**Review Article**

# Information Systems Development Methodologies: A Review Through a Teleology Approach

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### Abstract

The information systems analysis and design methodologies devised at the outbreak of the third industrial revolution shaped the systems analysis disciple and have trickled down to all systems influencing most aspects of human development. To cope with the explosion of digital technology, these methodologies had to be developed rapidly, drawing from a wide range of theoretical backgrounds, based mainly on the "hard" scientific method and the "softer" systems approach. In the run-up to industry 4.0, with multiple information systems emerging, reflection on systems' design fundamentals is important. Intended to serve human activity and well-being, information systems are anthropocentric. Their success lies in their ability to serve human goals. Information systems analysis and design methodologies play a role in this by ensuring the best match between what is sought from systems and what they deliver in terms of the systems' underlying final cause, or "telos". The paper investigates the teleological orientation of four founding systems analysis and design methodologies. Using the Wood-Harper and Fitzgerald taxonomy in order to identify the conceptual origins of the four methodologies under review, it categorizes and subsequently incorporates them in an extended taxonomy, assesses whether and how they are devised to cater to the incorporation of goals and explains the inferred results based on the taxonomy. The paper posits that the founding information systems analysis and design methodologies do not have a marked teleological orientation and do not dispose of techniques for adequately incorporating systems' goals.

*Keywords:* Teleology; Systems Analysis; Information Systems Analysis and Design Methodologies.

## 1. Introduction

The most severe failures of Information Systems (IS) are attributed to the early stages of their development, when the fundamentals of the design were conceptualized and set. This study focuses on what Churchman (1968) [1] considered an absolute requisite for the analysis and modelling of systems: purpose. The identification of the purpose of any given system is the compendium of the teleological aspects incorporated in the underlying philosophical systems, which has been termed the systems approach [1-9]. Teleology, as defined by Aristotle in Metaphysics [10], corresponds to what systems specialists refer to as goal orientation, characterised by seminal systems theorists as the systemic attribute "par excellence" [11, 12]. According to Schoderbek et al. [13], goal orientation is the litmus test distinguishing organized complexities, such as systems, from chaotic ensembles [14].

Systems incorporate two interlinked spheres: a perceptible sphere, which can be described as external and formal and includes materialistic aspects, such as events, data, points of location and time, and an imperceptible sphere, which refers to systems' internal and informal attributes and encompasses social aspects, such as beliefs, norms, goals and purposes. As argued by Mattessich (1978) [6], systems are goal-oriented and have a purpose either because: i) their internal or

social development allows norms to emerge out of this very system in the form of new holistic properties; or ii) norms are over-imposed externally, in which case the system becomes a quasi-extension of the influential external system by adopting its purpose wholly or partly. These two aspects are closely interconnected and constitute the two facets of any systemic entity. The perceptible sphere includes the constituent elements of a system, whereas the imperceptible one refers to the features that make "a system more than the mere sum of its parts" [6, 11, 15, 16]. This paper argues that, when analyzing or merely modelling an existing system, but foremostly when developing a new one, both spheres have to be equally considered to achieve a judicious blend connecting the materialist "upper structure" to the social "under-structure" of the systems' "edifice". Such a dual perspective is essential for evaluating the success of systems based on their "anchoring" to the underlying needs they are intended to serve. The successful interconnection of the two constitutes the acid test for systems" stability, effectiveness, relevance and ultimately their success. As they are intended to serve human activity and well-being, IS are anthropocentric in serving human goals.

Consequently, it is interesting to delve in hindsight into founding IS analysis and design methodologies, which have hitherto been the basis for the development of a plethora of IS applications marking human economic and social activity. The paper focuses on the teleological orientation of these founding methodologies. The aim is to assess whether they incorporate a teleological perspective and the extent to which they ensure that developed systems are "telos-oriented" or, in other words, serving their "final cause" [17].

The paper constitutes a meta-analysis of existing IS analysis and design methodologies, created in the formative years of the systems analysis discipline, contributing to its theoretical and operational establishment. Aiming to investigate their teleological perspective, the paper provides a concise overview of the theoretical approaches and operational bases of selected IS development methodologies while assessing their teleological "footprint". These methodologies determined the IS systems analysis and design that bolstered all aspects of human development over the last forty years. As founding elements of the emerging systems analysis discipline, they had to be shaped rapidly, drawing from a wide range of theoretical backgrounds. Nonetheless, they have strongly marked this era—also indirectly—by engendering numerous subsequent and more recent methodologies. Accordingly, their underling concepts are arguably topical, especially given that technology is currently at a similar historical juncture and Zeitgeist in the run-up to industry 4.0, facing a whirlwind of concepts, technological advancements and application proposals. The investigation elucidates and discusses goal orientation as a deliberate activity incorporated in methodologies drawing on different disciplinary streams, based on the Wood-Harper and Fitzgerald (1982) [18] taxonomy. The taxonomy evidences, indeed, that different methodologies reflect "in fact different perceptions in the field of systems analysis". This taxonomy serves as the study's theoretical framework. Interestingly, it coincides with their motivation for crafting the taxonomy, as "the development of technology is a powerful impetus to the re-examination of ideas".

The paper posits that the systems teleology perspective has been marginally integrated in the IS analysis and design founding methodologies. Furthermore, it has been sidelined at the application level due to the lack of recognition of its importance for IS analysis and design and the inherent challenges in incorporating social elements in the materialistic application processes. This has infiltrated the subsequent and currently used methodologies. As we are on the brink of a new technological quantum leap, further research on conceptual and methodological issues of systems analysis is timely, as developments are rapid and challenging, propelled by increased competition in the current multipolar and globalized world. Humans are threatened by climate change, rising inequality and pandemics, while space is calling them beyond Earth's borders. Thus, systems analysis is called to deliver.

The study material is gleaned from secondary scholarly sources, processed through the theoretical framework, and presented in the following structure: Section 2 presents the theoretical framework of the study; and Section 3 investigates the teleological orientation of four selected IS analysis and design methodologies using the theoretical framework for identifying their major influences.

## 2. Theoretical Approach

To investigate the teleological orientation of the founding IS analysis and design methodologies, the paper reviewed a number of methodologies, selecting four for further study. These four were selected on the basis of the following criteria: i) well-founded theoretically; ii) fully fledged, coving most aspects of the IS development cycle; iii) well established and widely used; iv) topical, having demonstrated a longitudinal impact either directly, by still being in use, or indirectly, by having influenced subsequent methodologies. The study uses the Wood-Harper and Fitzgerald taxonomy in order to i) identify the conceptual origins of the approaches in systems design; ii) trace back the conceptual origins of various methodologies to ensure a balanced mix of those selected for further investigation; and iii) further extend the taxonomy, to include the categorization of the methodologies under review. Subsequently, the study assesses whether and how the selected methodologies are devised and equipped to incorporate systems' goals. By juxtaposing the methodologies back onto the taxonomy at the end of the analysis, the paper derives further insights and some explanations for the teleology orientation of the methodologies under review.

Endeavoring to clear the confusion created by the explosion of numerous systems analysis methodologies, mainly in the 1970s, Wood-Harper and Fitzgerald (1982) [18] developed a taxonomy of the then-existing methodologies to support informed choices of appropriate methodologies. The taxonomy includes six major approaches to systems analysis: i) General Systems Theory Approach; (ii) Human Activity Systems Approach; (iii) Participative (Socio technical) Approach; (iv) Traditional (NCC, etc.) Approach; (v) Data Analysis Approach; (vi) Structured Systems (Functional) Approach. Apart from the General Systems Theory Approach, are all still currently used to some extent in the industry. The General Systems Theory is included as an approach "because of its important influence on systems thinking in general and because of the contribution it has made to almost all the other identified approaches". These differing approaches "arise because it is so difficult to observe objectively a system that exists "out there" in the real world. Our perceptions of that reality are different and subjective and it is these different perceptions that lead to the differing approaches". The various systems analysis approaches emerged from quite diverse underlying paradigms, which for the purposes of the taxonomy are understood in a Kuhnean sense, in particular as "a set of achievements which are acknowledged as the foundation of further practice …[and are as such]…subject free, in that [they] may apply to a number of problems regardless of their specific content". The taxonomy identified two major paradigms, which have "infiltrated" the IS analysis and design approaches: the "hard" scientific method and the "softer" systems approach. The former is characterised by "reductionism, repeatability and refutation" and the latter by "openness, low separability and high interdependence", for accommodating human activity in a holistic way [18].

A review of founding IS analysis and design methodologies highlights important differences in their approaches, which can be revealing with regard to their teleological orientation, using two criteria: i) is goal setting considered at the outset? ii) are methods provided for identifying and documenting goal setting in a structured and translucent way, possibly with the use of a refinement loop to increase detail? To assess whether, and if so to what extent, the teleological aspect is taken into consideration in these methodologies, the paper proceeds in the following four-step heuristic way: i) identification of focal methodologies, based on the frequency, range of applicability and topicality; ii) benchmarking of the selected methodologies against the Wood-Harper and Fitzgerald taxonomy in order to identify their conceptual origins, providing a first indication of their eventual teleological constituent elements; iii) closer study of the methodologies under review to demonstrate the specificities of their teleological orientation; and iv) juxtaposing the methodologies against the taxonomy backdrop to explain the results, or a "light" causarum cognitatio.

## 3. Assessment of selected Information System Analysis and Design Methodologies

Based on the literature review, the paper identified four major mainstream and widely applied methodologies on which it focuses: i) Problem Statement Language/Problem Statement Analyzer (PSL/ PSA); ii) Checkland's Soft System Methodology; iii) Information Systems Work and Analysis of Changes (ISAC); and iv) two similar methodologies, namely, the Structured Analysis and Design Technique (SAD) and the Structured Systems Analysis (SSA), belonging to a cohort of associated methodologies, comprising a variety of Data Flow Diagram (DFD) methodologies. The benchmarking of the selected methodologies against the Wood-Harper and Fitzgerald taxonomy of IS analysis and design approaches shows that they are mostly "hybrid", stemming from more than one approaches, given that the originating streams of systems analysis have never been at odds. Rather, it seems the two streams have coexisted, resulting in coalescent approaches, which, further down the line, have had overlapping spheres of influence in methodology developments. With the exception of the ensemble of methodologies resulting from the Structured Systems Analysis approach, as mentioned above, there is no orthodoxy in methodologies, as most of them draw on more than one approach (Figure 1).

### 3.1. Problem Statement Language/Problem Statement Analyzer

The Problem Statement Language/Problem Statement Analyzer (PSL/PSA) is a computer-aided methodology devised as part of the Information System Design and Optimization System (ISDOS) project at the University of Michigan to aid system development during the requirements definition stage.

The methodology—which has been uninterruptedly in use since its creation in 1968 [19, 20], emerged as a reaction to the frequently unsuccessful IS developments in the 1960s, given that the computer-based graphical techniques preferred at the time could not cope with the size and complexity of large systems. PSL/PSA is therefore "frontloaded", based mainly on the premise that the front end of the IS development process is more important because it deals with incorporating the user's point of view [21]. PSL/PSA is thus proffered for documenting and analyzing system requirements based on identified organizational information needs [21-25]. This frontloaded view of systems development is also shared by other major scholars [26, 27]. PSL/PSA was conceived to deal with the initiation of systems, and thus its principal objective is the shaping of the system request. Accordingly, it supports the clear specification of the system's requirements as a basis for the design phases. The methodology is problem oriented in the sense that it facilitates problem scanning and identification within the IS development process, such as error and consistency scrutiny. However, it considers the system's interaction with the organization as beyond its scope [28].
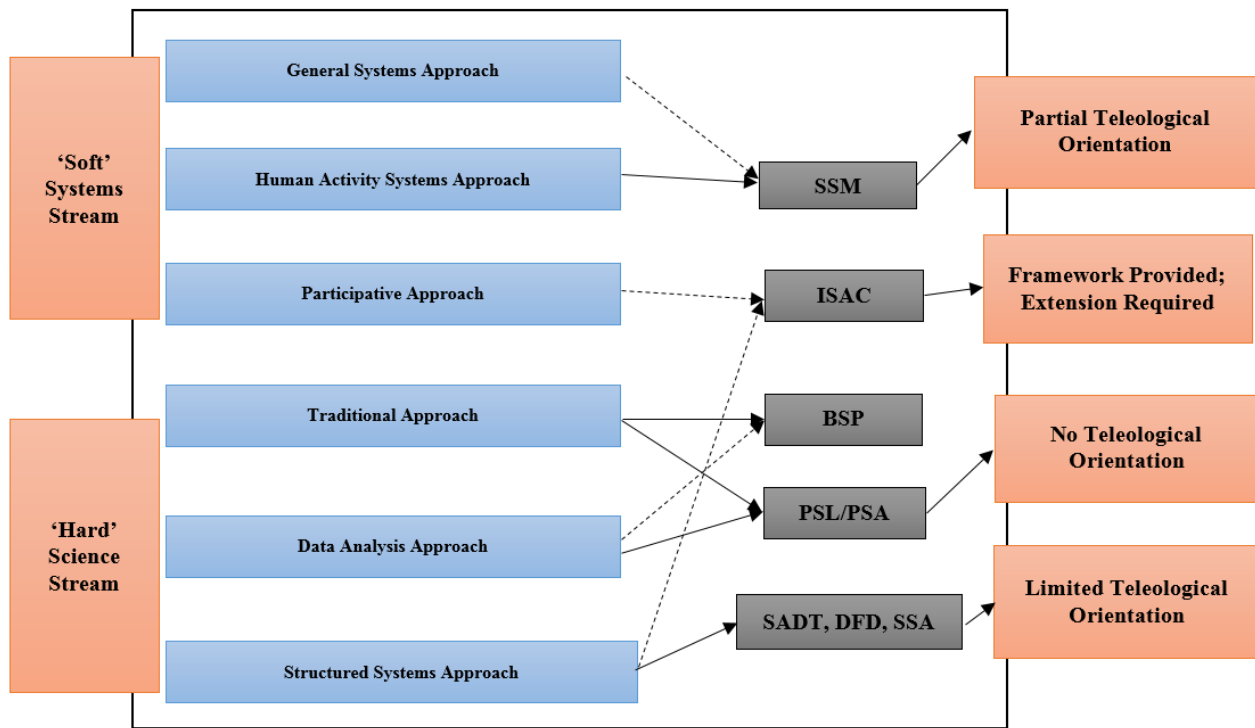
**Figure 1. Benchmarking IS development methodologies against the Wood-Harper and Fitzgerald taxonomy of IS analysis and design approaches.**

Inferentially, the methodology has no means for identifying, documenting and incorporating organizational needs beyond those linked to information processing despite calls to view the specification of system requirements merely as the means for fulfilling the needs of organizations [29-30]. Even so, PSL/PSA constitutes a representative example of the emphasis placed by most IS systems methodologies on "getting the requirements right" [31]. The vast majority of the IS development methodologies share the same focus [32-41]. Surely, setting the system requirements is the first in a series of methodological steps to transform vaguely expressed system needs into a "working manifestation", although with no guarantee that the system will ultimately serve the overarching organizational goals. For the latter, PSL/PSA is in no way equipped, as it does not have the means to even deal with needs and requirements, and hence it lacks any teleological orientation. In the literature, requirements are generally viewed as a list of particular tasks that have to be fulfilled before approaching the system design. Consequently, IS requirements are not goals or ends, in other words teloi, but rather means, prerequisites and conditions for their achievement. Prima facie, this contradicts Langefors [42, 43], who considers requirements to be goal statements, and as they specify what is to be achieved, goals extend well beyond practicalities into the sphere of value judgments [6] and subjective engagements [44].

Their nature, formation and articulation are subject to personal and organizational perspectives as well as Weltanschauungen. Upon second look, however, this is in line with Langefors, who refers to requirements as goals of the system design and the system analyst rather than of the system itself. In fact, considering that IS requirements must emanate from goals and subsequently serve as a means for achieving these goals through the design of effective systems, they do not diminish the importance of the requirement analysis and definition process. On the contrary, the apt specification of requirements is the sine qua non condition for ensuring systems' success in serving the interests of users and organisations [45]. Requirements are, in this sense, derivatives of the goals, but they are of great importance, as they reflect goals, which are often hidden and unspoken. Through their documentation, requirements enable consensus building around system goals and needs, streamlining modi of man-machine interactions and facilitating the judicious blend of formal and informal aspects of IS analysis and design [31, 45]. Deriving from a "hard" scientific method and a data processing approach, PSL/PSA fully lacks, however, the necessary teleological orientation for ensuring the optimal link between goals and requirements, as the means for their achievement.

## 3.2. Soft System Methodology

Checkland's Soft System Methodology (SSM) [15] was developed at the University of Lancaster, principally based on a Human Activity Systems Approach, while drawing on elements of the general systems theory. Widely used to the present day [46], this methodology has been further developed to deal with human activity situations involving technological as well as social and political aspects. It is an attempt to apply systems thinking to systems practice in order to tackle unstructured or so called "soft" problems.

The methodology consists of seven stages. The first two stages aim to express, in the richest way possible, not the problem but the prevailing situation in which the problem has arisen. Stage 3 identifies and defines systems possibly related to the putative problem, in terms of what these systems are and not what they do [15]. The definition of systems in this sense is based on a "particular view", aggregating the views of the analyst and all those related to the system solutions to be crafted, after achieving consensus among the concerned parties. Stage 4 consists of making "idealistic" conceptual models of the human activity, cast to fit the definition of the systems shaped in Stages 1 and 2. In ensuring the comprehensiveness of the conceptual model, the methodology foresees the use of techniques for framing organizational stakeholder perspectives, such as the CATWOE, which stands for Customer, Actor, Transformation, Worldview, Owner and Environment. Stage 5 consists of a comparison between the analysis outcomes of Stages 2 and 4, that is, the "idealistic"/ "should" and the "actual"/ "is" situation of the systems. Stage 6 refers to the debate triggered by the "comparison" of the "should" and "is" situations among the concerned parties. In this sense, the discussion is a means for generating proposals for possible changes, which are both desirable and feasible within the given context. The final Stage 7 rolls-out the necessary actions for improving the problem situation, based on the consensus achieved in Stage 6 [15].

The hallmark of Checkland's methodology is Stage 3, which he terms "root definition". He embedded the methodology in the systems approach, thus stressing that systems must be defined through a contextual approach, taking into consideration the system's environment [6]. The definition of the system's purpose—which is the quintessence of the teleological orientation of any system - is considered when shaping the root definition of its underlying Weltanschauung. Does this, however, justify the conclusion that the methodology includes teleological aspects as a deliberate activity in the way understood in this paper? Checkland uses the root definition as a means to comprehend the problem situation. The root definition is an arbitrary interpretation of the system under investigation, modelled to reflect the actual system, but in a simpler way than. Its reduced complexity allows a sharper focus on eventual problems, their nature and possible interrelations. A good root definition is one that best helps to understand the problem situation and not one that reflects the "telos" of the actual system. In this sense, it takes into consideration an "artificial" purpose crafted to understand reality [47] and not the purpose underlying reality.

Furthermore, Checkland does not address the increased complexity arising from the fact that different participants— working within or in association with the system - view the system from different perspectives and thus have different understandings of the situation and the system as well as different expectations and objectives [48]. As the latter cannot be easily understood, the identification of the systems' goals, which could possibly resolve the problem situation, is left aside. Admittedly, this could be attributed to Checkland's [15] acknowledgement that the goals of soft systems cannot be adequately dealt with within the framework of the methodology. Although SSM differs from other methodologies in its "soft" perspective with wide social and political components, it does not fully cater to the needs of a teleological orientation.

### 3.3. Information Systems Work and Analysis of Changes

Information Systems Work and Analysis of Changes (ISAC) is a participative, process-oriented approach to IS development with a particular focus on the analysis and design phases of the development process [49]. It is the result of research work carried out at the Royal Institute of Technology at the University of Stockholm in the early 1970s and is still in use [50]. Devised as a problem-solving methodology, it primarily aims at understanding and exposing the fundamental causes of a system's problems. The ISAC contains five phases that cover the entire IS development process, the first three of which focus on problem, while the last two focus on data-solving issues: i) change analysis identifies the necessary changes to resolve the problem situation; ii) activity studies refine the needs in more detail and model the proposed new system, using activity graphs, such as A-graphs; iii) information analysis concerns the extraction of information sets from the A-graphs; iv) documentation "crystallizes" the extracted information sets with Component graphs (C-graphs) and defines the requirements; iv) data system design crafts a technical solution to meet the requirement specification; v) equipment adaptation concerns the evaluation of the technology setting and the eventual changes to be introduced. ISAC is a complete methodology guiding the IS designer from the theoretical level of needs identification all the way to the implementation of necessary equipment adaptation [51-53].

The question of teleology concerns the change analysis phase of IS development, when "system logical aspects" are framed. This phase attempts to identify the improvements needed to resolve or improve the problematic issues [51]. The change analysis includes the following main sub-activities: i) analysis of problems and needs (problem listing, analysis of interest groups, problem groupings, description of current activities, description and analysis of goals, evaluation of current situation); ii) study of change alternatives (generation of changes alternatives, description of change alternatives, evaluation of change alternatives); iii) choice of change alternatives (choice of change alternatives, choice of development measures, analysis of parallel development measures). A change analysis clearly follows a generalized systems analysis trend, which emphasizes the identification of needs as the starting point for any IS development [28, 36, 42, 55-57]. Although some individual research streams have based proposed methodologies on the definition of "desires" rather than needs, the foundation of systems analysis methodologies has been based on expressed needs [33].

ISAC's change analysis phase concentrates on the identification of change motives [58] or possible needs. Nonetheless, unlike other mainstream methodologies, ISAC identifies needs on the basis of a comparison between what exists - the problem table and the description of current activities - and "what is wanted" - a table of goals - for the identification of needs, which are then evaluated in the next ISAC phase. "The problem to be attacked" is shaped in the "table of goals", which can be transformed into needs for change [51].

ISAC introduces goals as a decisive parameter in IS development. It is, nevertheless, necessary to investigate how the term "goal" is understood in the context of this methodology before evaluating its teleological orientation. ISAC illustrates this point with an example showing how problems, desires, goals and needs are related in the context of a change analysis: "A desire for an inventory item may be to attain a service level of 95% in the long run. A realistic goal may be a service level of 90%. The problem in the current situation is that the service level is only 70%, which is too low and leads to undesirable consequences. There is a need for change in order to raise the service level from 70 to 90%, a difference of 20%" [51]. The example reveals that ISAC understands goals as "goals for the activities", which is, as intended future activity states and not as goals for the information system as a whole. This focus on activity goals as opposed to overarching goals, in combination with the inherent feature of organizational hierarchies of tending to adopt sub-aims within complex organizations, may lead to system inefficiency and ineffectiveness if these sub-goals prove incompatible with the system's general goals [59]. In this light, ISAC shows no teleological orientation. Even so, in presenting the implementation of an adapted version of ISAC, Rajkovic (1979) [60] claimed that "an appropriate IS has to support development of man as producer, consumer, and manager, on the basis of goals such as: carrying out socio-political activities, expression of personality, job satisfaction, social security, education, etc.". His reference addresses broader goals of individuals or social systems, such as organizations, and not strictly IS goals. In this vein, ISAC provides a suitable framework for incorporating a teleological dimension in IS development, with different levels of aspiration and scope. However, this implies that additional tools and techniques need to be devised and added to the ISAC framework.

### 3.4. Structured Systems Analysis

SSA is a generic term for a whole range of methodologies that have been devised to improve the structuring of problem situations that are not clearly defined [61]. They consist of methodologies equipped with tools and techniques that emerged in a bottom-up fashion from system development, such as structured programming applications, rather than in a top-down sense of having systems theory as their starting point.

These methodologies are intended to be the blueprints of IS models. As explained by Gane & Sarson (1979) [36], their underlying concept is the drive to satisfy users' needs by enabling users and IS analysts to have a clear and common picture of the system and how its parts fit together through logical (non-physical) system models depicted with graphical techniques. Although claiming the importance of structuring systems' requirements, none of the SSA methodologies assists in the actual process of determining them. Rather, they assist in specifying and documenting the requirements, ensuring that no obvious requirements have been omitted [62]. In this context, the notion of defining requirements is considered in a broad sense, encompassing all the aspects of system development prior to the actual system design. This is particularly evident in the Structured Analysis and Design Technique (SADT), which is part of the SSA ensemble and proposes a requirements definition process based on three interrelated "subjects": context analysis, functional specification and design constraints [40]. In this sense, SADT can be viewed as problem- rather than goal oriented, given that context analysis only focuses on the reasons dictating the system development.

Another methodology in the SSA cohort, also named Structured Systems Analysis (SSA), consists of five main stages: the initial study, the detailed study, the definition of a "menu" of alternatives, gaining commitment from users based on the "menu" and the physical design of the new system. The definition of alternatives comprises the identification of objectives for the new system. System objectives are viewed as a means for achieving the overall organizational objectives and are derived from the limitations of the existing system. They are linked with principal organizational objectives, such as Increased Revenue, Avoidance of Cost and Improved Service, coined under the acronym IRACIS. Being universal and generic, these objectives can be attributed to any kind of IS, in any context. Objectives and goals of this kind are often mentioned in literature in the form of generally desired outcomes, such as the more rapid and accurate provision of up-to-date information. Although they can be adapted and tailored to fit particular organizational circumstances, their generality reduces their relevance for the development of any particular IS, whose nature and features are determined by the pertinent users in a specific organizational and general context. In this sense, SSA recognizes the importance of specifying systems goals; however it remains ensnared in generic objectives, without a systematic process for identifying specific goals, as needed in a teleological approach. The use of specific goals for IS development, derived from the organizational context, requires specialized techniques beyond the SSA checklists of universal and generic goals [63, 64].

## 4. Toward Goal-oriented Systems Analysis and Design Methodologies

In the maturing phase of the IS methodology development process, which began in the mid-1970s, a number of important, theoretically oriented works focused on the principles of IS analysis and design rather than on the process. In an effort to incorporate a social dimension into the IS methodologies, most of them assign particular importance to appropriate goal identification and setting. For example, the socio-technical approach stresses the need to focus on social as well as technical goals [9, 65, 66]. The socio-cybernetic meta-modelling includes preferences and values [67]. The contractual view of IS is clearly goal oriented [68]. In an effort to model systems of social norms, from which information requirements can be logically deduced, the semiotic approach to IS analysis and design—drawing on the theory of signs - emphasizes the importance of appropriately considering goals in IS development [27, 45, 69-72]. This approach yields 'methods and tools for analyzing and designing the social, pragmatic, and semantic aspects of IS that receive little attention in our current methodologies' [71]. Stamper (1981) [27] proposed a framework for a methodology based on an evolutionary approach of continuous creation, whereby IS development proceeds in loop-type cycles all the way from a system's definition to its implementation, taking into consideration the following: i) goals/tasks/destinations; ii) teams/units/jurisdictions; iii) subject matter/universe of discourse; iv) decisions, internal/external; v) information precedence/need to know; vi) rules/policies/laws; and vii) constraints upon discretion. The process consists of iterative cycles and embraces goal orientation to achieve the design of formal IS that are in harmony with the informal human systems [73]. Some authors have supplemented theoretical considerations with methods and techniques to deal with certain specific tasks that are relevant to systems teleology. One of these, value analysis, uses the teleological perspective to overcome organizational suboptimisation [73].

Cognizant of the importance of goal consideration in IS analysis and design, there have been attempts to guide analysts in their choice of appropriate methodologies. For this purpose, systematic evaluations of the performance of various methodologies have been performed. The evaluations attempted to shed light on and assess methodologies in the context of subjective and conflicting organisational objectives, where IS parameters are projected against a hierarchy of organizational goals [48].

The literature review reveals important endeavours for devising credible methods to extract and subsequently structure - usually in a hierarchical form - the particular IS goals in any given situation as well as documentation techniques for facilitating consensus building around IS development. Such goal hierarchies contribute to a deeper and more complete understanding of systems by enriching the specifications regarding the perceptible sphere of materialistic aspects, such as technology with those of the imperceptible sphere of a social nature, comprising norms, beliefs and goals. Additionally, these hierarchies can legitimize systems within their organizational context, offering a kind of yardstick for assessing IS effectiveness as well as further development prospects. IS developed on this basis can even become a vehicle for improved overall performance and support the accomplishment of organizational goals. Systems emerging in this way can thus be more easily accepted and integrated in their context, as they reflect users' and organizations' preferences and priorities, at the formal as well the informal levels.

As goals are the foundational elements of IS design, methods for their extraction, documentation and "processing" should be applied prior to, or in parallel and in combination with, existing methodologies. An important success factor for such methods has been identified: their ability to provide interfaces with sub-system layers or other systems, allowing the development of subsequent tasks to fit broader "multi-view methodologies" [74].

## 5. Conclusions

The IS analysis and design methodologies devised at the outbreak of the third industrial revolution shaped the systems analysis disciple and have infiltrated all aspects of human development ever since. Due to the explosion of digital technology, they had to be developed rapidly, drawing on a wide range of theoretical backgrounds, mainly based on the "hard" scientific method and the "softer" systems approach. Currently at a similar historic juncture and Zeitgeist in the run-up to industry 4.0, IS systems are expected to multiply exponentially. Revisiting system design fundamentals is thus not parochial but imperative. Intended to support human activity and well-being, IS systems are anthropocentric. Their success lies in their ability not to meet design requirements [75-80], but to serve human goals. IS analysis and design methodologies play an important role by ensuring the best match between the overarching goal of systems and what they provide in terms of the underlying "final cause", or "telos".

The paper reviewed four founding IS analysis and design methodologies and examined their teleological orientations, aiming to assess whether and how they cater to the incorporation of goals. The investigation reveals that systems teleology is not adequately considered in the generally applicable and widely accepted IS analysis and design methodologies. Using the Wood-Harper and Fitzgerald taxonomy to identify the conceptual origins of the methodologies under review, the analysis shows that the only one with no teleological orientation is the PSL/PSA. This can be explained by its purely "hard" science roots, although these roots did not hinder the SSA cohort of methodologies from allowing some sort of goal-setting, albeit in a generic check-list form. ISAC clearly provides a suitable framework for incorporating a teleological dimension in IS development, with different levels of aspiration and scope. However, this

implies that additional tools and techniques need to be devised and added to the ISAC framework. Also coming from the "soft" stream, SSM differs from other methodologies in its "soft" perspective, with wide social and political components. However, it does not fully cater to the needs of a teleological orientation. In a nutshell, there is a congruent approach among the "soft" system methodologies, which distinguishes them from those rooted in "hard" science, although the difference is not clear cut. On the contrary, the lack of orthodoxy leads to their coalescence. This should not lead to the conclusion that the significance of a teleological orientation in systems analysis and design has been disregarded. Without vociferous criticism, several theorists have stressed the importance of incorporating social elements in IS analysis and design, and many have proposed methodologies. However, no methodology has demonstrated the capability to support a structured teleological analysis, and thus the topic requires further research.

## 6. Declarations

### 6.1. Data Availability Statement

Data sharing is not applicable to this article.

### 6.2. Funding

### 6.3. Acknowledgements

### 6.4. Declaration of Competing Interest

The author declares that she has no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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