, and can be used to determine whether a service is ‘fit for use’ [39] (p. 18).
DC.04	Benefits	Design sub-criteria layer	Scale 2: Very Low, Low, Moderate, High, Very High.	DTS.01, DTS.02	DC.04: Benefits refers to the positive impacts and effects received by users of IT services such as enhanced capabilities, increased performance, enhanced resources, reduced costs and reduced risks (adapted from [92]).
DC.05	Risks	Design sub-criteria layer	Scale 2: Very Low, Low, Moderate, High, Very High.	DTS.01, DTS.02	DC.05: Risks refers to “a possible event that could cause harm or loss, or affect the ability to achieve objectives” [92] (p. 105).
DC.06	Availability	Design sub-criteria layer	Scale 2: Very Low, Low, Moderate, High, Very High.	DTS.01, DTS.02	DC.06: Availability refers to “ability of an IT service or other configuration item to perform its agreed function when required” [93] (p. 6).
DC.07	Capacity	Design sub-criteria layer	Scale 2: Very Low, Low, Moderate, High, Very High.	DTS.01, DTS.02	DC.07: Capacity refers to “the maximum throughput that a configuration item or IT service can deliver” [39] (p. 392).
DC.08	Security	Design sub-criteria layer	Scale 2: Very Low, Low, Moderate, High, Very High.	DTS.01, DTS.02	DC.08: Security refers to “confidentiality, integrity and availability of an organization’s assets, information, data and IT services match the agreed needs of the business” [93] (p. 29).
DC.09	Continuity	Design sub-criteria layer	Scale 2: Very Low, Low, Moderate, High, Very High.	DTS.01	DC.09: Continuity refers to “an essential part of the warranty of a service. If a service’s continuity cannot be maintained and/or restored in accordance with the requirements of the business, then the business will not experience the value that has been promised. Without continuity the utility of the service cannot be accessed” [39] (p. 179).
DC.10	Performance	Design sub-criteria layer	Scale 2: Very Low, Low, Moderate, High, Very High.	DTS.01, DTS.02	C.10: Performance refers to “a measure of what is achieved or delivered by a system, person, team, process or IT service” [93] (p. 41).

Table 3. Cont.

Id DC	DC	DC Type	DC Scale	DTSs	DC Description
DC.11	Costs	Design sub-criteria layer	Scale 2: Very Low, Low, Moderate, High, Very High.	DTS.01, DTS.02	DC.11: Costs refers to “The amount of money spent on a specific activity, IT service or business unit. Costs consist of real cost (money), notional cost (such as people’s time) and depreciation” [93] (p. 18).
DC.12	Architectural App Software Component	Design Component Alternative	Scale 2: Very Low, Low, Moderate, High, Very High.	DTS.01	DC.12: Architectural App Software Component refers to “the management and control of all applications software, including both bought-in applications and in-house developed applications software” [39] (p. 47).
DC.13	Architectural Data Component	Design Component Alternative	Scale 2: Very Low, Low, Moderate, High, Very High.	DTS.01	DC.13: Architectural Data Component refers to “the management and control of all data and information and its associated access, including test data where applicable” [39] (p. 47).
DC.14	Architectural Software Component	Design Component Alternative	Scale 2: Very Low, Low, Moderate, High, Very High.	DTS.01	DC.14: Architectural Software Component refers to “System Software: “operating systems, utilities, middleware, etc., including patches and bug fixes” [94] (p. 424), and a Database Management System: “A database management system or operating system that includes many software modules which are designed to perform a set of related functions” [39] (p. 47).
DC.15	Architectural Hardware Component	Design Component Alternative	Scale 3: Very Low, Low, Moderate, High, Very High.	DTS.01	DC.15: Architectural Hardware Component refers to computing, storage and networking devices (adapted from [39]).
DC.16	Architectural Network Component	Design Component Alternative	Scale 3: Very Low, Low, Moderate, High, Very High.	DTS.01	DC.16: Architectural Network Component refers to “data networks (LANs, MANs, WANs, VPNs, protocols), internet, intranet and extranet systems. Converged network technologies, including voice networks” [39] (p. 60).
DC.17	Architectural IT Service Environment	Design Assumption	Scale 3: Very Low, Low, Moderate, High, Very High.	DTS.01	DC.17: Architectural IT Service Environment refers to “the management and control of all environmental aspects of all major equipment rooms, including the physical space and layout, power, air conditioning, cabling, physical security, etc.” [39] (p. 47).
DC.18	Architectural IT Service Teams	Design Assumption	Scale 3: Very Low, Low, Moderate, High, Very High.	DTS.01	DC.18: Architectural IT Service Teams refers to “Any internal teams providing support for any of the components required to provide the service—for example, Unix, mainframe, networks—” [39] (p. 42).
DC.19	Architectural External IT Service Suppliers	Design Assumption	Scale 3: Very Low, Low, Moderate, High, Very High.	DTS.01	DC.19: Architectural External IT Service Suppliers refers to “supporting services: any services that are necessary to support the operation of the delivered service—for example, a shared service, a managed network service” [39] (p. 42) and “suppliers: any external third parties necessary to provide support for any of the components required to provide the service—for example, networks, hardware, software.” [39] (p. 42).

Table 4. AHP Scales.

Scale 1 for the Top Goal DC.01				Scale 2 for All DCs in the Criteria and Sub-Criteria Layers				Scale 3 for All DCs in the Bottom Decisions and Assumptions Layer			
	MIN	MEAN	MAX		MIN	MEAN	MAX		MIN	MEAN	MAX
very high	90%	95%	100%	very high	0.326	0.663	1.000	very high	88%	94%	100%
high	70%	80%	89%	high	0.163	0.244	0.325	high	63%	75%	87%
moderate	30%	50%	69%	moderate	0.082	0.122	0.162	moderate	38%	50%	62%
low	10%	20%	29%	low	0.055	0.068	0.081	low	13%	25%	37%
very low	0%	5%	9%	very low	0.000	0.027	0.054	very low	0%	6%	12%

4.1.4. The AHP Design of the Artifact A: The AHP Model for Supporting the Design and Evaluation of IT Service Architectural Agile Designs

In this sub-section, we report a summary of the AHP Step 1 applied to design the artifact A.

AHP Step 1. Elaboration of the AHP Decision Value Tree (DVT) model (top layer: goal; middle layers: criteria and sub-criteria attributes; and bottom layer: candidate decisions and assumptions elements).

To design the AHP decision value tree model, we rely on the DTSs and DCs obtained from the Literature Review reported in Sections 2.1 and 2.3.

Consequently, we applied the four design heuristic operators HOs based on the AHP literature [57,58] previously reported in Section 4.1.1. In particular, the research team conducted several design sessions to apply the design heuristic HO.3 to review the overall unambiguity, comprehensiveness, directionality, operability and understandability of the set of concepts (also known as attributes) in the last level, and HO.4 to review the overall completeness, operability, decomposability, lack of redundancy, and size of the current set of selected concepts. With these design sessions, the first three design objectives DOs were reached. These DOs refer to having a theoretically based design (DO.1), to have criteria and sub-criteria layers with expected attributes (DO.2), and to have a bottom decision–assumption layer also with expected attributes (DO.3). The remaining design objectives (DOs; DO.04, DO.05, DO.06 and DO.07) were reached by applying the next DSRM research steps.

Figure 2 shows the agreed structure of the AHP decision value tree model (VTM)—with one top goal layer, one criteria layer with two criteria, one sub-criteria layer with eight sub-criteria, and one bottom decisions and assumptions layer with five design decisions and three design assumptions.

In this research, we agreed to set up as the top goal the concept of “Value Index of Agile Architectural Design of IT Services”—DC.01—which is measured using Scale 1 from 0% to 100%. This top goal is the overall integrated measurement of the value reached for a specific agile architecture design of an IT service. It is expected to evaluate at least two agile architectural IT service designs, and thus, this DC.01 measurement ranks the evaluated designs. As Table 4 reports, this DC.01 is theoretically supported by the DTS.01 set of theoretical sources. In the criteria layer, two criteria were agreed to: DC.02 “Utility” and

DC.03 “Warranty”. These two concepts are also totally supported by both the DTS.01 and DTS.02 sets of theoretical sources, and both contribute to measuring the overall top goal DC.01. DC.02 “Utility” measures the fitness to purpose of using the planned IT service, and DC.03 “Warranty” measures the fitness to use it.

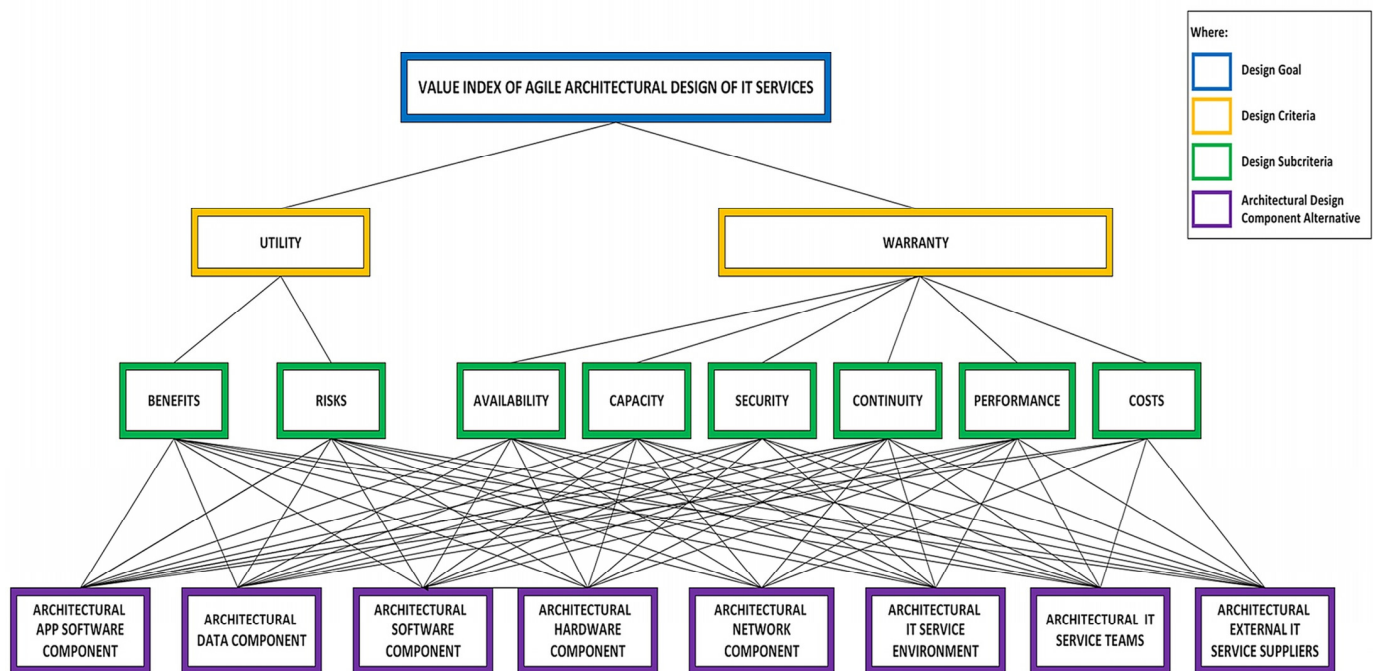


Figure 2. The AHP decision value tree model.

In the next sub-criteria layer, we agreed to use the two concepts DC.04 “Benefits” and DC.05 “Risks” linked to the DC.02 “Utility” criteria, and the six concepts DC.06 “Availability”, DC.07 “Capacity”, DC.08 “Security”, DC.09 “Continuity”, DC.10 “Performance”, and DC.11 “Costs” linked to the DC.03 “Warranty”.

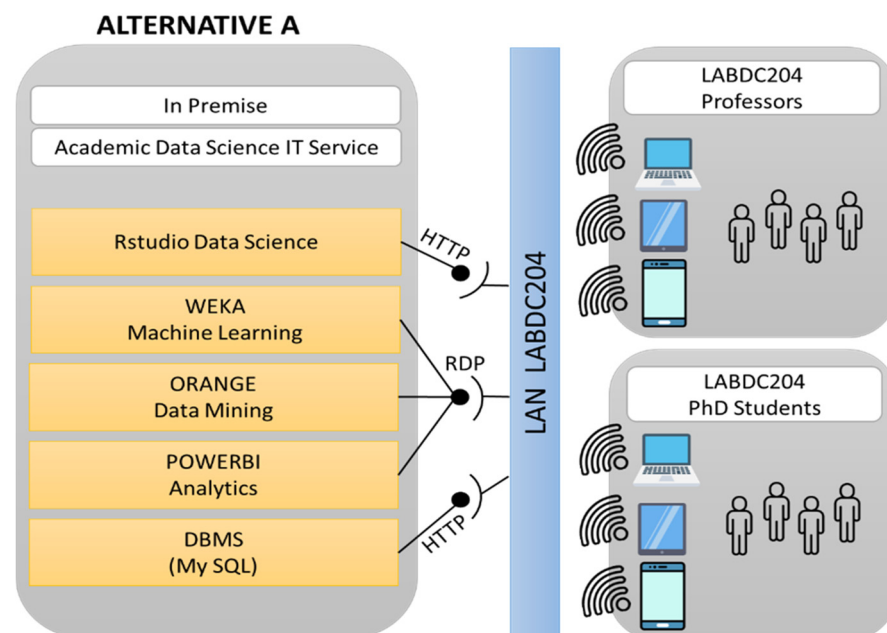
Finally, in the bottom layer of decisions and assumptions, we agreed to use five design decisions DC.12 “Architectural App Software Component”, DC.13 “Architectural Data Component”, DC.14 “Architectural Software Component”, DC.15 “Architectural Hardware Component”, and DC.16 “Architectural Network Component”, and three design assumptions DC.17 “Architectural IT Service Environment”, DC.18 “Architectural IT Service Teams” and DC.19 “Architectural External IT Service Suppliers”. Design decisions are considered controllable components by the architectural IT service decision maker. Assumptions are considered non-controllable or more difficult-to-control attributes, but they can be assumed with specific levels of measurement. In this way, these measurements can be varied to analyze different agile architectural IT design scenarios.

4.2. Development and Proof of Concept of the Artifact A*: Computational Implementation of the Artifact A (AHP-AgileITS-ArchDesign Model)

In this section, we report the application of the AHP Steps 2 and 3 to present the implementation of the artifact A*—Proof of Concept of the artifact A AHP-AgileITS-ArchDesign model—with an illustrative case: “Academic Data Science Analytics Platform IT Service”. This case is based on the real needs from the research team in the “Data Science Analytics LABDC204” at a Mexican University. Table 5 reports the IT Service Business Case for this IT service, and Figures 3 and 4 illustrate the general architectural views for the two proposed IT service agile designs A and B.

Table 5. Business case for the “Academic Data Science Analytics Platform IT Service”.

Item	Item Description
Business Case Aim	A short 4–12 week period is required to release “Academic Data Science Analytics Platform IT Service” to support the academic and research activities of the research team (4 Professors and 5 PhD students) in the “Data Science Analytics LABDC204”.
Business Case Requirements	Requirement 1. Users (Professors and PhD Students) need to access via the web (http) software that provides basic, intermediate and advanced functionalities for Data Science projects. R software is suggested (or other software with similar functionalities). Several users can be connected concurrently. Users can use their laptops, tablets or mobile phones. Requirement 2. Users (Professors and PhD Students) need to access remotely a software specialized for Machine Learning projects. WEKA software is suggested (or other software with similar functionalities). Several users can be connected concurrently. Users can use their laptops, tablets or mobile phones. Requirement 3. Users (Professors and PhD Students) need to access remotely a software specialized for Data Mining projects. ORANGE software is suggested (or other software with similar functionalities). Several users can be connected concurrently. Users can use their laptops, tablets or mobile phones. Requirement 4. Users (Professors and PhD Students) need to access remotely a software specialized for Business Analytics projects. POWERBI is suggested (or other software with similar functionalities). Several users can be connected concurrently. Users can use their laptops, tablets or mobile phones. Requirement 5. Users (Professors and PhD Students) need to remotely access a Laser Printer service. Requirement 6. Users (Professors and PhD Students) need to remotely access a DBMS software that is connected to the software tools from Requirements 1, 2, 3 and 4. MySQL is suggested (or other software with similar functionalities).
Business Case IT Services Design Alternatives	IT service design A: this overall design consists of implementing “Academic Data Science Analytics Platform IT Service” with the LABDC204 IT infrastructure and Open Source software tools, that is, on-premise. IT service design B: this overall design consists of implementing “Academic Data Science Analytics Platform IT Service” in the Cloud by paying for all components of the IT service.

**Figure 3.** General architectural view of the IT service design A for “Academic Data Science Analytics Platform IT Service”.

AHP Step 2. Quantitative Procedures (pairwise comparison matrices; derived local priority vectors, derived global priority vectors, and Consistency Ratios (CRs) for all criteria levels).

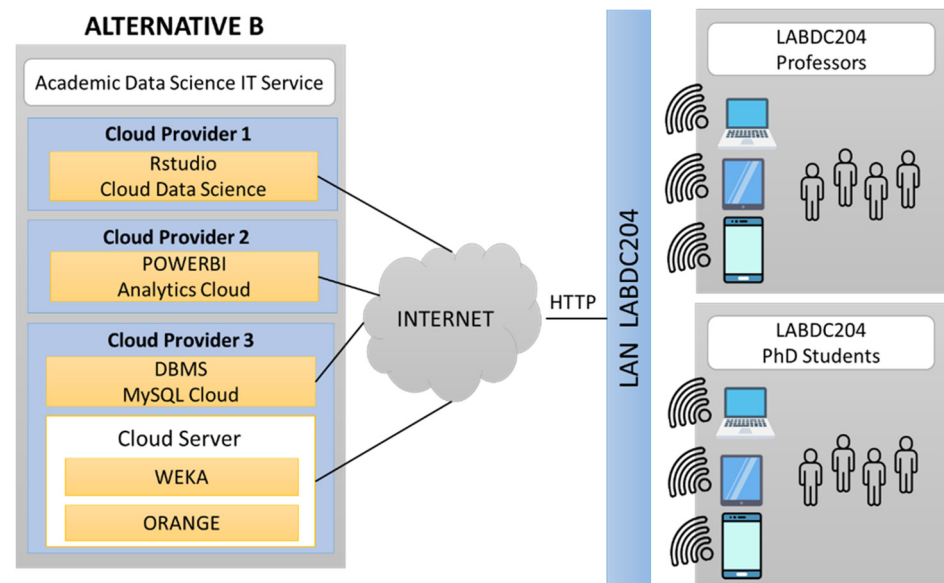


Figure 4. General architectural view of the IT service design B for “Academic Data Science Analytics Platform IT Service”.

We use the CDP free academic software tool [95] for implementing the AHP decision value tree model. With the CDP academic software tool, we calculated both derived local and global priority vectors and the CRs for all criteria layers. The relative measures method was used and, thus, pairwise comparisons using the fundamental 9-point scale were performed to generate the 3 initial pairwise comparison matrices A. Appendix C reports the three matrices A (Tables A8–A10).

The first matrix (Table A8) corresponds to the levels of importance assigned to Utility and Warranty criteria regarding the top Value Index of Agile Architectural Design of IT Services. The second matrix (Table A9) corresponds to the levels of importance assigned to Benefits and Risks sub-criteria regarding the Utility criteria. The last matrix (Table A10) corresponds to the levels of importance assigned to Availability, Capacity, Security, Continuity, Performance, and Costs sub-criteria regarding the Warranty criteria. It must be noted that the two proposed designs to be evaluated—called alternative A and alternative B—must use the same assignment of weights in the three matrices, which will help finally to measure the overall top Value Index of Agile Architectural Design of IT services. The assignment of levels of importance—i.e., the pairwise comparisons—must be made by the IT Service Architectural Design Team and the main User for the planned IT service, based on the experience of the team, the project objectives pursued, and the economic and technical feasibility of the potential IT components to be used. In this Academic Data Science Analytics Platform IT service case, the research team realized these assignments.

Figure 5 shows the AHP model with the values of the derived global priorities $w_2 = [0.500, 0.500]$ and $w_3 = [0.375, 0.125, 0.040, 0.040, 0.040, 0.040, 0.111, 0.227]$, respectively, for the second and third layers. These vectors represent the distribution of contribution percentages of such layers regarding the 100% in the top goal—i.e., the Value Index of Agile Architectural Design of IT Services. Consequently, in the second layer (Design criteria), the contributions to the top level (Value Index of Agile Architectural Design of IT Services) from Utility and Warranty were equally 50% (i.e., derived global priority of 0.500). For the third layer (Design sub-criteria), the contributions to Utility from Benefits and Risks were 37.5% (derived global priority of 0.375) and 12.5% (derived global priority of 0.125), respectively. Also, in this third layer (Design sub-criteria), the contributions to Warranty from Availability, Capacity, Security, and Continuity were 4.0% (derived global priority

of 0.040) and Performance and Costs were, respectively, 11.1% (derived global priority of 0.111) and 22.7% (derived global priority of 0.227).

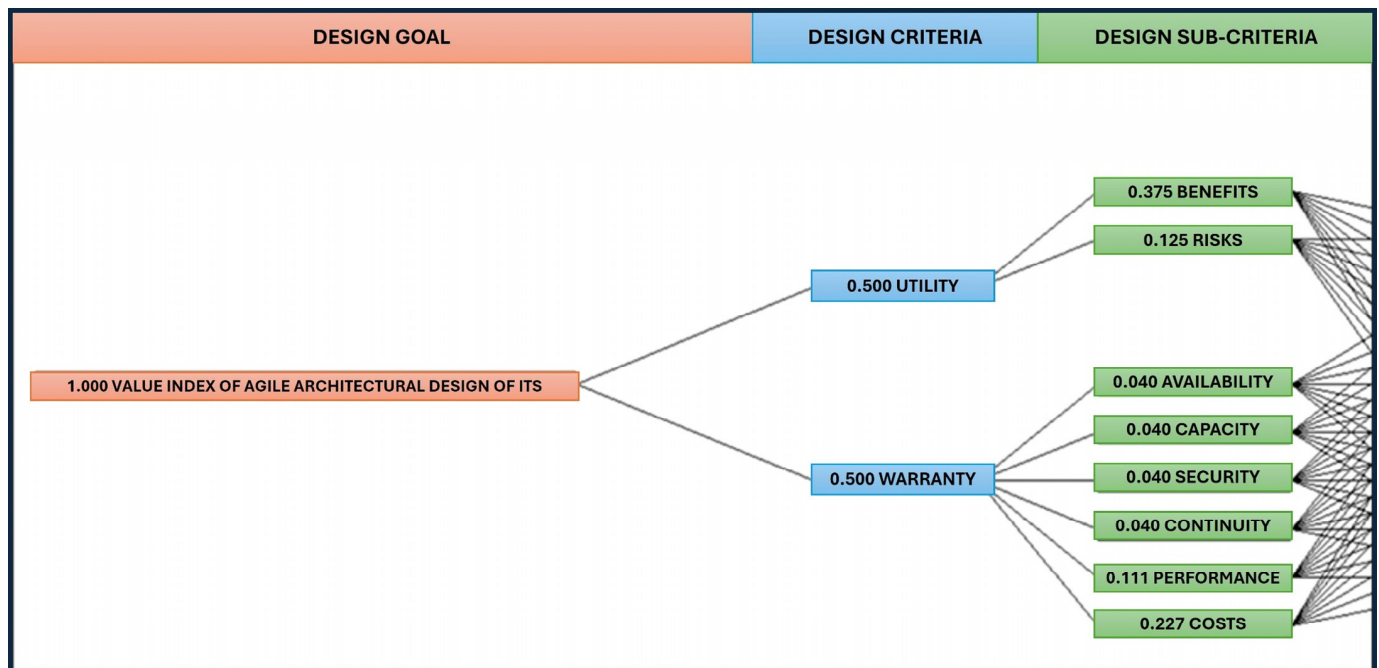


Figure 5. The AHP decision value tree model for the Value Index of Agile Architectural Design of IT Service.

The AHP pairwise comparison matrices and their respective CR values are reported in Tables A8–A10 in Appendix C. For this Academic Data Science Analytics Platform IT Service case, the levels of importance agreed were as follows:

- Utility and Warranty contribute equally (value 1) to the Value Index of Agile Architectural Design of IT Services.
- Benefits contribute moderately (value 3) more than Risks to the Utility score.
- Costs contribute strongly (value 5) more than Availability, Capacity, Security, and Continuity to the Warranty score, and contribute moderately (value 3) more than Performance to the Warranty score.
- Performance contributes moderately (value 3) more than Availability, Capacity, Security, and Continuity to the Warranty score, and contributes moderately (value 1/3) less than Costs to the Warranty score.
- All remaining pairwise comparisons are considered with equal contribution (value 1).

AHP Step 3. Evaluation and Reporting of Candidate Decisions and Assumptions (report results and conduct further analysis if required). We applied four sub-steps in this AHP Step 3 as follows:

- **AHP Step 3.1. Define Qualitative Input Data Matrices using Scale 3** (Tables 6 and 7, respectively, for IT service designs A and B). Scale 3 was of absolute type. In this scale mode, each candidate decision and assumption in the bottom layer is individually rated against each linked attribute in the next layer. A relative scale mode was not used because the number of pairwise comparisons in this bottom layer was high and it introduces unnecessary complexity to decision makers.

Table 6. Qualitative input matrix for the IT service design A using Scale 3.

Value Decision Tree		Architectural IT Service Design Components							
Design Criteria	Design Sub-Criteria	App Software	Software	Data	Hardware	Network	Environment	Teams	External IT Service Providers
Utility	Benefits Risks	Very High Moderate	Very High Moderate	Very High Moderate	Very High Moderate	Very High Moderate	Very High Moderate	Very High Moderate	Very High Moderate
Warranty	Availability	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate
	Capacity	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate
	Security	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate
	Continuity	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate
	Performance	Very High	High	High	High	High	High	High	High
	Costs	Very High	High	High	High	High	High	High	High

Table 7. Qualitative input matrix for the IT service design B using Scale 3.

Value Decision Tree		Architectural IT Service Design Components							
Design Criteria	Design Sub-Criteria	App Software	Software	Data	Hardware	Network	Environment	Teams	External IT Service Providers
Utility	Benefits Risks	Very High Moderate	Very High Moderate	Very High Moderate	Very High Moderate	Very High Moderate	Very High Moderate	Very High Moderate	Very High Moderate
Warranty	Availability	High	High	High	High	High	High	High	High
	Capacity	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate
	Security	High	High	High	High	High	High	High	High
	Continuity	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate
	Performance	Very High	High	High	High	High	High	High	High
	Costs	Low	Low	Low	Low	Low	Low	Low	Low

- **AHP Step 3.2. Transform to Quantitative Input Data Matrices using a LogNormal(μ , σ) function** (Appendix C: Tables A11 and A12 for IT service designs A and B respectively). We used a Probability Distribution Density (LogNormal(μ , σ)) instead of a crisp score for all eight decision and assumption DCs. This enables Uncertainty Analysis of results, and reflects a more real-like evaluation scenario including variability on the scores assigned by the research team.
- **AHP Step 3.3. Report the unique AHP matrix of derived global priorities for the Design goal (top level), Design criteria (second level) and Design sub-criteria (third level) of the AHP model** (Appendix C: Table A13). In this sub-step 3.3, we used a distributive calculation method—instead of an ideal method—to calculate the overall contributions from all candidate decisions and assumptions (bottom layer) to the next layer (the Design sub-criteria one in the third layer). Then, these overall contributions are similarly propagated toward the second (Design criteria) and the first (Agile Architectural Design of IT Services top goal) layers.
- **AHP Step 3.4. Report the Value Index of Agile Architectural Design of IT Services and the AHP matrix of the Overall Priorities of Contribution for the two IT service designs A and B evaluated using Scale 1** (Tables 8 and 9, respectively, for IT service designs A and B). Finally, we used Scale 1 here to determine the absolute score reached by the top goal (Agile Architectural Design of IT Services).

Table 8. AHP matrix of overall priorities of contribution and Value Index of agile architectural design of IT services for the two competitive IT service design A.

AHP Value Decision Tree				Architectural IT Service Design Components							
Design Goal	Design Criteria	Design Sub-Criteria		App Software	Software	Data	Hardware	Network	Environment	Teams	External IT Service Providers
Value Index of Agile Architectural Design of IT Services = 0.780	Utility = 0.391	Benefits	0.293	0.857	0.722	0.722	0.722	0.722	0.722	0.722	0.722
		Risks	0.098	0.857	0.722	0.722	0.722	0.722	0.722	0.722	0.722
	Warranty = 0.389	Availability	0.031	0.857	0.722	0.722	0.722	0.722	0.722	0.722	0.722
		Capacity	0.031	0.857	0.722	0.722	0.722	0.722	0.722	0.722	0.722
		Security	0.031	0.857	0.722	0.722	0.722	0.722	0.722	0.722	0.722
		Continuity	0.031	0.857	0.722	0.722	0.722	0.722	0.722	0.722	0.722
		Performance	0.087	0.857	0.722	0.722	0.722	0.722	0.722	0.722	0.722
		Costs	0.178	0.857	0.722	0.722	0.722	0.722	0.722	0.722	0.722

Table 9. AHP matrix of overall priorities of contribution and value index of agile architectural design of IT services for the two competitive IT service design B.

AHP Value Decision Tree				Architectural IT Service Design Components							
Design Goal	Design Criteria	Design Sub-Criteria		App Software	Software	Data	Hardware	Network	Environment	Teams	External IT Service Providers
Value Index of Agile Architectural Design of IT Services = 0.680	Utility = 0.341	Benefits	0.256	0.707	0.679	0.679	0.679	0.679	0.679	0.679	0.679
		Risks	0.085	0.707	0.679	0.679	0.679	0.679	0.679	0.679	0.679
	Warranty = 0.339	Availability	0.027	0.707	0.679	0.679	0.679	0.679	0.679	0.679	0.679
		Capacity	0.027	0.707	0.679	0.679	0.679	0.679	0.679	0.679	0.679
		Security	0.027	0.707	0.679	0.679	0.679	0.679	0.679	0.679	0.679
		Continuity	0.027	0.707	0.679	0.679	0.679	0.679	0.679	0.679	0.679
		Performance	0.076	0.707	0.679	0.679	0.679	0.679	0.679	0.679	0.679
		Costs	0.155	0.707	0.679	0.679	0.679	0.679	0.679	0.679	0.679

To complete the utilization of the AHP method, several specific expected and optional analyses can be conducted. The main usual ones are: (1) Analysis of Contributions; (2) Sensitivity Analysis; and (3) Uncertainty Analysis. In this paper, we illustrate only the Analysis of Contributions, but all these three analyses should be conducted for a real case application. Figures 6 and 7 show the contributions of each one of the 8 architectural IT service components to each one of the 8 criteria–sub-criteria elements, respectively, for the IT service designs A and B—using horizontal bar charts. Finally, Figure 8 illustrates the implementation of Requirement 1 in the IT service design A.

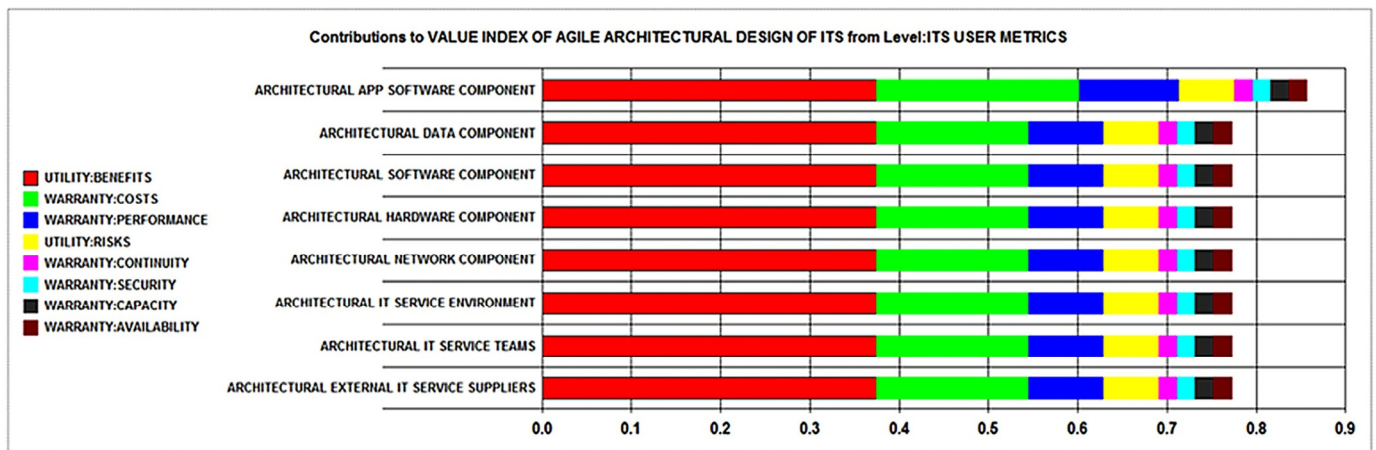


Figure 6. Contribution of the design components to the criteria and sub-criteria elements in IT service design A.

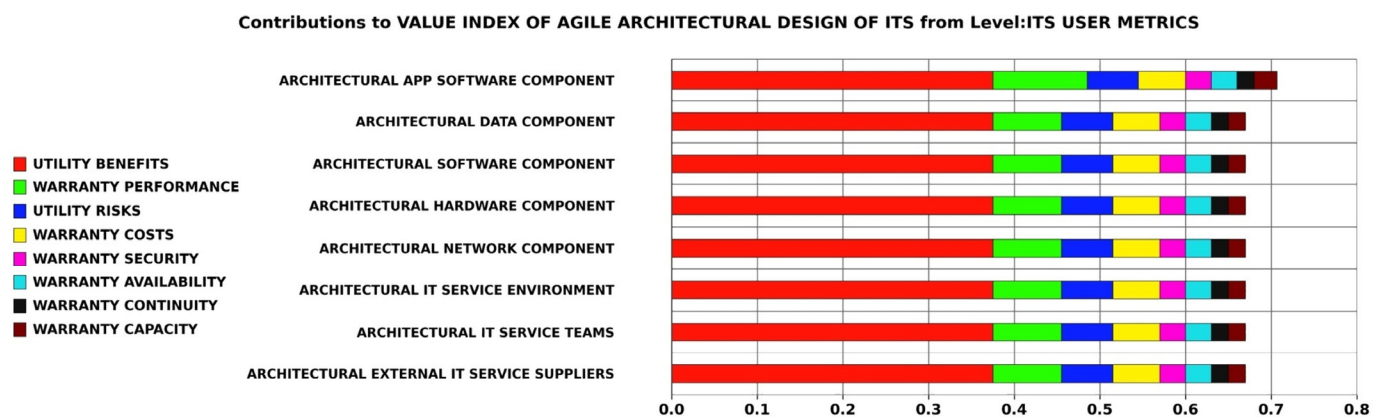


Figure 7. Contribution of the design components to the criteria and sub-criteria elements in IT service design B.



Figure 8. Illustration of the implementation of Requirement 1 in IT service design A.

4.3. Inclusion of the Artifact A (AHP-AgileITS-ArchDesign Model) in the Full AVS_FD_MVITS Workflow

AVS_FD_MVITS is an Agile Value Stream for developing Minimum Viable IT services recently reported in the literature [30,31]. AVS_FD_MVITS was designed using design components taken from Scrum-XP and ITIL v4 IT service design workflows. The new

proposed AHP-AgileITS-ArchDesign model has been included in an updated version of AVS_FD_MVITS—renamed as AHP_AVS_FD_MVITS_v3 [30,31]—but this AHP model can be included in other IT service design workflows, providing specific how-to knowledge for the agile but systematic evaluation of two or more architectural IT service designs.

The aim of the AHP_FD_MVITS workflow [30,31] is “to provide an agile and practical—useful, ease of use, compatible, and valuable—value stream for designing, AHP-based evaluating—selecting, building, and releasing a Minimum Viable IT Service (MVITS) in small and medium-sized Data Centers environments in an expected time-frame from 4 to 12 weeks”.

This new agile IT service design workflow basically updated the Task T.1.2—named MVITS architecture sketch elaboration and AHP evaluation—so that the Agile MVITS development team can iteratively elaborate two simple IT service designs, A and B. Each simple IT service design is an MVITS architecture sketch using the MVITS backlog (i.e., the MVITS vision and the set of user stories), and these two IT service designs will be evaluated with the AHP-AgileITS-ArchDesign model. The full AHP_AVS_FD_MVITS_v3 EPG can be downloaded from [31].

5. Conceptual Validity and Exploratory Usability Evaluation on the Designed Artifact A: AHP-AgileITS-ArchDesign Model

Here, Section 5.1 presents the conceptual evaluation performed by a Panel of Experts, and in Section 5.2, the exploratory usability evaluation performed by a pilot sample of 62 ITSM academics and practitioners.

5.1. Conceptual Evaluation by a Panel of Experts

For the conceptual validation of the proposed model, a methodological procedure adapted from [96–98] was implemented. This procedure allowed us to gather evidence on the Theoretical Validity and Theoretical Consistency of the AHP-AgileITS-ArchDesign model, considering the perceptions of a Panel of Experts in agile practices and IT service architectures. In order to structure this validation in a systematic manner, a set of six tasks was designed, ranging from the development of the conceptual artifact to the analysis of the collected data. These six tasks were planned and executed to ensure methodological consistency and the quality of the information obtained. The six tasks were: Task 1: Development of the Conceptual Artifact; Task 2: Design of Data Collection instruments; Task 3: Definition of Criteria for Expert Inclusion; Task 4: Selection and Contact with Experts; Task 5: Demographic Data Analysis; and Task 6: Conceptual Validation Analysis.

Appendix D reports the details of the execution of these six tasks. A summary of the main results from them is as follows:

- The Conceptual Validity Questionnaire (Table A14) used was formed with three items to measure Theoretical Validity and four items to measure Theoretical Consistency. Each item was evaluated using a 5-point Likert scale (1: strongly disagree; 5: strongly agree).
- Demographic data (Tables A15 and A16) revealed the seniority professional level of the contacted Panel of Experts: the 56% is at least 50 years old; 56% of them have accumulated at least 20 years in working settings; on average, 43% have 10 or more years involved in agile processes (37%) and ITSM practices (50%); a similar 43%, on average, have participated in at least 10 projects using agile processes (43.7%) and ITSM practices (43.6%); and most of them self-evaluated with high or very high levels of expertise on ITSM practices (55%) and a relevant percentage on agile processes (43%).
- Descriptive statistics (Table A17) of the used instrument were satisfactory. The mean, median, standard deviation and reliability metric (Cronbach’s alpha) obtained for the two constructs, Theoretical Validity and Theoretical Consistency, were (4.25, 4.50,

0.765, 0.830) and (3.86, 3.75, 1.037, 0.869), respectively. A Wilcoxon Signed-Ranks Test of medians [99] using the free academic JASP v19 tool [100] was also applied against a threshold value of 3.00 (Table A18) with satisfactory results.

- Internal Consistency Reliability, Convergent Validity and Discriminant Validity metrics of the measurement instrument also reached satisfactory statistical-based levels by using the PLS method [101–104] with the free academic tool SmartPLSv4 [105]. Table A19 presents the criteria for considering satisfactory the quality of the instrument, and Table A20 reports the results obtained for the sample of 16 senior Experts.

5.2. Exploratory Empirical Evaluation on Usability Metrics from a Pilot Sample of Academics and Practitioners

This section presents the results of the exploratory empirical evaluation carried out with a pilot sample of 62 evaluators, including mainly practitioners from business organizations, complemented with academic and governmental IT people. The objective of this evaluation was to analyze and compare perceptions of the AHP-AgileITS-ArchDesign model versus an alternative IT service architectural design Model Y in terms of usefulness, ease of use, compatibility, perceived value, and attitude toward potential use to evaluate the usability.

In this usability evaluation, we used a classic case: “The Pet e-Store Case Study” [106]. Evaluation materials on this case and the Demographic and Usability Questionnaires were sent to the group of evaluators through email. This group was formed from volunteers contacted through LinkedIn groups on IT systems architecture and voluntary academics from academic list servers. Appendix E (Table A21) reports the instructions sent to potential evaluators. This case study is used to evaluate the usability metrics on the AHP-AgileITS-ArchDesign model against any alternative IT service architectural design Model Y used by them. We did not pre-define a set of plausible models Y because the literature reviewed did not provide evidence of a particular Model Y—i.e., methods based on the main IT Service Management (ITSM) frameworks and standards such as ITIL v2011 [1], CMMI-SVC [2], ISO/IEC 20000 [6], and ISO/IEC 29110—through the complementary Technical Reports (TR) 29110-4-3 [7] and 29110-5-3 [8] and ITIL v4 [3,4] and VeriSM [5].

Additionally, due to the exploratory pilot evaluation and the relatively small sample size collected, applying statistical tests for comparing usability metrics from Model X vs. each particular Model Y was considered not feasible for potentially very small sub-samples. Then, we agreed to compare the usability metrics from Model X vs. the overall obtained from the set of any used Model—e.g., each unknown Model Y.

Task 1: Demographic Data Analysis. The sample consisted of 62 evaluators in total. The demographic description of the sample is presented in Table 10.

Table 10 (part 1 from questions 1 to 8) reveals that the most participants were in the youngest range level of 20–30 age range (64.5%), but most of them have a Master’s or graduate level of formal education (61.3%), and work for business organizations (46.8%) with a nationwide (50.0%) or worldwide scope (25.8%), and come from a Computer Engineering background (48.4%).

Table 10 (Part 2 from questions 9 to 11) also reveals that most of them can be considered IT novice professionals in their first professional stage by the number of years engaged with agile processes and ITSM practices, as well as by the low number of agile and ITSM projects involved. However, around 80% and 62% of them self-evaluate with at least a moderate level of expertise on agile processes and ITSM practices, respectively. These percentages suggest that most of the 62 evaluators, despite their initial level of practice expertise, are satisfactorily aware—through previous academic and/or professional training courses—of knowledge about agile processes and ITSM practices.

Table 10. Demographic characteristics of the evaluators.

Demographic Item	Expert Evaluators (%)	Demographic Item	Expert Evaluators (%)
1. Age range:		5. Scope of work setting:	
() 20–30 years	64.5	() Regional	24.2
() 31–40 years	8.1	() Nationwide	50.0
() 41–50 years	21.0	() Worldwide	25.8
() >50 years	6.5	6. Region of working setting:	
2. Academic highest gained level:		() USA/CAN	43.5
() Bachelor level	24.2	() Europe	3.2
() Bachelor (plus Prof. Certifications)	6.5	() Asia/Oceania	21.0
() Master's level	61.3	() Latin America	32.3
() Doctorate level	8.1	7. Years in work settings:	
3. Main area of formal studies:		() 1–5 years	62.9
() Computer Engineering	48.4	() 6–10 years	6.5
() Business Informatics	19.4	() 11–15 years	4.8
() Business Management	8.1	() 16–20 years	12.9
() Other	24.2	() 20 or more years	12.9
4. Main work setting:		8. Main Work Position:	
() Business enterprise	46.8	() Academic/Researcher	21.0
() University/Research Unit	38.7	() IT Project Manager/IT Consultant	51.6
() Government Unit	14.5	() Business Mgr./Business Consultant	4.8
9A. Years involved in AGILE PROCESS (SCRUM, XP, etc.):		() Other	22.6
() <1 year	45.2	9B. Years involved in ITSM PRACTICES (ITIL, CMMI-SVC, etc.):	
() 1–3 years	24.2	() <1 year	56.5
() 4–6 years	12.9	() 1–3 years	9.7
() 7–9 years	14.5	() 4–6 years	4.8
() 10 or more years	3.2	() 7–9 years	16.1
10A. Number of projects in AGILE PROCESS (SCRUM, XP, etc.):		() 10 or more years	12.9
() 1–3	62.9	10B. Number of projects in ITSM PRACTICES (ITIL, CMMI-SVC, etc.):	
() 4–6	12.9	() 1–3	66.1
() 7–9	6.5	() 4–6	9.7
() 10 or more	17.7	() 7–9	6.5
11A. Self-evaluation of expertise in AGILE PROCESS (SCRUM, XP, etc.):		() 10 or more	17.7
() Very high level of expertise	6.5	11B. Self-evaluation of expertise in ITSM PRACTICES (ITIL, CMMI-SVC, etc.):	
() High level of expertise	17.7	() Very high level of expertise	6.5
() Moderate level of expertise	54.8	() High level of expertise	17.7
() Low level of expertise	12.9	() Moderate level of expertise	38.7
() Very low level of expertise	8.1	() Low level of expertise	16.1
		() Very low level of expertise	21.0

We must remark that due to the small size of the sample collected and with a Pilot Sample Exploratory Evaluation approach, the response biases (acquiescence, extremity, interviewer, and social desirability) were not analyzed. These bias controls are usually reported in confirmatory survey research using a larger sample size (between 100 and 300 respondents) [107,108].

Task 2: Measurement Scales of Usability Metrics. The usability evaluation was structured around five main constructs: usefulness, ease of use, compatibility, value, and attitude of potential use. The first four were evaluated using 5-point Likert-type items from 1 = strongly disagree to 5 = strongly agree. The construct attitude of potential use was measured with a 7-point semantic differential scale, ranging from −3 (extremely negative)

to +3 (extremely positive). Table 11 presents the constructs evaluated, their number of items (*item EOU3 into the Ease of Use construct was dropped in the PLS calculation process), and their measurement scales. The full Usability Questionnaire is reported in Appendix E, and this was adapted from [109].

Table 11. Constructs evaluated, number of items, and measurement scales.

Construct	Definition	Items	Scale
Usefulness	Degree to which the tool is perceived as better than the one currently used.	4	5-point Likert scale (1 = Strongly disagree, 5 = Strongly agree)
Ease of Use	Degree to which the tool is perceived as easy to use.	3 *	5-point Likert scale (1 = Strongly disagree, 5 = Strongly agree)
Compatibility	Degree to which the tool is compatible with the user's tasks.	3	5-point Likert scale (1 = Strongly disagree, 5 = Strongly agree)
Value	Perceived value in terms of savings in time, money, and resources.	4	5-point Likert scale (1 = Strongly disagree, 5 = Strongly agree)
Attitude of Potential Use	Positive or negative assessment of the potential use of the tool.	3	7-point semantic differential scale (−3 to +3)

To determine the Internal Consistency Reliability, the Convergent Validity and the Discriminant Validity of the five usability metrics—i.e., the construct's usefulness, ease of use, compatibility, value and attitude of potential use—we again used the PLS method [101–104] and the free academic version of the SmartPLS v4 software tool [105]. For this case, two datasets of 62 records were collected for the usability metrics of the AHP-AgileITS-ArchDesign model and for the alternative IT service architectural design Model Y used for the senior Experts.

PLS [101–104] is a multivariate statistical analysis method of second generation that: (1) estimates simultaneously the Internal Consistency Reliability, the Convergent Validity, and the Discriminant Validity metrics of constructs, the Regression Coefficients between plausible hypothesized associations among constructs—called Path Analysis—as well as the explained Variance R^2 of the dependent constructs; (2) is valid for small-sized samples; and (3) does not require datasets that can be considered from Normal statistical distributions for each construct. In this research, we used PLS only for validating the measurement instruments. The validation of the structural PLS model of associations among constructs is not reported. Tables 12 and 13 report the Internal Consistency Reliability, the Convergent Validity, and the Discriminant Validity results, respectively, for the AHP-AgileITS-ArchDesign model and the alternative IT service architectural design Model Y.

Tables 12 and 13 use the label abbreviations [USF, EOS, COM, VAL, ATT] for the factor items assigned respectively to the constructs usefulness, ease of use, compatibility, value and attitude of potential use. It is important to remark that a single Usability Questionnaire was used, where evaluators assigned their scores simultaneously to the two models. However, because two datasets are generated, it is necessary to determine the quality of the same instrument with each dataset.

The values of the Internal Consistency Reliability metrics (ρ_c ; Cronbach α) for the five constructs for the two models (AHP-AgileITS-ArchDesign model and the alternative IT service architectural design Model Y) were satisfactory. They fitted the recommended threshold range of 0.700 to 0.950, except for attitude potential of use in Model Y, with a slight excess of 0.006.

Table 12. Quality of the usability metrics measurement instrument for the AHP-AgileITS-ArchDesign model.

Metrics		Constructs				
		Usefulness	Ease of Use	Compatibility	Value	Attitude of Potential Use
Composite Reliability Index (rho_c) $0.700 \leq \text{rho_c} < 0.950$		0.814	0.833	0.846	0.842	0.920
Cronbach's Alpha Reliability (α) $0.700 \leq \alpha < 0.950$		0.704	0.707	0.736	0.756	0.873
Convergent Validity $0.707 \leq \lambda$ Discriminant Validity $\lambda > \sim \lambda$	Items	Factor Item Loadings (λ)				
	USF1	0.749	0.094	0.242	0.474	0.422
	USF2	0.696 *	0.270	0.410	0.418	0.385
	USF3	0.771	0.228	0.171	0.411	0.478
	USF4	0.674 *	0.310	0.209	0.257	0.410
	EOU1	0.063	0.687 *	0.300	0.105	0.073
	EOU2	0.320	0.984	0.309	0.428	0.237
	COM1	0.328	0.237	0.858	0.556	0.303
	COM2	0.229	0.277	0.794	0.339	0.093
	COM3	0.300	0.311	0.759	0.371	0.430
	VAL1	0.381	0.257	0.480	0.768	0.485
	VAL2	0.571	0.361	0.444	0.790	0.453
	VAL3	0.347	0.145	0.371	0.713	0.263
	VAL4	0.334	0.413	0.331	0.753	0.142
	ATT1	0.543	0.261	0.326	0.509	0.911
	ATT2	0.563	0.082	0.318	0.407	0.949
	ATT3	0.441	0.248	0.289	0.310	0.808
Convergent Validity $0.500 \leq \text{AVE}$		Average Extracted Variances (AVE)				
		0.524	0.720	0.647	0.572	0.795
Discriminant Validity $r_{XY} < \sqrt{\text{AVE}}$; $0.850 < \text{HTMT}$ (very different constructs) $0.900 < \text{HTMT}$ (very similar constructs)	sqrt(AVE) vs. Correlations (r_{XY}); HTMT					
	Usefulness	sqrt(AVE) = 0.724 $r_{XY}(\text{EOU}, \text{USF}) = 0.291$;	-	-	-	-
	Ease of Use	HTMT(EOU,USF) = 0.382 $r_{XY}(\text{COM}, \text{USF}) = 0.361$;	sqrt(AVE) = 0.849	-	-	-
	Compatibility	HTMT(COM,USF) = 0.502 $r_{XY}(\text{VAL}, \text{USF}) = 0.558$;	$r_{XY}(\text{COM}, \text{EOU}) = 0.332$;	sqrt(AVE) = 0.805	-	-
		HTMT(COM,USF) = 0.502 $r_{XY}(\text{VAL}, \text{EOU}) = 0.394$;	HTMT(COM,EOU) = 0.502 $r_{XY}(\text{VAL}, \text{COM}) = 0.547$;		-	-
	Value	HTMT(VAL,USF) = 0.703 $r_{XY}(\text{ATT}, \text{USF}) = 0.583$;	HTMT(VAL,EOU) = 0.423 $r_{XY}(\text{ATT}, \text{EOU}) = 0.221$;	sqrt(AVE) = 0.756	$r_{XY}(\text{ATT}, \text{COM}) = 0.291$;	$r_{XY}(\text{ATT}, \text{VAL}) = 0.350$;
	Attitude of Potential Use	HTMT(ATT,USF) = 0.744	HTMT(ATT,EOU) = 0.254			
					HTMT(ATT,COM) = 0.426	HTMT(ATT,VAL) = 0.532
						sqrt(AVE) = 0.892

Regarding the Convergent Validity (AVE, factor item loadings (λ)) metrics, for the two models, the Average Extracted Variances (AVE) for the five constructs were satisfactory by exceeding the threshold of 0.500. According to the factor item loadings (λ), 13 of 16 for the AHP model and all 16 of 16 for Model Y were satisfactory by exceeding the expected threshold of 0.708. The other three factor item loadings were very near to 0.708 and all of them loaded more in their assigned construct than in the others, also supporting adequate related Discriminant Validity. These factor item loadings vectors were: [USF2, 0.696*, 0.270, 0.410, 0.418, 0.385] and [USF4, 0.674*, 0.310, 0.209, 0.257, 0.410] item loadings for usefulness construct, and [EOU1, 0.063, 0.687*, 0.300, 0.105, 0.073] for ease of use construct, all of them in the model AHP. For Model Y, this first criterion of Discriminant Validity was totally satisfactory.

Table 13. Quality of the usability metrics measurement instrument for the alternative IT service architectural design Model Y.

Metrics		Constructs				
		Usefulness	Ease of Use	Compatibility	Value	Attitude of Potential Use
Composite Reliability Index (rho_c) $0.700 \leq \text{rho_c} < 0.950$		0.946	0.915	0.931	0.900	0.956 *
Cronbach's Alpha Reliability (α) $0.700 \leq \alpha < 0.950$		0.924	0.815	0.889	0.851	0.931
Convergent Validity $0.707 \leq \lambda$ Discriminant Validity $\lambda > \sim \lambda$	Items	Factor Item Loadings (λ)				
	USF1	0.915	0.058	0.728	0.736	0.716
	USF2	0.858	0.249	0.759	0.668	0.649
	USF3	0.890	0.303	0.655	0.706	0.620
	USF4	0.947	0.131	0.796	0.728	0.691
	EOU1	0.192	0.912	0.091	0.369	0.125
	EOU2	0.180	0.925	0.074	0.397	0.050
	COM1	0.725	0.113	0.902	0.527	0.522
	COM2	0.741	0.097	0.899	0.565	0.554
	COM3	0.740	0.028	0.913	0.504	0.571
	VAL1	0.597	0.368	0.399	0.755	0.458
	VAL2	0.649	0.302	0.459	0.849	0.603
	VAL3	0.740	0.204	0.646	0.820	0.599
	VAL4	0.617	0.536	0.432	0.900	0.496
	ATT1	0.673	0.078	0.603	0.582	0.923
	ATT2	0.738	0.098	0.564	0.645	0.969
	ATT3	0.673	0.088	0.543	0.606	0.921
Convergent Validity $0.500 \leq \text{AVE}$		Average Extracted Variances (AVE)				
		0.816	0.844	0.819	0.693	0.880
		sqrt(AVE) vs. Correlations (r_{XY}); HTMT				
Discriminant Validity $r_{XY} < \text{sqrt(AVE)}$; $0.850 < \text{HTMT}$ (very different constructs) $0.900 < \text{HTMT}$ (very similar constructs)	Usefulness	sqrt(AVE) = 0.903 $r_{XY}(\text{EOU}, \text{USF}) = 0.202$;	-	-	-	-
	Ease of Use	$\text{HTMT}(\text{EOU}, \text{USF}) = 0.237$ $r_{XY}(\text{COM}, \text{USF}) = 0.813$;	sqrt(AVE) = 0.919	-	-	-
	Compatibility	$r_{XY}(\text{COM}, \text{EOU}) = 0.089$;	$r_{XY}(\text{COM}, \text{EOU}) = 0.108$	sqrt(AVE) = 0.905	-	-
		$\text{HTMT}(\text{COM}, \text{USF}) = 0.897 *$				
	Value	$r_{XY}(\text{VAL}, \text{USF}) = 0.787$;	$r_{XY}(\text{VAL}, \text{EOU}) = 0.417$;	$r_{XY}(\text{VAL}, \text{COM}) = 0.589$;	sqrt(AVE) = 0.833	-
		$\text{HTMT}(\text{VAL}, \text{USF}) = 0.882 *$	$\text{HTMT}(\text{VAL}, \text{EOU}) = 0.508$	$\text{HTMT}(\text{VAL}, \text{COM}) = 0.667$		
	Attitude of Potential Use	$r_{XY}(\text{ATT}, \text{USF}) = 0.742$;	$r_{XY}(\text{ATT}, \text{EOU}) = 0.094$;	$r_{XY}(\text{ATT}, \text{COM}) = 0.607$;	$r_{XY}(\text{ATT}, \text{VAL}) = 0.652$;	sqrt(AVE) = 0.938
		$\text{HTMT}(\text{ATT}, \text{USF}) = 0.798$	$\text{HTMT}(\text{ATT}, \text{EOU}) = 0.109$	$\text{HTMT}(\text{ATT}, \text{COM}) = 0.668$	$\text{HTMT}(\text{ATT}, \text{VAL}) = 0.727$	

The second criterion assessed for Discriminant Validity, regarding the root square of each AVE exceeding the correlations (r_{XY}) to other constructs, was satisfactory for the two models. Finally, the third criterion for Discriminant Validity regarding the Heterotrait–Monotrait ratios of the correlations (r_{XY}) among constructs (HTMT) can also be considered satisfactory for the two models. For the model AHP, the two versions of thresholds ($0.850 < \text{HTMT}$ for very different constructs and $0.900 < \text{HTMT}$ for very similar constructs) were reached. For Model Y, the $\text{HTMT}(\text{COM}, \text{USF}) = 0.897*$ and the $\text{HTMT}(\text{VAL}, \text{USF}) = 0.882*$ can be considered satisfactory under the assumption that some of the four usability items are semantically very similar to three items of compatibility and four items of value.

Hence, Internal Consistency Reliability, Convergent Validity and Discriminant Validity metrics of the usability measurement instrument can be considered satisfactory for the two models, X(AHP) and Y (overall, any Model Y).

Task 4: Descriptive Statistical Results for Usability Metrics. These results were calculated by using the free academic tool JASP [100]. Table 14 reports these descriptive statistical results (mean, median, standard deviation, and the 25th and 75th percentiles) for the usability metrics collected for the AHP-AgileITS-ArchDesign model and the alternative IT service architecture design Model Y.

Table 14. Descriptive usability metrics: comparison between the AHP-AgileITS-ArchDesign model and the alternative IT service architectural design Model Y.

Construct	AHP-AgileITS-ArchDesign Model					Alternative IT Service Architectural Design Model Y				
	Mean	Median	Std. Dev	25th Percentile	75th Percentile	Mean	Median	Std. Dev	25th Percentile	75th Percentile
Usefulness	4.319	4.250	0.504	4.000	4.750	3.532	3.500	0.935	3.000	4.000
Ease of Use	3.911	4.000	0.802	3.500	4.500	3.863	4.000	0.850	3.500	4.500
Compatibility	3.984	4.000	0.611	3.333	4.333	3.613	3.667	0.839	3.333	4.333
Value	4.016	3.875	0.563	3.500	4.500	3.532	3.500	0.709	3.000	4.000
Attitude of Potential Use	1.952	2.000	0.855	1.667	2.667	1.129	1.000	1.285	0.667	2.000

A 5-point Likert scale was used (from 1 strongly disagree to 5 strongly agree) for the usefulness, ease of use, compatibility and value constructs, and a 7-point semantic differential scale (from -3 extremely {negative, bad, harmful} to +3 extremely {positive, good, beneficial}) for the attitude potential of use construct. Overall, the descriptive statistics obtained for the AHP-AgileITS-ArchDesign model are better than those obtained for the alternative IT service architecture design Model Y. However, the scores assigned to ease of use and compatibility constructs in the 2 models are more moderate rather than high. Actually, for these two constructs, the 50% (the 25th–75th percentile range) of the 62 evaluations fits in the score ranges of [3.500–4.500] and [3.333–4.333] in the two models.

We applied a Wilcoxon Paired Signed-Rank Test of medians [99]—by using the free academic tool JASP [100]—and the results are reported in Table 15. This statistical test is a Non-parametric one used to compare two measures of central tendency (median in this test) that does not require the Normal statistical distribution fit of the data. We used this Non-parametric test because the data did not fit the normality distribution condition (through ShapiroWilk tests).

Table 15 uses the label abbreviations [USF, EOS, COM, VAL, ATT] for the factor items assigned, respectively, to the constructs usefulness, ease of use, compatibility, value and attitude of potential use. The five null hypotheses—expected to be rejected—refer to the medians (Med_X) of the AHP-AgileITS-ArchDesign model (AHP-model) being less than or equal to the medians (Med_Y) of the alternative IT service architecture design model (Y-model) for the five usability constructs. The results reported in Table 15 indicate statistical evidence supporting a better perceived usefulness, compatibility, value and attitude potential of use for the AHP-AgileITS-ArchDesign model through the Paired Wilcoxon Signed-Rank Test of medians [99]. For the ease of use construct, the statistical evidence indicates a similar perception.

Table 15. Wilcoxon Paired Signed-Rank Test of medians among AHP-AgileITS-ArchDesign model and the alternative IT service architectural design Model Y.

Null Hypothesis	AHP-AgileITS-ArchDesign Model Median (AHP-Model Mdn_X)	Alternative IT Service Architectural Design Model Y Median (Y-Model Mdn_Y)	<i>p</i> -Value	Implication
H0.1 $Mdn_X(USF) \leq Mdn_Y(USF)$	4.250	3.500	<0.001	H0.1 is rejected, and thus the AHP-model was perceived with better usefulness than the alternative Y-model.
H0.2 $Mdn_X(EOU) \leq Mdn_Y(EOU)$	4.000	4.000	0.396	H0.2 cannot be rejected, and thus the AHP-model was perceived with similar ease of use as the alternative Y-model.
H0.3 $Mdn_X(COM) \leq Mdn_Y(COM)$	4.000	3.667	0.002	H0.3 is rejected, and thus the AHP-model was perceived with better compatibility than the alternative Y-model.
H0.4 $Mdn_X(VAL) \leq Mdn_Y(VAL)$	3.875	3.500	<0.001	H0.4 is rejected, and thus the AHP-model was perceived as having better value than the alternative Y-model.
H0.5 $Mdn_X(ATT) \leq Mdn_Y(ATT)$	2.000	1.000	<0.001	H0.5 is rejected, and thus the AHP-model was perceived with a better attitude of potential use than the alternative Y-model.

6. Discussion and Contributions

6.1. Discussion

This research has addressed the specific problem of the lack of fine-grain guidance on the systematic IT service architectural design and on the evaluation of the plausible candidate solutions, which still exists in the main IT Service Management (ITSM) frameworks [1–5] and ITSM standards [6–8].

We identified in the theoretical background reported in Section 2.1 the overall deficiencies for the main rigorous and lightweight-agile IT service design workflows regarding the specific fine-grain guidance on IT service architectural design. In the best of the cases—for rigorous ITSM frameworks like ITIL v2011 [1,39] and the CMMI-SVC [2]—the guidance is provided in a coarse-grain style. Furthermore, in the worst of the cases—for lightweight-agile ITSM standards and frameworks like the ISO/IEC 29110 standard (TR 4-3 [7] and TR 5-3 [8]), and the ITIL v4 [3,4] and VeriSM [5] frameworks—the specific guidance is practically null. In particular, the rigorous ITSM standard ISO/IEC 20000 [6] also lacks specific guidance for this relevant aim. Then, academics and practitioners on IT service design must elaborate ad hoc specific models and procedures for this aim.

This research addressed such a problem through a Design Science Research Methodological (DSRM) approach [27–29], and has reported the motivation, design, and implementation as Proof of Concept, a conceptual validity evaluation, and an empirical usability exploratory evaluation of the conceptual artifact A (AHP-AgileITS-ArchDesign model) and its realized artifact tool A* (AHP-AgileITS-ArchDesign model tool). This dual-artifact A/A* aims to provide theoretically valid, systematic and agile guidance for supporting the design and evaluation of IT service architectural agile designs. However, we only consider that this dual-artifact A/A* provides a plausible solution for lightweight-agile ITSM frameworks and in the context of SMBs. We do not claim that this proposed solution

completely solves the full IT service design requirements for rigorous ITSM frameworks used in the context of large businesses. However, for small projects in large businesses, this proposed solution can be used. Additionally, we consider that this proposed solution can be extended to fit the full IT service design requirements for rigorous ITSM frameworks with sufficient further research.

Hence, this design, implementation and exploratory evaluation of the dual-artifact A/A* was guided by the following research questions that can be considered satisfactorily answered as follows:

- **RQ.1: How can the artifact A—AHP-AgileITS-ArchDesign model—be designed and computationally implemented? Response:** A 6-step Design Science Research Methodology was applied to the design and the computational implementation of the dual-artifact A/A* (AHP-AgileITS-ArchDesign model; AHP-AgileITS-ArchDesign model tool).
- **RQ.2: What is the degree of achievement of the proposed Design Objectives (DOs) and the identified Design Restrictions (DRs) for the artifact A—AHP-AgileITS-ArchDesign model? Response:** The seven Design Objectives (DOs) and the three Design Restrictions were satisfied adequately as follows: DO.1: The designed artifact A (the AHP-AgileITS-ArchDesign Model) only used Design Components (DCs) from relevant Design Theoretical Sources (DTSs); DO.2: The designed artifact A has a Value Tree Hierarchy that was considered complete, operational, decomposable, non-redundant, and minimal with a three-layer model derived from the main IT service design literature; DO.3: The designed artifact A has a set of attributes directly operationable, unambiguous, comprehensive and understandable due to its design from the core IT service design literature; DO.4: The designed artifact A was assessed as a theoretically valid, systematic and agile decision-making model supported by the results obtained through the Panel of Experts Evaluation (reported in Section 5.1); DO.5: The designed artifact A was computationally implemented using standard Information Technology (a free academic AHP tool); DO.6: The A* artifact—as the computational implementation of the designed artifact A—provides the usual AHP evaluation functionalities with the used free academic AHP tool; and DO.7: The A* artifact reached satisfactory levels of usefulness, ease of use, compatibility, value and attitude potential of use from an Exploratory Pilot Sample of ITSM academics and practitioners (results in Section 5.2).
- **RQ.3: What is the degree of conceptual validity of the artifact A—AHP-AgileITS-ArchDesign model—from a Panel of Experts on ITSM and the Agile Approach? Response:** Section 5.1 presented the statistical results of the conceptual validity of the designed artifact A. A panel of 16 Experts on ITSM and agile workflows reviewed a design document of artifact A, and assessed two constructs (Theoretical Validity and Theoretical Consistency), and the statistical results—by using the PLS technique—were highly satisfactory. The mean, median, standard deviation and reliability metric (Cronbach's alpha) obtained for the two constructs, Theoretical Validity and Theoretical Consistency, were (4.25, 4.50, 0.765, 0.830) and (3.86, 3.75, 1.037, 0.869), respectively, both satisfactory. Furthermore, a Non-parametric Wilcoxon Signed-Rank Test of medians vs. a 3.00 threshold value was supported (Appendix D: Table A18). Regarding the Internal Consistency Reliability, the Convergent Validity, and the Discriminant Validity of the measurement instrument, they were also satisfactory regarding the expected statistical criteria (Appendix D: Tables A19 and A20).
- **RQ.4: What is the degree of usability—i.e., usefulness, ease of use, compatibility, value and attitude potential of use—of the artifact A—AHP-AgileITS-ArchDesign model—compared with an alternative IT service architectural design Model Y, from**

an Exploratory Pilot Sample of ITSM academics and practitioners in the context of SMBs? Response: Section 5.2 presented the statistical results of the exploratory and comparative usability evaluation between the designed artifact A and, overall, an alternative IT service architectural design Model Y (i.e., any Model Y). An Exploratory Pilot Sample of 62 evaluators (academics and practitioners on ITSM and agile workflows) reviewed a Design Package—including several documents—and assessed five usability constructs (usefulness, ease of use, compatibility, value and attitude potential of use) for both Model X (the artifact A) and Model Y (any Model Y). The statistical results—by using the PLS technique—were also highly satisfactory. Firstly, the Internal Consistency Reliability, the Convergent Validity, and the Discriminant Validity of the two measurement instruments were considered satisfactory regarding the expected statistical criteria (Appendix D: Table A19; Tables 12 and 13). Finally, Table 15 reported the five hypothesis tests—by using a Paired Wilcoxon Signed-Rank Test of medians—regarding the comparison between the medians (Med_X) of the AHP-AgileITS-ArchDesign model (AHP-model) and the medians (Med_Y) of the overall alternative IT service architecture design Model Y (Y-model) for the five usability constructs, and was found statistical evidence for supporting a better perceived usefulness, compatibility, value and attitude potential of use for the AHP-AgileITS-ArchDesign. For the ease of use construct, the statistical evidence indicated a similar perception.

6.2. Contributions

Hence, we consider that this research provides the following three main contributions to the theory of IT service architectural design from an agile perspective as follows.

First, this research identified a still existent and relevant knowledge gap regarding the lack of fine-grain guidance for supporting the design and evaluation of IT service architectural agile designs in the two types of workflows—rigorous and lightweight-agile. The extant scientific and professional literature has remarked on the relevance of the IT service design activity as a fundamental one to deliver a cost-effective IT service, and some of them have provided recommendations on the specific IT service architectural design task; in the end, these are only reported as coarse-grain, minimal or practically null guidance. This research brings attention to the scientific and practitioner communities on the need to provide valid, systematic and usable solutions documented at a fine-grain content level.

Second, this research provided an updated review on how systematic decision-making procedures such as the AHP method have been used (2010–2024 period) for supporting the task of design and evaluation of IT artifacts, and also revealed that its specific application for the design and evaluation of IT service architectures has been largely omitted. The extant scientific and professional literature on IT service design activity has recommended the utilization of systematic decision-making procedures and tools for supporting this core activity, but, in particular, on the IT service architectural service task, such recommendations are limited without any well-reported solution. In this research, the SSLR conducted for the 2010–2024 period collected evidence on the adequate utilization of MADM procedures and tools for related IT service design problems, but none were aligned to the IT service concept and expected metrics of value, Warranty and Utility.

Third, this research produced a dual designed artifact A/A* (AHP-AgileITS-ArchDesign model, and its realization as a tool) that was designed through a systematic Design Science Research Methodology, where specific and explicit Design Goal (DG), Design Approach (DA), Design Objectives (DOs), Design Restrictions (DRs), Design Theoretical Sources (DTSs) and Design Components (DCs) were stated, and satisfactory empirical validation of its Conceptual Validity (by a Panel of 16 Experts) and usability (by a Pilot Sample of 62 Evaluators) was reached by using usual statistical procedures. This dual-designed

artifact A/A* emerged from a systematic design and validation process by using DSRM. The design of the artifact A/A* was based on fundamental literature on IT services and that related to the application of the MADM AHP method in related IT service design problems.

Similarly, this research also provides the following three contributions to the praxis of IT service architectural design from an agile perspective as follows.

First, this research produced a free academic A* AgileITS-ArchDesign tool that can be used by ITSM academics and practitioners for supporting the design and evaluation of IT service architectural designs considering the usual criteria from the ITSM literature (Utility: benefits and risks; Warranty: availability, capacity, continuity, security, performance, and costs) to determine an overall Value Index of Agile Architectural Design of IT services. To the best of our knowledge, no similar tool has been reported in the scientific and professional literature on IT service design activity. This A* tool implemented the theoretically valid, systematic and agile AgileITS-ArchDesign model, and its exploratory usability evaluation from a pilot sample of 62 academics and practitioners in ITSM produced satisfactory usability levels.

Second, this research permitted the enhancement of an available free academic Electronic Process Guide of AVS_FD_MVITS v3, which provides an agile fine-grain workflow for designing IT services, by the inclusion of the new systematic and theoretically based decision-making artifact A (AHP-AgileITS-ArchDesign model) to provide a theoretically valid, systematic, agile and usable model and tool for supporting the design and evaluation of IT service architectural agile designs.

Third, this research encourages ITSM practitioners to improve their IT service design activity by using computer-based tools. These kinds of tools have been largely used for IT service operational activities in the last 25 years, and some of them for IT service planning activity. However, for core engineering-based IT service design activity, their availability is practically null. In other system engineering contexts, the utilization of computer-based tools for design activity is frequently found, but surprisingly, in the IT service design domain, this situation is still nonexistent.

Table 16 highlights the contrasted main findings from this research versus the main rigorous and lightweight-agile IT service architectural design guidance from a theoretical and practical perspective.

Finally, we must remark that the results reported in the illustrated AHP case are contingent on the assumed pairwise criteria preferences and the absolute scores of the alternative solutions assessed by the AHP evaluator. Thus, other AHP evaluator can generate different results contingent on their specific preferences and scores.

Table 16. Status of IT service architectural design guidance documents vs. this research.

This Research	Rigorous IT Service Design Guidance	Lightweight-Agile IT Service Design Guidance
Contribution to Theory: This research provided evidence of a relevant knowledge gap on IT service architectural design and its practical relevance with supported and updated references.	ITIL v2011 framework is focused on the economic–financial evaluation of competitive IT service designs, and thus technical engineering and architectural IT service design attributes are missed. CMMI-SVC framework recommends utilization of decision-making methods for evaluation of IT service design alternatives, but the guidance provided is coarse-grained and generic. Whereas the standard ISO/IEC 20000 has a specific IT service design workflow—called Service Design and Transition—there is no explicit guidance on how to evaluate different IT service architectural designs.	The ISO/IEC TR 29110-4-3 and TR 29110-5-3 just mention “make trade-offs among the different possible functional architectures relative to the requirements.” No additional guidance is provided. Both agile ITIL v4 and VeriSM frameworks report an IT service design workflow, but neither provides articulated guidance for evaluating IT service architectural designs.

Table 16. Cont.

This Research	Rigorous IT Service Design Guidance	Lightweight-Agile IT Service Design Guidance
Contribution to Theory: This research provided an updated review of how MADM are used for related IT service design problems, and, in particular, on how the AHP method is still efficiently and effectively used for this design aim.	No similar research article was found in the literature.	No similar research article was found in the literature.
Contribution to Theory: This research provided a theoretically valid, systematic and agile artifact A (AgileITS-ArchDesign model) for supporting the design and evaluation of IT service architectural agile designs.	No artifact is provided.	No artifact is provided.
Contribution to Praxis: This research provided a computer-based tool, A*AgileITS-ArchDesign, that was evaluated as usable.	No artifact is provided.	No artifact is provided.
Contribution to Praxis: This research reported the inclusion of the A* AHP-AgileITS-ArchDesign model in a free academic Electronic Process Guide (EPG) of an agile workflow for IT service design (AVS_FD_MVITS v3).	No Electronic Process Guide (EPG) is provided.	No Electronic Process Guide (EPG) is provided.
Contribution to Praxis: This research showed evidence for encouraging ITSM practitioners to develop and use computer-based tools in IT service design activity, and not only in IT service operations as in the last 25 years.	No evidence was found.	No evidence was found.

7. Conclusions

This research addressed an important theoretical and relevant practical problem found in the core literature and praxis on the design of IT services—focusing on the competitive IT service architectural artifacts—and stated the lack of fine-grain workflow guidance for such design aim. We found, through the review of the theoretical background of this research, that the main rigorous and lightweight-agile ITSM frameworks and standards currently provide either coarse-grain guidance or practically null guidance.

To address this research problem, we used a Design Science Research Methodological (DSRM) approach for designing, building a proof of concept, and empirically evaluating the conceptual Theoretical Validity and a set of usability metrics of the dual-artifact A/A* (A: the AHP-AgileITS-ArchDesign model; A*: its proof of concept implemented in a free academic AHP software tool CDP v3.0). The design, building and proof of concept of this dual-artifact A/A* was realized systematically through the six steps of the applied DSRM. In particular, an illustrative case of the application of the dual-artifact A/A* was reported, as well as conceptual validity and exploratory usability evaluations. The conceptual validity was realized by a Panel of 16 Experts, and the results can be considered satisfactory. The exploratory usability evaluation was performed by an Exploratory Pilot Sample of 62 academics and practitioners in ITSM and the agile approach. This usability evaluation also produced satisfactory results for the metrics of usefulness, compatibility, value and attitude potential of use compared with an overall Model Y (any Model Y). Consequently,

we consider that this research, overall, provides contributions to the theory and to the praxis of IT service designs—focusing on the architecture artifact—from an agile perspective through the design and proof of concept of the dual-artifact A/A*.

We must also report the following methodological limitations: (1) the dual-artifact A/A* used the most reported Multi-Attribute Decision-Making (MADM) procedure (AHP), but the utilization of other MADM procedures could produce different results; (2) this research was conducted during the 2024–2025 period, and by the assigned research budget, the review of the related work was realized in the 2024 year; (3) the free academic AHP tool was implemented in a free academic software that requires an old Operating System, but this limitation can be over-passed through a virtual machine.

We consider that this stream research can be advanced through the following avenues: (1) conduct more empirical comparative research—via Case Study and Experimental—on the utilization of the dual designed artifact A/A* by ITSM academics and practitioners; (2) explore the redesign of the dual-artifact A/A* with extensions to the original AHP method and other Multi-Attribute Decision-Making (MADM) methods; (3) explore the utilization of the dual designed artifact A/A* in the context of large business; (4) explore the required changes to accommodate the evaluation of IT services in the context of Artificial Intelligence workloads; and (5) implement the dual designed artifact A/A* in a free academic web-based platform for promoting its utilization in ITSM academics and practitioners in the context of SMBs.

Finally, we encourage conducting further empirical research in the context of SMBs to collect confirmatory evidence, and conceptual research in the context of large businesses to extend the proposed solution to one that fits the full IT service design requirements from rigorous ITSM frameworks.

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Abbreviations

The following abbreviations are used in this manuscript:

AHP	Analytical Hierarchical Process
ITSM	Information Technology Service Management
DSRM	Design Science Research Methodology
MADM	Multi Attribute Decision-Making

Appendix A. Application of the SSLR Method on the Topic “Architectural Design of IT Services Using AHP”

Table A1. The SSLR method.

Step, Purpose and Expected Outcomes	Application of SSLR
Step: (1) Formulation of the research goal and research questions. Purpose: To state the expected research goal that delimits the scope of the research, and the research questions that focus on the knowledge gaps of interest. Expected Outcomes: Research goal statement, Research questions.	Research goal statement: “To collect high-quality studies on the topics of {utilization of the AHP decision-making method in the architectural design of IT services} through a Systematic Selective Literature Review method in a set of top Software–Systems and Decision Science JC-indexed journals for the 2010–2024 period”. Research questions: RQ.1. How has the AHP decision-making method been structurally (design goal, design criteria and sub-criteria, design alternatives, and AHP techniques) used alone or combined with other methods for the architectural design of IT services? RQ.2. Have the results achieved in the utilization of the AHP decision-making method for the architectural design of IT services been satisfactory?
Step: (2) Definition of the research context. Purpose: To define and agree on the research context characteristics (type of literature, types of sources of studies, publishing language, period of publication, and selection (inclusion and exclusion) criteria of studies). Expected Outcomes: • Type of literature. • Types of sources of studies. • Publishing language. • Period of publication. • Selection (inclusion and exclusion) criteria of studies.	Type of literature: Scientific literature exclusively. Gray (Professional) literature is not consulted. Types of sources of studies: Top-7 JCR-indexed journals in the Software–Systems and top-7 JCR-indexed journals in the Decision Science areas. Journals in other indices, book chapters and conference proceedings are not included. Tables A2 and A3 report the list of top-7 JCR-indexed journals in Software–Systems and top-7 JCR-indexed journals in Decision Science areas, respectively. Publishing language: English. Period of publication: 2010–2024. Selection (inclusion and exclusion) criteria (integrated filters) of studies: Filter 1: Articles returned in the search-of-keywords-full-text (AHP architecture service design). Filter.2 Abstract of articles in Filter.1 contains the AHP keyword. Filter 3: Article used the AHP method to design an IT service.
Step: (3) Collection and selection of the studies. Purpose: To get the studies that satisfy the conditions stated in the inclusion and exclusion criteria, through the automatic search using academic search engines, and the required logical analysis for selecting/discarding studies. Expected Outcomes: • Academic search engine(s). • Search queries. • Tables of results by applying the inclusion and exclusion criteria.	Academic search engine(s): Google Scholar. Search queries: 14 individual searches were performed with the following parameters (all-words-in-full-text (AHP architecture service design) AND publishing-range(2010, 2024) AND journal-name (x?), where x? was instantiated 14 times with the names of the 14 selected JCR-indexed journals. Tables of results by applying the inclusion and exclusion criteria (integrated filters): Table A4 and Table A5 report the results respectively for the Software–Systems and the Decision Science areas.
Step: (4) Review and synthesis of the findings from the collected–selected studies. Purpose: To conduct the analysis and integration of findings. Expected Outcomes: • Selection of theoretical schemas for conducting the review. • Structured schemas of findings.	Selection of theoretical schemas for conducting the review: The research team agreed to identify the following elements in each study (title, design objective, design criteria, Design sub-criteria, decision alternatives, type of AHP scale, and main results). Structured schemas of findings: Tables A6 and A7 report the data of the final selected 26 studies. Table 1—in the main content of this article—summarizes the analysis conducted on the final selected 26 studies.
Step: (5) Elaboration of the findings report. Purpose: To produce valid and visible results for academic venues and outlets. Expected Outcomes: • Research report.	Research report: Section 2.3 in this article.

Table A2. Summary of studies located in the SSLR in the domains of Software–Systems area for the 2010–2024 period.

ID	Code Journal	Journal Name	Journal Impact Factor	Filter 1: Results Returned in Search-of-Keywords-Full-Text (AHP Architecture Service Design)	Filter 2: Abstract with AHP as Keyword	Filter 3: AHP Method Helped to Design an IT Service
1	TSE	<i>IEEE Transactions on Software Engineering</i>	9.322	11	1	1
2	IST	<i>Information and Software Technology</i>	3.862	63	7	6
3	ESE	<i>Empirical Software Engineering</i>	3.762	10	0	0
4	ACMT	<i>ACM TOSEM</i>	3.685	2	0	0
5	JSS	<i>Journal of Systems and Software</i>	3.514	52	5	4
6	JSC	<i>Journal of Supercomputing</i>	3.300	87	8	8
7	SPE	<i>Software: Practice and Experience</i>	3.200	23	3	3
Total				248	24	22

Table A3. Summary of studies located in the SSLR in the domain of Decision Science area for the 2010–2024 period.

ID	Code Journal	Journal Name	Journal Impact Factor	Filter 1: Results Returned in Search-of-Keywords-Full-Text (AHP Architecture Service Design)	Filter 2: Abstract with AHP as Keyword	Filter 3: AHP Method Helped to Design an IT Service
1	JOM	<i>Journal of Operations Management</i>	10.639	3	0	0
2	OMG	<i>Omega</i>	8.673	11	1	1
3	EJOR	<i>European Journal of Operational Research</i>	6.363	30	2	2
4	MSC	<i>Management Science</i>	6.172	4	0	0
5	COR	<i>Computers & Operations Research</i>	5.159	7	0	0
6	OR	<i>Operations Research</i>	3.924	1	1	1
7	MP	<i>Mathematical Programming</i>	3.060	0	0	0
Total				56	4	4

Table A4. Summary of findings from the SSLR on the topic of “Architectural Design of IT services using AHP” in the Software-System area (studies 1–22).

ID Journal-Article	Year	Design Decision Goal	Decision Criteria	IT Service Design Impact	Decision Alternatives	Type of AHP Utilization
TSE.01 [61]	2019	Select the best class (or package) ranking of a software system.	1. Method call relation. 2. Inheritance relation. 3. Parameter relation. 4. Return type relation. 5. Global variable relation. 6. Implements relation. 7. Local variable relation.	IT service warranty	Java Software Classes/Packages [2..N]	Classic AHP
IST.01 [62]	2013	Prioritize software requirements based on user preferences and systems constraints and dependencies.	1. Effectiveness. 2. Efficiency. 3. Robustness.	IT service utility, IT service warranty	Software requirements [1..60]	Incomplete AHP
IST.02 [63]	2013	Select the best method to choose Quality Attribute Techniques.	1. Quality impact. 2. Cost of application. The effort, time and resources required. 3. Expertise. 4. Ease of use. 5. Regulatory requirements. 6. Contractual requirements.	IT service warranty	Projects [1..3]	Classic AHP

Table A4. Cont.

ID Journal-Article	Year	Design Decision Goal	Decision Criteria	IT Service Design Impact	Decision Alternatives	Type of AHP Utilization
IST.03 [64]	2014	Calculate non-functional property weights of an ATM.	1. Cost. 2. Security. 3. Performance. 4. Reliability. 5. Ease of use.	IT service warranty	ATM [1..N]	Classic AHP and FCM
IST.04 [65]	2019	Select the optimal cloud deployment option for File Upload and Video-conferencing.	1. Throughput. 2. Latency. 3. Packet loss rate. 4. Cost. 5. CPU Utilization. 6. Memory Utilization. 7. QoS.	IT service warranty	Cloud designs [1..6]	Classic AHP and FoQoSAM
IST.05 [66]	2019	Estimate the best mobile application testing factors.	1. Usability. 2. Efficiency. 3. Network. 4. Diverse Devices. 5. Integration with other Apps.	IT service warranty	Mobile Apps [1..2]	Classic AHP
IST.06 [67]	2023	Select the optimal workflow configuration for FaaS applications.	1. Execution time. 2. Privacy. 3. Cost. 4. Network bandwidth.	IT service warranty	FaaS workflow configurations [1..18]	Fuzzy AHP
JSS.01 [68]	2011	Select the most suitable software packages.	1. Functionality. 2. Reliability. 3. Efficiency. 4. Maintainability.	IT service utility, IT service warranty	Software packages [1..4]	Classic AHP, WSM and HKBS
JSS.02 [69]	2010	Analyze the ERP Maintenance Risk Factors.	1. Problem/Modification Identification. 2. Analysis. 3. Design. 4. Implementation. 5. Test. 6. Acceptance. 7. Delivery.	IT service warranty	Risk factors [1..30]	Classic AHP
JSS.03 [70]	2012	Compare vulnerability evaluation systems (X-Force, CVSS and VRSS).	1. High vulnerability level. 2. Medium vulnerability level. 3. Low vulnerability level	IT service warranty	Types of vulnerability [1..19]	Classic AHP
JSS.04 [71]	2017	Prioritize software requirements based on user preferences and systems dependencies.	1. Benefits. 2. Costs. 3. Penalties. 4. Risks. 5. Others.	IT service utility, IT service warranty	Software requirements [1..n]	DRank vs. AHP, CBRank, and EVOLVE
JSC.01 [72]	2020	Select an adaptive degraded read optimization strategy for heterogeneous distributed erasure code-based storage.	1. CPU performance. 2. Storage device performance. 3. Network throughput.	IT service warranty	Heterogeneous distributed erasure code-based storage strategies [RS(6,4), RS(9,6), RS(14,10)].	Classic AHP
JSC.02 [73]	2021	Select the UAVs that should be CH (Cluster Heads) at regular intervals.	1. Residual energy (RE). 2. Coverage area (CA). 3. Number of neighbors (NN). 4. Mobility speed (MS).	IT service warranty	UAV equipment [1..10]	Hybrid classic AHP and TOPSIS
JSC.03 [74]	2021	Rank the best placement of the controller in several sub-domains of SDWANs.	1. The number of ports per controller. 2. The processing capacity of each controller. 3. Link cost per linear meter. 4. Packet Size-Static. 5. Packet size-Dynamic.	IT service warranty	Controllers for the SDWAN [1..M]	Hybrid classic AHP and TOPSIS
JSC.04 [75]	2022	Select a set of key success factors of intelligent logistics based on IoT Technology.	1. Technical Services. 2. Information security. 3. Expected benefits. 4. Enterprise characteristics. 5. Management characteristics.	IT service utility, IT service warranty	Not used.	Classic AHP
JSC.05 [76]	2022	Select the best possible computing networking route.	1. Expected transmission count. 2. Hop count. 3. Number of neighbors. 4. Received power. 5. Signal-to-interference noise ratio. 6. Residual energy.	IT service warranty	Computing networking paths [1..M]	Hybrid classic AHP and TOPSIS
JSC.06 [77]	2023	Select the security factors of fog computing and their corresponding sub-factors according to their impact on fog-level security.	1. Access Control. 2. Integrity. 3. Data Protection. 4. Privacy. 5. Intrusion Detection.	IT service warranty	Not used.	Neutrosophic AHP

Table A4. Cont.

ID Journal-Article	Year	Design Decision Goal	Decision Criteria	IT Service Design Impact	Decision Alternatives	Type of AHP Utilization
JSC.07 [78]	2023	Select a network for efficient handover decisions to handle mobility management in a 5G wireless heterogeneous network.	1. Bandwidth. 2. Delay. 3. Litter. 4. Packet loss ratio. 5. Bit error rate. 6. Price rate.	IT service warranty	Network [GSM, UMTS, LTE-A, WLAN].	Fuzzy AHP combined with CRITIC and TOPSIS
JSC.08 [79]	2023	Evaluate the rigorous and agile levels of several ITSM service design workflows.	Rigorous Model: 1. Rigorous roles. 2. Rigorous activities-practices. 3. Rigorous artifacts. Agile Model: 1. Agile roles. 2. Agile activities-practices. 3. Agile Artifacts.	IT service warranty	Rigorous and agile IT service design workflows [1..6]	Classic AHP
SPE.01 [80]	2018	Optimize the resource provisioning for multitier cloud applications.	1. Requested number of services. 2. Response time violation. 3. Cost violation.	IT service warranty	Scaling Strategy [Scale in; No Scale; Scale out].	Fuzzy AHP
SPE.02 [81]	2021	Assign transmission priority to secure messages in the context of mobile edge computing in the Internet of Vehicles.	1. Data size of the message. 2. CPU cycles required by the message. 3. Deadline requirement.	IT service warranty	Secure messages [1..n].	Classic AHP
SPE.03 [82]	2022	Minimize cost of Data Center by selecting the Virtual Machines for migration process.	1. Migration Time. 2. Migration Risk. 3. Releasable Resource. 4. SLA Violation Penalty. 5. Virtual Machine Connectivity.	IT service warranty	Virtual Machine [1..M]	Classic AHP

Table A5. Summary of findings from the SSLR on the topic of “architectural design of IT services using AHP” in the Decision Science area (studies 23–26).

ID Journal-Article	Year	Design Decision Goal	Decision Criteria	IT Service Design Impact	Decision Alternatives	Type of AHP Utilization
OME.01 [83]	2015	Select the best mobile phone.	1. Basic requirements. 2. Physical characteristics. 3. Technical features. 4. Functionality. 5. Brand choice. 6. Customer excitement.	IT service utility, IT service warranty	Mobile phones [1..4].	Classic AHP and BWM
EJOR.01 [84]	2015	Select the best MRI system hospitals with foresight perspective.	1. Shimming. 2. Gradient standard strength. 3. Guaranteed homogeneity. 4. Frequency drift. 5. Standard number of channels. . . . 12. Maximum sound pressure level at peak. 13. Gradient amplitude. 14. Table dimensions. 15. Cryogen refill frequency.	IT service utility, IT service warranty	MRI systems [1..13].	Classic AHP and Delphi method
EJOR.02 [85]	2023	Evaluate fresh fruit supply chain indicators.	Production Stage Indicator Categories [1. Financial. 2. Stakeholder. 3. Internal Process. 4. Learn and Growth.]. Marketing Stage Indicator Categories [1. Financial. 2. Stakeholder. 3. Internal Process. 4. Learn and Growth.].	IT service utility, IT service warranty	Not proposed.	Classic AHP and Fuzzy AHP
OR.01 [86]	2013	Multiple exemplary cases of AHP are reported.	Multiple exemplary cases of AHP are reported.	IT service utility, IT service warranty	Multiple exemplary cases of AHP are reported.	Classic AHP and the new ANP

Appendix B. Description of the DSRM

DSRM.1: Design Research Initiation. This step aims to frame the specific research problem—i.e., undesired situation and/or knowledge gap—and motivation—i.e., practical relevance—to be addressed based on a relevant research background supported by the main related literature. Once these research issues are determined, DSRM.1 also defines the specific research goal statement, research questions and research hypothesis.

DSRM.2: Design Research Formulation. This step aims to state all design elements required to design the expected artifact A. For this, a Design Approach (DA) between analytic, axiomatic, heuristic or hybrid modes must be agreed based on the technical feasibility of using such an approach. An analytic Design Approach refers to design spaces characterized by the existence of design solutions that can be represented using analytical formulas and equations that can be solved. An axiomatic Design Approach refers to a systematic design process driven by the independence of functional requirements axiom, and the minimization of the information content of the design, through the mapping from customer needs to functional requirements, to design parameters, and to process variables. In axiomatic design, therefore, the design space is characterized by the existence of design solutions that can be represented using logical equations that satisfy the two axioms. A heuristic Design Approach refers to design spaces characterized by the existence of design solutions that cannot be represented using numerical, analytical or logical equations. Instead, the design space contains design solutions that are generated iteratively by applying a set of design heuristics against the expected design objectives and restrictions to be satisfied. A hybrid Design Approach combines one or several of the previous Design Approaches. Design Objectives (DOs) are affirmative statements that declare logical attributes expected in the artifact designed. Design Objectives (DOs) include general requirements, functional requirements, and non-functional—i.e., quality—requirements. Usual categories of non-functional requirements are performance metrics, usability metrics, and beneficial metrics. Design Restrictions (DRs) are statements that define limits on the overall design process applied to get the artifact already designed and built, and usually refer to economic, time, and other resource limitations. Design Theoretical Sources (DTs) refer to the conceptual schemas, frameworks, or models selected from the extant literature that provide a theoretical basis for the expected artifact. Design Components (DCs) are the specific elements from the Design Theoretical Sources used in the designed artifact A.

DSRM.3: Design and Development of the Artifact A. The main outputs of this DSRM.3 step correspond to the designed artifact A and its built as A*. In this research, we use the AHP method. This designed artifact A can include the conceptual functional architecture, i.e., the high-level organization and interrelationships between the design components that enable the expected functionalities that the designed artifact must provide; the conceptual physical architecture, i.e., the high-level representation of the selected physical resources used to implement the functional architecture; the conceptual allocated architecture, i.e., the mapping of functions to resources between the functional and physical architectures; and the conceptual detailed design of components, i.e., the detailed description of inputs, tasks, and outputs for each design component. The final artifact A* implements the designed artifact A.

DSRM.4: Demonstration of the Artifact A (Proof of Concept). This step is executed to obtain a conceptual validation from a Panel of Experts, if available, of the designed artifact A, and to demonstrate the built artifact A*—i.e., the concept proof. The concept proof of the artifact A* consists of using the designed artifact in an exemplary case of use that has similar operational characteristics to the expected real cases of use, and applying DRF modes of evaluation (mode 4) empirical laboratory testing evaluation; and/or mode 5) logical argumentative evaluation).

DSRM.5: Evaluation of the Artifact A*. In this step, we conduct an empirical quantitative statistical evaluation of the artifact A* on a set of adequate usability metrics—such as usefulness, ease of use, compatibility, value and attitude of use—from a Pilot Sample of Evaluators. DRF evaluation modes can be applied: mode (1) empirical observational evaluation in a real setting; and/or mode (2) analytical and mathematical; and/or mode (3) controlled laboratory experiment. It is also expected that the seven DRF principles can be achieved.

DSRM.6: Communication of Research Results. In this last step, the final research results should be reported in scientific outlets and it is strongly suggested to report them also in professional venues. These research findings should contribute, thus, to advance the scientific knowledge on the studied topic as well as to the exercise of the related professional practices.

Table A6. The 6-Step Design Science Research Methodology (DSRM).

Step	Purpose	Complementary Research Methods	Outcomes
DSRM.1: Design Research Initiation.	To state the expected overall research goal that delimits the scope of the research, the research questions that focus on the knowledge gaps of interest as well as the guiding hypothesis, and the motivations to pursue the research design. (For these aims, conducting a review of the State of the Art on the specific problem is required.)	Conceptual Literature Review (CLR), or Systematic Literature Review (SLR), or Systematic Selective Literature Review (SSLR).	Research overall goal statement. Research questions and hypothesis. Research motivation statements. Review of the State of the Art.
DSRM.2: Design Research Formulation.	To define the specific Design Approach, DA (i.e., analytics, axiomatic or heuristic), the design objectives (DOs) (i.e., expected qualities in the designed artifact), design restrictions (DRs) (i.e., the limitations on time, cost and resources utilized to design the artifact), the Design Theoretical Sources, DTSs (i.e., the design materials), and the design components, DCs (i.e., the specific design building blocks).	Conceptual Design.	Design Approach (DA). Design Objectives (DOs). Design Restrictions (DRs). Design Theoretical Sources (DTSs). Design Components (DCs).
DSRM.3: Design and Development of the Artifact A.	To design the artifact A conceptually and implement it as A* guided—controlled by the design objectives (DOs) and restrictions (DRs), and using the agreed Design Approach (DA), Design Theoretical Sources (DTSs) and design components (DCs).	Conceptual Design (complemented with the AHP method [27,28] reported in Table 2).	Conceptually designed artifact A. Implemented designed artifact A*.
DSRM.4: Demonstration of the Artifact A* (Proof of Concept).	To demonstrate the designed artifact A and implemented artifact A* and conduct initial conceptual validation (from a Panel of Experts, if available) and apply DRF evaluations (modes 4 and/or 5).	Conceptual Validation from Panel of Experts. Empirical lab testing. Logical Argumentation.	Conceptual Validation. DRF evaluation modes: (4) empirical laboratory testing evaluation; and/or (5) logical argumentative evaluation.
DSRM.5: Evaluation of the Artifact.	To conduct empirical statistical evaluation of the designed and implemented artifact A* on a set of agreed usability metrics, with a Pilot Sample of Evaluators.	Empirical Statistical Validation (from a Pilot Sample of Evaluators). Analytical–Mathematical Analysis. Logical Argumentation.	Empirical Validation with Statistical Analysis. DRF evaluation modes: (1) empirical observational evaluation in a real setting; and/or (2) analytical and mathematical; and/or (3) controlled laboratory experiment.
DSRM.6: Communication of Research Results.	To generate a structured scientific report (i.e., Thesis, Technical Report, Chapter, Conference Proceeding or Journal article) of results and communicate them in academic outlets.	Guidelines for Scientific Reports in Computing.	Structured Scientific Report.

Appendix C. Complementary Data on the AHP Method

Table A7. Specific Design sub-objectives for the DO.6.

Design Sub-Objective ID	Description
DO.6.1	Calculation of the derived local and global priority vectors, and the Consistency Ratios (CRs) for all criteria layers, after establishing the weights matrix using pairwise comparisons with the 9-point fundamental scale.
DO.6.2	Evaluation of each Design Component (DC) regarding its linked upper-layer attributes using a local absolute scale and a distributive mode for its overall contribution to upper layers.
DO.6.3	Reporting the expected views for AHP models: (1) pairwise comparison matrices; (2) local and globally derived priority vectors; and (3) overall matrix with the contributions to the top goal—in this case, the IT Service Value Agile Design Index (VAD index)—from the candidate decision—in this case, the two competitive IT service architectural designs. Furthermore, the optional ones include: (1) Sensitivity Analysis on the impacts on the top goal and other affected sub-criteria from changes on the pairwise comparison between specific attributes of interest; (2) Uncertainty Analysis on the impacts on the top goal and other affected sub-criteria from using a specific Probability Density Distribution for some candidate solution inputs; and (3) Analysis of Contributions for visualizing graphically the contributions of elements in the AHP DVT in a specific layer on an specific element in an upper layer.

Table A8. Matrix 1 of the pairwise comparison for Design criteria (second level) regarding the contribution to Value Index of Agile Architectural Design of IT Services (top level).

Attribute Y			
CR: 0.00	Contribution to Value Index of Agile Architectural Design of IT Services	Utility	Warranty
Attribute X	Utility	-	1: X:Utility and Y:Warranty have equal importance
	Warranty	1: X:Warranty and Y:Utility have equal importance	-

Table A9. Matrix.2 of the pairwise comparison for Design sub-criteria (third level) regarding the contribution to Utility (second level).

Attribute Y			
CR: 0.00	Contribution to Utility	Benefits	Risks
Attribute X	Benefits	-	3: X:Benefits is moderately more important than Y:Risks
	Risks	1/3: X:Risks is moderately less important than Y:Benefits	-

Table A10. Matrix.3 of the pairwise comparison for Design sub-criteria (third level) regarding the contribution to Warranty (second level).

		Attribute Y					
CR: 0.00	Contribution to: Warranty	Availability	Capacity	Security	Continuity	Performance	Costs
Attribute X	Availability	-	1 X:Availability and Y:Capacity have equal importance	1 X:Availability and Y:Security have equal importance	1 X:Availability and Y:Continuity have equal importance	1/3 X:Availability is moderately less important than Y:Performance	1/5 X:Availability is strongly less important than Y:Costs
	Capacity	1 X:Capacity and Y:Availability have equal importance	-	1 X:Capacity and Y:Security have equal importance	1 X:Capacity and Y:Continuity have equal importance	1/3 X:Capacity is moderately less important than Y:Performance	1/5 X:Capacity is strongly less important than Y:Costs
	Security	1 X:Capacity and Y:Security have equal importance	1 X:Security and Y:Capacity have equal importance	-	1 X:Security and Y:Continuity have equal importance	1/3 X:Security is moderately less important than Y:Performance	1/5 X:Security is strongly less important than Y:Costs
	Continuity	1 X:Continuity and Y:Availability have equal importance	1 X:Continuity and Y:Capacity have equal importance	1 X:Continuity and Y:Security have equal importance	-	1/3 X:Continuity is moderately less important than Y:Performance	1/5 X:Continuity is strongly less important than Y:Costs
	Performance	3 X:Performance is moderately more important than Y:Availability	3 X:Performance is moderately more important than Y:Capacity	3 X:Performance is moderately more important than Y:Security	3 X:Performance is moderately more important than Y:Continuity	-	1/3 X:Performance is moderately less important than Y:Costs
	Costs	5 X:Costs is strongly more important than Y:Availability	5 X:Costs is strongly more important than Y:Capacity	5 X:Costs is strongly more important than Y:Security	5 X:Costs is strongly more important than Y:Continuity	3 X:Costs is moderately more important than Y:Performance	-

Table A11. Quantitative input matrix for the IT service design A using Scale 3 with probabilistic values.

Value Decision Tree		Architectural IT Service Design Components							
Design Criteria	Design Sub-Criteria	App Software	Software	Data	Hardware	Network	Environment	Teams	External IT Service Providers
Utility	Benefits Risks	Log(0.94,0.05) Log(0.50,0.05)	Log(0.94,0.05) Log(0.50,0.05)	Log(0.94,0.05) Log(0.50,0.05)	Log(0.94,0.05) Log(0.50,0.05)	Log(0.94,0.05) Log(0.50,0.05)	Log(0.94,0.05) Log(0.50,0.05)	Log(0.94,0.05) Log(0.50,0.05)	Log(0.94,0.05) Log(0.50,0.05)
Warranty	Availability	Log(0.50,0.05)	Log(0.50,0.05)	Log(0.50,0.05)	Log(0.50,0.05)	Log(0.50,0.05)	Log(0.50,0.05)	Log(0.50,0.05)	Log(0.50,0.05)
	Capacity	Log(0.50,0.05)	Log(0.50,0.05)	Log(0.50,0.05)	Log(0.50,0.05)	Log(0.50,0.05)	Log(0.50,0.05)	Log(0.50,0.05)	Log(0.50,0.05)
	Security	Log(0.50,0.05)	Log(0.50,0.05)	Log(0.50,0.05)	Log(0.50,0.05)	Log(0.50,0.05)	Log(0.50,0.05)	Log(0.50,0.05)	Log(0.50,0.05)
	Continuity	Log(0.50,0.05)	Log(0.50,0.05)	Log(0.50,0.05)	Log(0.50,0.05)	Log(0.50,0.05)	Log(0.50,0.05)	Log(0.50,0.05)	Log(0.50,0.05)
	Performance	Log(0.94,0.05)	Log(0.75,0.05)	Log(0.75,0.05)	Log(0.75,0.05)	Log(0.75,0.05)	Log(0.75,0.05)	Log(0.75,0.05)	Log(0.75,0.05)
	Costs	Log(0.94,0.05)	Log(0.75,0.05)	Log(0.75,0.05)	Log(0.75,0.05)	Log(0.75,0.05)	Log(0.75,0.05)	Log(0.75,0.05)	Log(0.75,0.05)

Table A12. Quantitative input matrix for the IT service design B using Scale 3 with probabilistic values.

Value Decision Tree		Architectural IT Service Design Components							
Design Criteria	Design Sub-Criteria	App Software	Software	Data	Hardware	Network	Environment	Teams	External IT Service Providers
Utility	Benefits Risks	Log(0.94,0.05) Log(0.50,0.05)	Log(0.94,0.05) Log(0.50,0.05)	Log(0.94,0.05) Log(0.50,0.05)	Log(0.94,0.05) Log(0.50,0.05)	Log(0.94,0.05) Log(0.50,0.05)	Log(0.94,0.05) Log(0.50,0.05)	Log(0.94,0.05) Log(0.50,0.05)	Log(0.94,0.05) Log(0.50,0.05)
Warranty	Availability	Log(0.75,0.05)	Log(0.75,0.05)	Log(0.75,0.05)	Log(0.75,0.05)	Log(0.75,0.05)	Log(0.75,0.05)	Log(0.75,0.05)	Log(0.75,0.05)
	Capacity	Log(0.50,0.05)	Log(0.50,0.05)	Log(0.50,0.05)	Log(0.50,0.05)	Log(0.50,0.05)	Log(0.50,0.05)	Log(0.50,0.05)	Log(0.50,0.05)
	Security	Log(0.75,0.05)	Log(0.75,0.05)	Log(0.75,0.05)	Log(0.75,0.05)	Log(0.75,0.05)	Log(0.75,0.05)	Log(0.75,0.05)	Log(0.75,0.05)
	Continuity	Log(0.50,0.05)	Log(0.50,0.05)	Log(0.50,0.05)	Log(0.50,0.05)	Log(0.50,0.05)	Log(0.50,0.05)	Log(0.50,0.05)	Log(0.50,0.05)
	Performance	Log(0.75,0.05)	Log(0.75,0.05)	Log(0.75,0.05)	Log(0.75,0.05)	Log(0.75,0.05)	Log(0.75,0.05)	Log(0.75,0.05)	Log(0.75,0.05)
	Costs	Log(0.25,0.05)	Log(0.25,0.05)	Log(0.25,0.05)	Log(0.25,0.05)	Log(0.25,0.05)	Log(0.25,0.05)	Log(0.25,0.05)	Log(0.25,0.05)

Table A13. AHP matrix of global priorities for the top, criteria and sub-criteria levels using Scale 2.

Top Level	Weight	Criteria Level	Weight	Sub-Criteria Level	Weight
Value Index of Agile Architectural Design of IT Services	1.000	Utility	0.500	Benefits	0.375
				Risks	0.125
		Warranty	0.500	Availability	0.040
				Capacity	0.040
				Security	0.040
				Continuity	0.040
				Performance	0.111
				Costs	0.227

Appendix D. Evaluation of the Conceptual Validity of the Artifact A

Task 1: Development of the Conceptual Artifact A. An artifact was developed consisting of a 10-page technical document and two explanatory videos, which together present the proposed model. These materials include the theoretical justification, general structure, key components, and possible applications in real environments. The set of resources was sent to the Panel of Experts as essential input for their analysis and evaluation.

Task 2: Design of Data Collection instruments. Two questionnaires were defined for data collection: the Demographic Data Questionnaire and the Conceptual Validity Questionnaire. The Demographic Data Questionnaire included eight generic items and six specific items designed to identify senior evaluators. The Conceptual Validity Questionnaire consisted of three items to measure Theoretical Validity and four items to measure Theoretical Consistency. Each item was evaluated using a 5-point Likert scale (1: strongly disagree; 5: strongly agree). Table A14 presents the Conceptual Validity Questionnaire.

Table A14. Conceptual Validity Questionnaire.

Conceptual Validity Questionnaire						
Theoretical Validity: the extent of the artifact evaluated is perceived with adequate validity in its content and supported from relevant scientific references.						
TV1. The conceptual product (AHP-AgileITS-ArchDesign model) is supported by robust theoretical knowledge (e.g., based on scientific literature).						
Strongly disagree	1	2	3	4	5	Strongly agree
TV2. The theoretical knowledge used for elaborating this conceptual product (AHP-AgileITS-ArchDesign model) is relevant for the addressed topic.						
Strongly disagree	1	2	3	4	5	Strongly agree
TV3. The scientific literature considered for elaborating this conceptual product (AHP-AgileITS-ArchDesign model) does not present important omissions for the topic.						
Strongly disagree	1	2	3	4	5	Strongly agree
Theoretical Consistency: the extent of the artifact evaluated is perceived with adequate logical consistency in its content and its format structure.						
TC1. The conceptual product (AHP-AgileITS-ArchDesign model) is logically coherent.						
Strongly disagree	1	2	3	4	5	Strongly agree
TC2. The conceptual product (AHP-AgileITS-ArchDesign model) is adequate for achieving the purpose of its utilization.						
Strongly disagree	1	2	3	4	5	Strongly agree
TC3. The conceptual product (AHP-AgileITS-ArchDesign model) provides new scientific-based knowledge (e.g., it is not a just a duplication of an existent conceptual product).						
Strongly disagree	1	2	3	4	5	Strongly agree
TC4. The presentation style of the conceptual product (AHP-AgileITS-ArchDesign model) is adequate for a scientific report.						
Strongly disagree	1	2	3	4	5	Strongly agree

Task 3: Definition of Criteria for Expert Inclusion. The criteria established for the selection of Experts were as follows:

- IC.1: Experience in agile development practices and/or IT service architectures.
- IC.2: Participation in academic or professional projects related to the design or evaluation of IT architectures in Data Centers.
- IC.3: Self-assessment with a high or very high skill level in the aforementioned domains.

These qualitative criteria were verified and controlled using the last six specific items of the Demographic Data Questionnaire, designed to identify senior evaluators and ensure the applicability of the validation metrics.

Task 4: Selection and Contact with Experts. A group of international experts with relevant academic and professional profiles was invited. They were contacted by email from a list elaborated by the two senior researchers in this research team (given their previous attendance at multiple international conferences on decision-making support systems and ITSM). Of the 16 Experts contacted, all met the inclusion criteria and completed the assessment within the assigned period.

Task 5: Demographic Data Analysis. The evaluation panel was made up of specialists with extensive experience and diversity in age ranges, academic levels, areas of training, and years of professional practice (see Tables A15 and A16).

Table A15. Demographic data of the Panel of Experts (Part 1).

Demographic Item	Expert Evaluators (%)	Demographic Item	Expert Evaluators (%)
1. Age range:		5. Scope of work setting:	
() 20–30 years	6.3	() Regional	18.8
() 31–40 years	12.5	() Nationwide	31.2
() 41–50 years	25.0	() Worldwide	50.0
() >50 years	56.3	6. Region of working setting:	
2. Academic highest gained level:		() USA/CAN	37.5
() Bachelor level	12.5	() Europe	31.3
() Bachelor (plus Prof. Certifications)	0.0	() Asia/Oceania	6.2
() Master's level	50.0	() Latin America	25.0
() Doctorate level	37.5	7. Years in work settings:	
3. Main area of formal studies:		() 1–5 years	0.0
() Computer Engineering	37.5	() 6–10 years	12.5
() Business Informatics	50.0	() 11–15 years	6.3
() Business Management	12.5	() 16–20 years	25.0
() Other	0.0	() 20 or more years	56.2
4. Main work setting:		8. Main Work Position:	
() Business enterprise	68.8	() Academic/Researcher	25.0
() University/Research Unit	25.0	() IT Project Manager/IT Consultant	37.5
() Government Unit	6.2	() Business Mgr./Business Consultant	18.8
		() Other	18.7

Table A15 reports Part 1 of the Demographic Data of the Panel of Experts and reveals the seniority and professional levels of the contacted Panel of Experts. Most of them (81%) work on international worldwide or nationwide organizations; 56% is at least 50 years old; 87% of them have gained a graduate education level; 56% of them have accumulated at least 20 years in working settings; almost 70% (68.8%) work in business organizations; and, consequently, around 75% have professional work positions (only around 25% are academic and/or researchers).

Table A16 reports Part 2 of the Demographic Data of the Panel of Experts regarding their involvement in agile processes and ITSM practices, as well as in IT projects using agile and/or ITSM practices. Table 12 reveals also the seniority level of the Panel of Experts:

on average a 43% have 10 or more years involved in agile processes (37%) and ITSM practices (50%); a similar 43% on average have participated in at least 10 projects using agile processes (43.7%) and ITSM practices (43.6%); and most of them self-evaluated with high or very high level of expertise on ITSM practices (55%) and a relevant percentage on agile processes (43%).

Table A16. Demographic data of the Panel of Experts (Part 2).

Demographic Item	Expert Evaluators (%)	Demographic Item	Expert Evaluators (%)
9A. Years involved in AGILE PROCESS (SCRUM, XP, etc.):		9B. Years involved in ITSM PRACTICES (ITIL, CMMI-SVC, etc.):	
() <1 year	0.0	() <1 year	0.0
() 1–3 years	12.5	() 1–3 years	0.0
() 4–6 years	31.3	() 4–6 years	18.8
() 7–9 years	18.8	() 7–9 years	31.2
() 10 or more years	37.4	() 10 or more years	50.0
10A. Number of projects in AGILE PROCESS (SCRUM, XP, etc.):		10B. Number of projects in ITSM PRACTICES (ITIL, CMMI-SVC, etc.):	
() 1–3	25.0	() 1–3	18.8
() 4–6	12.5	() 4–6	18.8
() 7–9	18.8	() 7–9	18.8
() 10 or more	43.7	() 10 or more	43.6
11A. Self-evaluation of expertise in AGILE PROCESS (SCRUM, XP, etc.):		11B. Self-evaluation of expertise in ITSM PRACTICES (ITIL, CMMI-SVC, etc.):	
() Very high level of expertise	31.3	() Very high level of expertise	37.5
() High level of expertise	12.5	() High level of expertise	18.8
() Moderate level of expertise	56.2	() Moderate level of expertise	43.7
() Low level of expertise	0.0	() Low level of expertise	0.0
() Very low level of expertise	0.0	() Very low level of expertise	0.0

Task 6: Conceptual Validation Analysis. Task 6 was performed in the following 6.1 and 6.2 sub-tasks.

Task 6.1: *Descriptive Statistics of the Instrument.* Table A17 reports the descriptive statistics and the reliability of the used instrument. This instrument measures the constructs Theoretical Validity (TV) and Theoretical Consistency (TC), by using 3 and 4 operational variables, respectively. A 5-point Likert scale was used from 1 (strongly disagree) to 5 (strongly agree). The mean, median, standard deviation and reliability metric (Cronbach's alpha) obtained for these 2 constructs, TV and TC, were (4.25, 4.50, 0.765, 0.830) and (3.86, 3.75, 1.037, 0.869), respectively.

These results for the descriptive statistics and the reliability metric can be considered satisfactory for the small sample size. Additionally, we applied a Wilcoxon Signed-Ranks Test of medians against a threshold value of 3.00 reported in Table A18. This test used a Non-parametric approach due to the lack of a normal distribution in the dataset. Results from Table A18 indicate that the two constructs TV and TC can be considered with medians over 3.00, which is satisfactory. In particular, Theoretical Validity was assessed as stronger than Theoretical Consistency.

Task 6.2 *Quality of the Conceptual Validity Measurement Instrument.* To evaluate the quality of the measurement instrument used in the conceptual validation of the model, the Partial Least Squares (PLS) Statistical Technique was used [103–106]. We used a free academic version of the SmartPLS v4 software tool [107] and the data provided by 16 senior Experts. The quality of the measurement instrument can be assessed through the determination of its Internal Consistency Reliability, Convergent Validity, and Discriminant Validity.

PLS, in particular, is suitable for small-sized samples and does not require the normal distribution of the data. Internal Consistency Reliability refers to the repeated consistency of the measures when using the instrument multiple times. Convergent Validity refers to the convergence—i.e., high correlation r_{XY} —of the instrument items assigned to the construct. Discriminant Validity refers to the distinction of the instrument items assigned to the construct regarding the other instrument items not assigned—i.e., low correlation r_{XY} . The PLS literature has reported criteria to assess these metrics (Table A19).

Table A17. Descriptive statistics and reliability of the conceptual evaluation.

Id Var.	Construct and Variable Descriptions	Mean	Median	Std. Dev.	Cronbach's Alpha
Theoretical Validity Construct (measured with 3 operational variables): the extent to which the artifact evaluated is perceived as having adequate validity in its content and supported by relevant scientific references.					
TV1	The conceptual product (AHP-AgileITS-ArchDesign model) is supported by robust theoretical knowledge (e.g., based on scientific literature).	4.25	4.50	0.765	0.830
TV2	The theoretical knowledge used for elaborating this conceptual product (AHP-AgileITS-ArchDesign model) is relevant for the addressed topic.				
TV3	The scientific literature considered for elaborating this conceptual product (AHP-AgileITS-ArchDesign model) does not present important omissions for the topic.				
Theoretical Consistency Construct (measured with 4 operational variables): the extent of the artifact evaluated is perceived with adequate logical consistency in its content and its format structure.					
TC1	The conceptual product (AHP-AgileITS-ArchDesign model) is logically coherent.	3.86	3.75	1.037	0.869
TC2	The conceptual product (AHP-AgileITS-ArchDesign model) is adequate for achieving the purpose of its utilization.				
TC3	The conceptual product (AHP-AgileITS-ArchDesign model) provides new scientific-based knowledge (e.g., it is not just a duplication of an existing conceptual product).				
TC4	The presentation style of the conceptual product (AHP-AgileITS-ArchDesign model) is adequate for a scientific report.				

Table A18. Non-parametric Wilcoxon Signed-Ranks Test of medians vs. a threshold value.

Id. Construct	Construct	Wilcoxon W Statistics	p-Value	Null Hypothesis	Decision
TV	Theoretical Validity	119	<0.001	HO.TV: "The median of TV is ≤ 3.00 ".	Rejected
TC	Theoretical Consistency	106	0.005	HO.TV: "The median of TC is ≤ 3.00 ".	Rejected

Table A19. Internal Consistency Reliability, Convergent Validity, and Discriminant Validity criteria.

Validation Dimension	Metric	Gefen et al. Criteria [77,78]	Hair et al. Criteria [79]	Russo and Stol Criteria [80]
Reliability	Composite Reliability Index (ρ_c) (a sub-type of Internal Consistency Reliability metric)	$0.700 \leq \rho_c$	$0.700 \leq \rho_c < 0.950$	$0.700 \leq \rho_c \leq 0.900$
	Cronbach's Alpha (α) (a sub-type of Internal Consistency Reliability metric)	$0.700 \leq \alpha$	$0.700 \leq \alpha < 0.950$	$0.700 \leq \alpha \leq 0.900$
Convergent Validity	All factor item loadings in the assigned construct (λ)	$0.707 \leq \lambda$	$0.708 \leq \lambda$	$0.708 \leq \lambda$
	Average Variance Extracted of each construct (AVE)	$0.500 \leq AVE$	$0.500 \leq AVE$	$0.500 \leq AVE$
Discriminant Validity	Average Variance Extracted of each construct (AVE) and correlations per construct with other constructs (r_{XY})	$r_{XY} < \sqrt{AVE}$	$r_{XY} < \sqrt{AVE}$	$r_{XY} < \sqrt{AVE}$
	All factor item loadings in the assigned construct (λ) and all factor item loadings in the other non-assigned constructs ($\sim\lambda$)	$\lambda > \sim\lambda$	No reported	$\lambda > \sim\lambda$
	All Heterotrait–Monotrait ratios of the correlations among constructs (HTMT)	No reported	HTMT < 0.850 (very different constructs) HTMT < 0.900 (very similar constructs)	HTMT < 0.850 (very different constructs) HTMT < 0.900 (very similar constructs)

Table A20 presents the results for the Conceptual Validity instrument. The factor item loadings (λ) assigned to TV ([0.888, 0.946, 0.728]) and to TC ([0.890, 0.935, 0.756, 0.801]) show that these λ exceed the threshold of 0.708. The other metric indicates that the Average Extracted Variances (AVE) for all constructs must exceed the threshold of 0.500, and thus the values 0.738 and 0.719, respectively, for TV and TC were satisfactory. Discriminant Validity was also assessed as satisfactory through the three metrics used. All factor item loadings (λ) assigned to the two constructs were greater than the ones not assigned ($\sim\lambda$). The root square of each AVE was 0.859 (for TV) and 0.848 (for TC) and they exceeded the correlations (r_{XY}) to other constructs (the off-diagonal values of 0.583 in the 2X2 matrix). Finally, all Heterotrait–Monotrait ratios of the correlations (r_{XY}) among constructs (HTMT) it is indicated to be less than 0.850, and in this case the unique HTMT calculated (0.610) was satisfactory.

Hence, Internal Consistency Reliability, Convergent Validity and Discriminant Validity metrics of the measurement instrument are considered satisfactory.

Table A20. Quality of the conceptual validity measurement instrument.

Metrics	Constructs	
	VT Theoretical Validity	CT Theoretical Consistency
Composite Reliability Index (ρ_{c_c}) $0.700 \leq \rho_{c_c} < 0.950$	0.893	0.911
Cronbach's Alpha Reliability ($C\alpha$) $0.700 \leq \alpha < 0.950$	0.830	0.869
Convergent Validity $0.707 \leq \lambda$ Discriminant Validity $\lambda > \sim\lambda$	Items	Factor Item Loadings (λ)
	TV1	0.888
	TV2	0.946
	TV3	0.728
	TC1	0.590
	TC2	0.507
	TC3	0.482
Convergent Validity $0.500 \leq AVE$	Average Extracted Variances (AVE)	
	0.738	0.719
Discriminant Validity $r_{XY} < \sqrt{AVE}$; $0.850 < HTMT$ (very different constructs) $0.900 < HTMT$ (very similar constructs)	$\sqrt{AVE}$ vs. Correlations (r_{XY}); HTMT	
	VT	$\sqrt{AVE_{VT}} = 0.859$
	Theoretical Validity	$r_{XY}(VT,CT) = 0.583$; HTMT(VT,CT) = 0.610
	CT	$r_{XY}(VT,CT) = 0.583$; HTMT(VT,CT) = 0.610
Theoretical Consistency		$\sqrt{AVE_{CT}} = 0.848$

Appendix E. Evaluation of Usability Measurement Instrument for the Artifact A

Table A21. Usability Questionnaire instructions.

Instructions
This research investigates how AHP quantitative-based models can help to design IT services in an agile way, and achieve satisfactory usability metrics (usefulness, ease of use, compatibility, value, and intention of use). For this aim, we require kindly your collaboration, as an international professional of IT Service Management, to evaluate the AHP-Model-Arch-ITS (AHP Model for Evaluating Agile Design of Architectures of IT Services) implemented in the free-cost software tool CDP. The evaluation steps are the following ones: 1. To answer the DOC.1.Q-DEMOGRAPHIC-DATA.OK word document (10 min). 2. To review the DOC.2.AHP.MODEL.ARCH.ITS.OK pdf document (5 min). 3. To observe the VIDEO.01.AHP.MODEL.ARCH.ITS.OK (18 min). 4. To observe the VIDEO.02.AHP.MODEL.ARCH.ITS.OK (20 min). 5. To answer the DOC.3.QUESTIONNAIRES.EVALUATIONS.OK word document (15 min). 6. To return us the filled DOC.1 and DOC.3 word documents to paola.reyesd@edu.uaa.mx with copy to jose.mora@edu.uaa.mx, once ended and completed in the next 6 weeks. Thanks really for your valuable participation.

Table A22. Usability Questionnaire (Part 1). **INSTRUCTIONS.** Thanks in advance for responding to the following statements regarding the usability metrics for the **AHP-AgileITS-ArchDesign model (AHP Model for Evaluating Agile IT Service Architecture Designs in Small Data Centers)**. Please respond to the following questions with the most immediate response that you think.

Construct and Items	5-Point Likert Scale									
	STRONGLY DISAGREE	DISAGREE	NETURAL	AGREE	STRONGLY AGREE	STRONGLY DISAGREE	DISAGREE	NETURAL	AGREE	STRONGLY AGREE
	RESPONSES FOR X = AHP-AgileITS-ArchDesign Model					RESPONSES FOR Y = Alternative Model Y				
USEFULNESS —is the degree to which using the new TOOL is perceived as being better than using the current used TOOL.										
1. If I were to use the TOOL (X Y), it would enable me to accomplish my IT Service Architectural Design tasks more quickly.	1	2	3	4	5	1	2	3	4	5
2. If I were to use the TOOL (X Y), the quality of my work (IT Service Architectural Design) would improve.	1	2	3	4	5	1	2	3	4	5
3. If I were to use the TOOL (X Y), it would enhance my effectiveness on the job (related with IT Service Architectural Design).	1	2	3	4	5	1	2	3	4	5
4. If I were to use the TOOL (X Y), it would make my job easier (related with IT Service Architectural Design).	1	2	3	4	5	1	2	3	4	5
EASE OF USE —is the degree to which using the new TOOL is perceived as being free of effort.										
1. Learning to use the TOOL (X Y), it would be easy for me.	1	2	3	4	5	1	2	3	4	5
2. If I were to use the TOOL (X Y), it would be easy to operate.	1	2	3	4	5	1	2	3	4	5
3. If I were to use the TOOL (X Y), it would be difficult to use.	1	2	3	4	5	1	2	3	4	5
COMPATIBILITY —is the degree to which using new the TOOL is perceived as compatible with what people do.										
1. If I were to use the TOOL (X Y), it would be compatible with most aspects of my work (related with IT Service Architectural Design).	1	2	3	4	5	1	2	3	4	5
2. If I were to use the TOOL (X Y), it would fit my work style (related with IT Service Architectural Design).	1	2	3	4	5	1	2	3	4	5
3. If I were to use the TOOL (X Y), it would fit well with the way I like to work (related with IT Service Architectural Design).	1	2	3	4	5	1	2	3	4	5
VALUE —the degree to which using the new TOOL is perceived as a value delivery entity for users by savings on money, time, and the provision of a variety of valuable resources, and by an overall value.										
1. The value for saving money by using the TOOL (X Y), for IT Service Architectural Design tasks is:	1	2	3	4	5	1	2	3	4	5
2. The value for saving valuable time by using the TOOL (X Y), for IT Service Architectural Design tasks is:	1	2	3	4	5	1	2	3	4	5
3. The value for being able to locate a wide variety of IT Service Architectural Design data, information and knowledge by using the TOOL (X Y) is:	1	2	3	4	5	1	2	3	4	5
4. In overall, the value of using the TOOL (X Y) for IT Service Architectural Design tasks is:	1	2	3	4	5	1	2	3	4	5

Table A23. Usability Questionnaire (Part 2).

Construct and Items	7-Point Semantic Differential Scale													
	RESPONSES FOR X = AHP-AgileITS-ArchDesign Model							RESPONSES FOR Y = Alternative Model Y						
	EXTREMELY NEGATIVE							EXTREMELY POSITIVE	EXTREMELY NEGATIVE					EXTREMELY POSITIVE
ATTITUDE POTENTIAL OF USE —Positive or negative assessment of the potential use of the tool.														
ATTITUDE.01 —All considered things, using TOOL (X Y) in my job within next six months would be:	−3	−2	−1	0	+1	+2	+3	−3	−2	−1	0	+1	+2	+3

Table A23. Cont.

Construct and Items	7-Point Semantic Differential Scale													
	RESPONSES FOR X = AHP-AgileITS-ArchDesign Model							RESPONSES FOR Y = Alternative Model Y						
	EXTREMELY BAD						EXTREMELY GOOD	EXTREMELY BAD						EXTREMELY GOOD
ATTITUDE.02—All considered things, using TOOL (X Y) in my job within next six months would be:	−3	−2	−1	0	+1	+2	+3	−3	−2	−1	0	+1	+2	+3
	EXTREMELY HARMFUL						EXTREMELY BENEFICIAL	EXTREMELY HARMFUL						EXTREMELY BENEFICIAL
ATTITUDE.03—All considered things, using TOOL (X Y) in my job within next six months would be:	−3	−2	−1	0	+1	+2	+3	−3	−2	−1	0	+1	+2	+3

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