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Framework for Describing a Theoretical Perspective: Application to the Bunge-Wand-Weber Ontology and General Systems Theory

Steven Alter
University of San Francisco, alter@usfca.edu

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Full research paper

Steven Alter
School of Management
University of San Francisco
San Francisco, CA, USA
Email: alter@usfca.edu

Abstract

A Delphi study reported in *Business Information System Engineering (BISE)* in 2015 identified "rethink the theoretical foundations of the IS discipline" as a grand challenge for the discipline. Pursuit of that challenge calls for developing a framework for describing a theoretical perspective (an FDTP) because a coherent theoretical foundation ideally should be based on a well-articulated theoretical perspective. This paper defines *theoretical perspective* and presents a proposed FDTP that consists of 25 topics divided into 7 categories. It illustrates the use of the FDTP by applying it to the Bunge-Wand-Weber (BWW) ontology and to general systems theory (GST), two sets of ideas that could be related to a theoretical foundation for IS. Application of the FDTP reveals topic areas that the BWW ontology and GST cover and other that they do not cover. Subsequent sections explain how the FDTP was produced and suggest follow-on research.

Keywords Theoretical perspective, framework for describing a theoretical perspective, Bunge-Wand-Weber ontology, general systems theory

1 Need for a Framework for Describing a Theoretical Perspective

"Rethink the theoretical foundations of the IS discipline" was tied for first of 21 challenges as a grand challenge for IS research in a Delphi study reported in *Business Information System Engineering* by Becker et al. (2015). It was ranked third of 21 as having an impact on the discipline if it were solved. It was ranked 13 of 21 in terms of time frame, i.e., whether it could be dealt with or solved within 10 years.

Various aspects of the need for a theoretical foundation for IS have been discussed for decades, e.g., at the first ICIS meeting (Keen, 1980), in commentaries about whether the IS field is in a crisis (Hirschheim and Klein, 2003; Benbasat and Zmud, 2003), in discussions related to academic legitimacy (Baskerville and Myers 2002; Lyytinen and King 2004; Wade et al. 2006; Avison and Malaurent 2014), and in debates about whether IS is stuck using an unproductive mid-range script (Grover and Lyytinen 2015).

Part of the challenge in that entire discourse is the lack of an established framework for specifying a theoretical foundation for IS or for other disciplines. A Google Scholar search on "theoretical foundation" returned over five million hits that touched on an extremely diverse set of topics, the first of which were theoretical foundations for fraud detection, relationship-centered care, concept planning, and managing destination brands. In IS, it is not obvious how to evaluate whether General System Theory (GST), the Bunge-Wand-Weber (BWW) ontology, sociotechnical design, sociomateriality, actor-network theory, the viable system model, activity theory, or other possibilities might serve as an effective theoretical foundation either individually or in some defined combination. Also, it is not obvious how to compare the value of alternative theoretical foundations that might be proposed, especially since most of the related discussions over recent decades has focused on describing different aspects of problems and issues and have not attempted to propose an answer that covers all or most of the IS discipline. For example, GST says nothing specific about IS and Wand and Weber (1990, p. 162) says explicitly that the BWW ontology does not try to address many important IS topics related to usage and implementation.

This paper assumes that choosing or developing a framework for describing theoretical perspectives (an FDTP) is an important step toward defining and justifying a coherent theoretical foundation for the IS discipline. Producing an effective FDTP would help in describing and comparing the above possibilities and possibly others with respect to their content, omissions, applications, and so on.

This paper presents a proposed FDTP but makes no claim that it is the best possible FDTP. To the contrary, it assumes that other researchers might prefer other FDTPs, especially if they use their own preferred starting points. Also, this paper proposes an FDTP as a step toward explaining and evaluating a theoretical foundation for IS, but it does not attempt to propose a theoretical foundation. Research in that direction is being pursued but has not been completed.

Contribution and organization. This paper's primary contribution is the presentation and explanation of a proposed FDTP including two illustrative applications of the FDTP. The underlying assumption is that other FDTPs might be proposed by other researchers.

This paper's organization is designed to explain its primary contribution and to minimize redundancy. To satisfy both goals, presentation of the proposed FDTP and two illustrative applications precedes an explanation of the iterative process that produced the FDTP. First this paper defines *theoretical perspective* and presents a proposed FDTP that consists of 25 topics divided into 7 categories. Then it illustrates the use of the FDTP by applying the FDTP to the BWW ontology and to GST. Application of the FDTP reveals topic areas that the BWW ontology and GST cover and other that they do not cover. Subsequent sections explain how the FDTP was produced and suggest follow-on research.

2 A Framework for Describing Theoretical Perspectives

A theoretical perspective related to a specific discipline or body of knowledge can be defined as a coherent assemblage of concepts, assumptions, generalizations, associations, and methods that constitutes a useable viewpoint for recognizing, understanding, and analyzing ideas and situations within that discipline or body of knowledge. That definition is consistent with results of Google Scholar searches on "theoretical perspective," which returned many thousands of hits identifying theoretical perspectives for many topics in many disciplines. A theoretical perspective for a discipline should include much more than a few central ideas and typically risks highlighting some topics and obscuring others. Burton-Jones et al. (2015) apply a different view of theoretical perspectives, treating them as approaches for performing research, e.g., variance, process, or systems perspectives in research design.

A theoretical perspective is much more like a framework than like a theory. The discussion of the FDTP follows distinctions between frameworks, theories, and models presented by the Nobel Prize winning economist Elinor Ostrom. As explained in Ostrom (2009, pp. 27-28) a framework helps to "identify the elements (and the relationships among these elements) that one needs to consider. … Frameworks provide a metatheoretic language that is necessary to talk about theories and that can be used to compare theories." Theories "enable the analyst to specify which components of a framework are relevant for certain kinds of questions and to make broad working assumptions about these elements." … "Models make precise assumptions about a limited set of parameters and variables. Multiple models are compatible with most theories." That view of frameworks, theories, and models addresses confusions that occur when those three terms are used almost interchangeably by diverse authors, leading to "considerable confusion as to what they mean" because "what one scholar calls a framework others call a model or a theory." (p. 27). That view of frameworks, theories, and models differs from the view expressed in Gregor (2006), whose five categories of theory combine various aspects of Ostrom's view of frameworks, theories, and models.

Thus, an FDTP is a broad framework for presenting theoretical perspectives, which themselves are like frameworks. Table 1 lists the 25 topics in the proposed FDTP in 7 categories for ease of visualization:

Category	Topics
Justification	1) rationale
Coverage	2) domain, 3) omissions
Focal points	4) primary entity types, 5) special cases of entity types,6) facets of entities, 7) portrayals of entities, 8) functions of entities, 9) interactions of entities, 10) overlaps of entities
Attributes of entities	11) characteristics, 12) performance variables, 13) phenomena
Change	14) events, 15) trajectories of change, 16) forces
Generalizations	17) axioms, 18) design principles, 19) frameworks, 20) theories, 21) models, 22) metamodels, 23) methods
Fundamental limitations	24) uncertainties, 25) indeterminacies

Table 1. The FDTP's 25 topics organized based on 7 categories

The proposed FDTP's 25 topics are defined below and then illustrated by their use in describing the BWW ontology and GST, two theoretical perspectives that are applicable to the IS discipline.

(Justification)

- **Rationale**. Explanation of why a specific theoretical perspective is plausible and usable as a theoretical perspective for a specific domain or discourse.

(Coverage)

- **Domain**. The entities, relationships, and interactions to which a theoretical perspective applies (e.g., systems in general vs. information systems or databases or software).
- **Omissions**. Possibly relevant topics that a theoretical perspective treats as beyond its scope (e.g., describing an IS without describing its users or their responsibilities).

(Focal points)

- **Primary entity types**. Entity types that are frequently viewed as essential to consider (e.g., information system, software, user)
- **Special cases of entity types**. Definable groups of entity types whose classification and inherent characteristics are useful in understanding the primary entity types and their position in the broader domain (e.g., management information system, internet of things, social media)
- **Facets of entities**. Noteworthy aspects or sides of an entity type that has multiple noteworthy aspects or sides (e.g., making decisions, communicating, coordinating, improvising, and maintaining security as facets of a business process).
- **Portrayals of entities**. Views of the entirety of an entity or phenomenon, often useful for comparing different views (portrayals) of the same entity (e.g., portrayal of information as conveyer of meaning vs. as digital object, portrayal of a user as a person vs. an employee).
- **Functions of entities**. An entity's behaviors and responsibilities related to its roles, activities, and/or positions (e.g., providing information, controlling execution, performing task)
- **Interactions of entities**. Unidirectional, mutual, or reciprocal actions, effects, relationships, influences, or interplay between two or more entities (e.g., supplying resources, negotiating, coordinating, interfering with task)
- **Overlaps of entities**. Instances of two or more entities sharing all or part of themselves as a whole or of specific components (e.g., processes overlap when a physician serves simultaneously in a process of providing medical care and in a process of recording information for billing)

(Attributes of entities)

- **Characteristics.** Inherent properties of entities, assumed constant for purposes of an analysis (e.g., weight of a laptop, capacity of a solid state disk) but in some instances changeable over longer time spans, e.g., age, years of experience).
- **Performance variables**. Measurable results that can be monitored and evaluated instantaneously or periodically and often by comparison with goals (e.g., a factory's defect rate).
- **Phenomena**. Perceptible circumstances or occurrences that have an impact or are otherwise noteworthy but that are neither inherent characteristics and nor performance variables (e.g., organizational culture, misfit with culture, business/IT alignment, environmental turbulence, absorptive capacity, competitive challenges, transient bottleneck, value-in-use, work/life balance, missing data, techno-stress, obsolescence, mission creep, noncompliance)

(Change)

- **Events**. Changes or actions that occur at a specific time or over a time interval and are treated as relevant (e.g., completion of a process step, resignation of a key employee)
- **Trajectories of change**. Identifiable sequences of changes or actions (e.g., a factory's manufacturing process, steps in a software development process)
- **Forces**. Frequently relevant influences of entities, group of entities, or phenomena that induce or impede specific types of transitions in the state of entities (e.g., innovative energy, discord within a work group, inertial forces that impede progress).

(Generalizations)

- **Axioms**. Statements that are assumed to be true for all entities or all entities of a specific type within a domain. Axioms within a domain should be mutually independent and mutually non-contradictory. A claim that a statement qualifies as an axiom within a domain can be disproved using a counterexample within the relevant domain.
- **Design principles**. Desired or beneficial characteristics of all entities or all entities of a specific type. Design principle is a synonym of design theory. Unlike axioms, design principles often have exceptions, may be mutually inconsistent, and may conflict in practice.
- **Frameworks**. These identify elements and relationships among elements and provide a metatheoretic language for expressing and comparing theories (Ostrom, 2009).
- **Theories**. These specify components of a framework that are relevant for certain kinds of questions and express broad assumptions about those elements.
- **Models**. These specify precise assumptions about a limited set of parameters and variables. Multiple models are compatible with most theories.
- **Metamodels**. These identify concepts and relationships that can be used for conceptual modeling of entities within a theoretical perspective.
- **Methods.** These are descriptions of actions required to achieve specific results related to entities or obtained through the use or interaction of those entities.

(Fundamental limitations)

- **Uncertainties**. These are knowledge gaps (incomplete or inaccurate information) about the past, current, or future states, events (state transitions), or causes of states or events related to entities or phenomena (e.g., not knowing which untested component may have a flaw).
- **Indeterminacies**. These are fundamental limitations on the possibility of knowing specific aspects of the past, current, or future states, events, or causes related to entities or phenomena (e.g., inability to know exactly what a specific customer was thinking when selecting an item).

The initial topics such as rationale, domain, omissions, and primary entity types should seem obvious to most researchers. However, a quick look at the "Theories Used in IS Research Wiki" (Larsen and Eargle 2015) shows why even the initial topics should not be taken for granted. Seemingly obvious topics such as the domain of relevance and omissions of potentially relevant issues are not stated explicitly for many of those theories. Other topics such as portrayals, facets, functions, interactions, overlaps, events, trajectories of change, forces, various types of generalizations, uncertainties, and indeterminacies are not as obvious, and are not mentioned at all in many accounts of IS research results.

Some of the topics in the FDTP are not totally independent of each other. For example, *events* and *trajectories of change* are treated as separate topics even though trajectories of change are sequences of events. Similarly, some *interactions* between entities involve *overlaps* between those entities. Thus, it might be possible to reduce the number of topics in the FDTP by folding some topics into others. Overall, the criterion of usefulness seems more important than the criterion of independence in deciding which concepts to include. For example, *overlaps* and *interactions* are included because both point to issues that might not be recognized based on only overlaps or only interactions.

3 Illustrative Applications of the FDTP

This section applies the FDTP to two sets of ideas that can be viewed as theoretical perspectives. The purpose of these illustrative examples is to demonstrate the application of the FDTP to explore whether a specific set of ideas might provide a useful theoretical perspective on information systems. The BWW ontology is discussed first because its constructs are all specified (Wand and Weber 1990, p. 64). The GST is defined less clearly, although Skyttner (1996, pp. 20-21) states "There is near total agreement on which properties, together, comprise a general systems theory. Discussing other theoretical perspectives such as sociotechnical design would be more difficult in a relatively short paper due to the lack of agreement about what they comprise and how they are best applied to ISs.

3.1 Exploring the BWW Ontology as a Possible Theoretical Perspective for IS

An ontological model such as the Bunge-Wand-Weber (BWW) ontology identifies relevant entities and their properties and interrelationships. "An 'ontological model' is a set of constructs of an ontology that represents reality as perceived by an observer." (Fettke and Loos 2003, p. 2947). Those models document relevant concepts and support communication by revealing differences in perspectives, metaphors, and lenses. The BWW ontology is a general ontology for describing things in the world, in contrast with a domain ontology that identifies constructs in a specific domain such as database design (Lukyanenko et al. 2021). Ontological models can be evaluated based on usefulness to users and criteria for evaluating constructs. Ontological deficiencies include incompleteness (omission of constructs related to an important meaning), redundancy (two constructs with the same meaning), excess (constructs in the model that do not map to important aspects of the situation), and overload (a construct with multiple meanings).

The BWW ontology is reflected in representation theory, whose significance in IS research is discussed in Burton-Jones et al. (2017) and Recker et al. (2021). According to Wand and Weber (1990, p. 62), an IS is a representation of a real-world system and "information systems are primarily intended to model the states and behavior of some existing or conceived real world system." Constructs in the BWW ontology include: thing, properties, state, conceivable state space, state law, lawful state space, event, event space, transition law, lawful event space, history, coupling, system, system composition, system environment, system structure, subsystem, system decomposition, level structure, external event, stable state, unstable state, internal event, well-defined event, poorly-defined event (p. 64).

The BWW ontology energized important research but does not address many important IS topics. Allen and March (2006, p. 1) says the BWW ontology is limited because it "is concerned with representing the material world - the world of material objects that possess physical properties existing independently from human perception. It has no place for human intentions, interpretations, creations, or meaning." Wand and Weber (1990, p. 62) say something similar about IS: "When modeling an information system we are not concerned with the way it is managed in organizations, the characteristics of its users, the way it is implemented, the way it is used, the impact it has on such factors as quality of working life or the distribution of power in organizations or the type of hardware or software used to make it operational." The following summarizes how the 25 topics in the FDTP can be applied to the question of whether the BWW ontology seems plausible as the basis of a theoretical perspective on the IS discipline. Many of topics can be addressed greater detail, but not in the context of a 10-page paper.

(Justification)

- **Rationale**. The BWW might serve as the basis of a theoretical perspective on ISs because ISs can be viewed as consisting of things characterized by properties, states, events, and so on.

(Coverage)

- **Domain**. As a general ontology, BWW covers things in the world and therefore covers ISs in some ways, although many of its basic elements are rarely applied directly to specific ISs.
- **Omissions**. As a general ontology rather than a domain ontology, BWW says nothing specific about the domain of IS. Its focus on things, properties, states, and so on emphasizes material things and does not deal directly with topics and issues related to IS development, usage, implementation, and impacts.

(Focal points)

- **Primary entity types**. In the BWW these include things, properties, states, systems, and so on, as listed above.
- **Special cases of entity types**. The BWW distinguishes between internal vs. external events, well-defined vs. poorly defined events, event spaces in general vs. lawful event spaces, stable vs. unstable states, conceivable vs. lawful state space. It says nothing about different types of ISs.
- **Facets of entities**. Not included in the BWW.

- **Portrayals of entities**. Not included in the BWW.
- **Functions of entities**. Not included in the BWW.
- **Interactions of entities**. The BWW covers interactions somewhat indirectly through the concepts of coupling, system composition, and system decomposition.
- **Overlaps of entities**. BWW's inclusion of system decomposition implies that it potentially covers the simplest form of overlap between a system and its subsystem.

(Attributes of entities).

- **Characteristics.** Special cases of certain entity types are based on yes/no characteristics, e.g., internal vs. external events, well-defined vs. poorly defined events, event spaces in general vs. lawful event spaces, stable vs. unstable states, conceivable vs. lawful state space.
- **Performance variables**. Not included in the BWW.
- **Phenomena**. Coupling, system composition, and system decomposition

(Change)

- **Events**. The BWW includes events of different general types. It also includes transition laws that can govern events.
- **Trajectories of change**. The construct *history* can be viewed as a trajectory of events.
- **Forces**. Not included in the BWW.

(Generalizations)

- **Axioms**. The entire BWW ontology has an axiomatic nature.
- **Design principles**. Not included in the BWW.
- **Frameworks**. The BWW might be viewed as a framework.
- **Theories**. Not included in BWW even though the BWW is the basis of representation theory.
- **Models**. Not included in the BWW.
- **Metamodels**. The BWW might be viewed as a metamodel for modeling aspects of the world.
- **Methods.** Not included in the BWW.

(Fundamental limitations)

- **Uncertainties**. Not included in the BWW.
- **Indeterminacies**. Not included in the BWW.

Applying the FDTP's 25 topics to BWW ontology shows that it omits many topics and issues that can be useful in understanding ISs. This will be discussed further in a comparison with GST.

3.2 Exploring GST as a Possible Theoretical Perspective for IS

GST "integrates a broad range of special systems theories by naming and identifying patterns and processes common to all of them. By use of an overarching terminology, it tries to explain their origin, stability and evolution." (Skyttner 1996, p. 16). Ackoff (1971, p. 662) says, "a system is an entity which is composed of at least two elements … each of a system's elements is connected to every other element, directly or indirectly. No subset of elements is unrelated to any other subset." GST recognizes that the term system is highly subjective in nature. "A system is not something presented to the observer, it is something to be recognized by him/her. Usually this word does not refer to existing things in the real world but, rather, to a way of organizing our thoughts about the same." (Skyttner 1996, p. 16). For Checkland (1999, p. 121), systems thinking starts "with an observer/ describer of the world outside ourselves who … wishes to describe it 'holistically', … in terms of whole entities linked in hierarchies with other wholes." … At minimum, the observer's description will include: "his purpose, the system(s) selected, and various system properties such as boundaries, inputs and outputs, components, structure, the means by which the system retains its integrity, and the coherency principle which makes it defensible to describe a system as a system." Skyttner (1996, pp. 20-21) concludes: "There is near total agreement on which properties, together, comprise a general systems theory." Those properties include interrelationship and interdependence of objects and their attributes, holism, goal seeking, transformation process, inputs and outputs, entropy, regulation, hierarchy (nesting of subsystems), differentiation (specialized units) and equifinality and multifinality (alternative paths to the same objectives or different outcomes). Applying the FDTP's 25 topics to GST shows that it touches on many important IS-related topics and issues but omits many others.

(Justification)

- **Rationale**. Many statements by researchers such von Bertalanffy, Boulding, Ackoff, Checkland, Churchman and others point to a systems approach in which observers view specific parts of the world as systems that typically exhibit the properties identified above by Skyttner (1996).

(Coverage)

- **Domain**. GST covers purposeful systems that exhibit behavior, as implied by GST properties such as goal seeking, inputs, outputs, and transformation processes.
- **Omissions**. GST does not describe algorithms, software and other systems that cannot exhibit behavior even when they guide or control behavior of human or nonhuman actors.

(Focal points)

- **Primary entity types**. These include the system that is being studied, its environment, its components and their interactions, relevant goals, inputs, and outputs, all of which are relevant to ISs. In GST systems operate through transformation processes, regulation, hierarchy, and differentiation, all of which are viewed as operational topics rather than entities.
- **Special cases of entity types**. Skyttner (1996, p. 16) notes that GST "integrates a broad range of special systems theories by naming and identifying patterns and processes common to all of them. The main properties of GST seem not to be useful for differentiating between special cases of ISs or between special cases of important IS topics such as information or technologies.
- **Facets of entities**. The idea of facets is not widely associated with GST.
- **Portrayals of entities**. Alternative portrayals are not widely associated with GST.
- **Functions of entities**. Goal seeking, inputs and outputs, and transformation processes are important properties of GST that can be used to describe ISs.
- **Interactions of entities**. GST recognizes that the operation of systems relies on interactions between system components, as is implied by GST properties that apply to ISs, such as hierarchy, differentiation. interrelationship and interdependence of objects and their attributes.
- **Overlaps of entities**. The GST properties of hierarchy and differentiation imply that GST potentially covers a minimal form of overlap between an IS and its subsystem.

(Attributes of entities)

- **Characteristics.** GST touches on important characteristics of ISs including holism, goal seeking, hierarchy, differentiation
- **Performance variables**. The idea of performance variable is not typically associated with GST even though goal seeking, equifinality, and multifinality imply that performance is a key concern, at least at the level of an entire system.
- **Phenomena**. GST properties such as interrelationship and interdependence of entities, entropy, equifinality, and multifinality all can be viewed as phenomena that are potentially relevant to ISs even though entropy, equifinality, and multifinality of ISs are rarely mentioned.

(**Change)**

- **Events**. The GST property of transformation process typically can be tracked through events.
- **Trajectories of change**. GST transformation processes can be viewed as trajectories of change and regulation can be viewed as trying to control those trajectories.
- **Forces**. GST typically does not focus on forces or their effects.

(Generalizations)

- **Axioms**. The relevance of most of the GST properties identified by Skyttner (1995) can be viewed as axiom-like within GST and apply to most ISs.
- **Design principles**. GST does not include design principles.
- **Frameworks**. GST itself is much more like a framework than like a theory.
- **Theories**. GST typically is not associated with specific theories even though special systems theories may be associated with theories
- **Models**. GST typically is not associated with specific models even though special systems theories (mentioned by Skyttner 1995) may be associated with some models.
- **Metamodels**. GST typically is not associated with metamodels.
- **Methods.** GST typically is not associated with specific methods even though many methods may claim to use a systems approach.

(Fundamental limitations)

- **Uncertainties**. GST typically is not associated with specific uncertainties.
- **Indeterminacies**. GST typically is not associated with specific indeterminacies.

3.3 Comparison of the BWW Ontology and GST as possible FDTPs for IS

Table 2 provides a brief comparison of the BWW ontology and GST as possible FDTPs for IS. The columns for BWW and GST in Table 2 identify properties in each approach that in some way link each of the 25 FDTP topics with topics or issues in IS. An entry of "x" indicates that a topic in the FDTP seems not to be covered directly (sometimes a matter of interpretation). A substantially more detailed comparison would require a more extensive presentation of BWW and GST and a more extensive table.

FDTP topic	BWW Ontology	GST
1) rationale	ISs can be characterized to some extent using BWW elements such as properties, states, events, and so on.	ISs can be characterized to some extent by GST properties identified by Skyttner (1995).
2) domain	Material things in the world	Purposeful systems that exhibit behavior
3) omissions	Not a domain ontology	Static systems, e.g., specifications
4) entity types	Things, properties, states, systems, subsystems, laws, etc.	System, environment, components, interactions, goals, inputs, outputs
5) special cases	Types of entities, not types of ISs	x
6) facets	x	x
7) portrayals	x	x
8) functions	x	Goal seeking, inputs, outputs, transformation processes, regulation
9) interactions	coupling, system composition, and system decomposition	hierarchy, differentiation. interrelationship, interdependence
10) overlaps	system decomposition	hierarchy and differentiation
11) characteristics	definition of special cases, e.g., internal vs. external event	holism, goal seeking, hierarchy, differentiation
12) performance variables	x	x, but goal seeking implies that performance matters
13) phenomena	coupling, system composition, system decomposition	interrelationship, interdependence, entropy, equifinality, multifinality
14) events	Types of events plus transition laws	transformation process implies events
15) trajectories of change	Events, transition laws, history	transformation process, regulation
16) forces	x	x
17) axioms	BWW ontology has an axiomatic nature	GST properties have an axiomatic nature
18) design principles	x	x
19) frameworks	BWW might be viewed as a framework	GST is more a framework than a theory
20) theories	x	x
21) models	x	x
22) metamodels	BWW seems a bit like a metamodel	x GST seems a bit like a metamodel
23) methods	x	x
24) uncertainties	x	x
25) indeterminacies	x	x

Table 2. Brief comparison of BWW and GST based on topics in the FDTP

Table 2 shows that BWW covers material things in the world whereas GST is limited to purposeful systems that exhibit behavior. Both contain a limited set of entity types that can be applied to IS only in a very distant way that reveals little that is not obvious. Both touch on specific entity types, interactions, overlaps, characteristics, events, and trajectories of change, but they do so at a level of generality that is too broad to provide many useful insights about ISs. The main difficulty in using either BWW or GST for understanding, analyzing, or designing an IS is the distance between the topics they cover and the functions and issues associated with real world ISs. Table 2 reinforces that thought by saying that neither touches on facets, portrayals, performance variables, IS-related phenomena, forces, design principles, frameworks (other than their own elements), theories, models, metamodels (other than their own elements), methods, uncertainties, and indeterminacies.

4 Developing the FDTP

At the beginning of this project I was not aware of any conceptual scheme that would help in organizing and presenting a broad and deep view of a theoretical perspective. Carefully explained classification schemes from the natural sciences and social sciences (e.g., biological taxonomy, the Myers-Briggs model of personality types, the periodic table of elements) exemplify ways to organize complex ideas, but a theoretical perspective for IS seemed to require a broad range of ideas of different types.

I decided to try to develop a new FDTP for disciplines that involve systems. Google Scholar searches on "theoretical perspective" convinced me that a formal literature review would not be effective. Lacking an established approach for creating this type of framework I used an iterative approach based on analogies with issues and questions from a different discipline that brings rigorous theories, frameworks, models, and methods. I selected particle physics as an object of comparison because it seeks clarity about topics in physics that are loosely analogous to topics about systems, i.e., entity types, key characteristics and phenomena, state transitions, forces, overlaps, interactions, and uncertainties. The gap between IS and physics is very large, but while writing this paper I learned that Mario Bunge used ideas in particle physics as an inspiration for trying to develop a new system-oriented ontology that might supplant the thing-oriented BWW ontology. Lukyanenko et al. (2021) called that incomplete effort the Bunge Systemist Ontology (BSO) to differentiate it from the BWW ontology.

The process of trying to produce the FDTP started by skimming accounts of particle physics in Lincoln (2017) and Mee (2012) to find topics or issues (e.g., domain, fundamental forces, overlaps) that seemed somewhat analogous to topics or issues in IS. The analogies were not about the details of subatomic particles, but rather about the types of topics, such as phenomena and interactions. I rejected or modified many initial ideas through numerous iterations of asking questions such as "is this issue in physics an appropriate example of events or uncertainties or some other topic that might be included?" or "would it be better to combine two specific topics that are somewhat related?" or "what might be an example from physics that is related to an issue that might be included, and did I encounter something like that in my sources?" Colleagues generously took time to discuss early thoughts about the project and to provide insightful criticisms during research visits and at conferences during 2019 and 2020. In a rough sense I followed the spirit of abductive research explained by Bamberger (2019) and summarized by Markus and Rowe (2021) as a valid approach to theorizing. That effort mirrored Weick's (1995, p. 386) comment that "theory development starts with guesses and speculations and ends with explanations and models." This approach combined aspects of "analogizing, metaphorizing, modelling and constructing the research framework, all taking place outside the context of justification" (Hassan et al. 2019, p. 199). Other researchers likely would have produced a different FDTP if they had started from a different starting point.

Rough analogies with topics and issues in physics proved useful in developing the FDTP, but it would be silly to make too much of any imagined similarity between ideas in IS and ideas describing the behavior of subatomic particles. The Appendix provides examples showing how each concept in the FDTP mirrors one or several physics-related ideas. Those links are deferred to the Appendix because the key question is about whether the FDTP provides a plausible way to describe theoretical perspectives, not whether it was developed in one way or another.

5 Conclusion

The FDTP-based overviews of BWW and GST and the comparison of BWW and GST in Table 2 show that the topics in the FDTP provide a way to organize the content of a theoretical perspective related to IS and especially to identify important topics or issues that are omitted.

Research toward developing improved versions of the FDTP could start by applying the FDTP to other theoretical perspectives related to ISs or to systems in organizations, such as sociotechnical design, sociomateriality, the viable systems model, activity theory, and so on. In each case, application of the current FDTP would likely require a literature review to produce a clearly articulated response for each of the FDTP's 25 topics. The resulting structured descriptions of the content of different theoretical perspectives would be useful in two ways: 1) providing greater clarity about the content of each theoretical perspective and 2) providing insight about strengths and weaknesses of the current FDTP and about ways in which the FDTP might be improved, possibly by building on those or other alternatives.

A next step would return to this project's starting point by applying a version of the FDTP as an outline for part of a proposed answer to the grand challenge that motivated the attempt to produce an FDTP, i.e., rethinking the theoretical foundations of the IS discipline.

More generally, the notion of theoretical perspective is mentioned frequently but often is not applied carefully as part of the real content of IS research papers. This paper's presentation and use of the FDTP might be a step toward taking theoretical perspectives more seriously as tools for explanation and as part of the philosophical underpinnings of the IS discipline.

6 References

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Appendix 1

The 25 items in the FDTP were identified through an iterative process of searching for analogies between the kinds of topics and issues that are relevant to IS and the kinds of topics and issues that are relevant to particle physics. A complete explanation of the analogies would require many pages of discussing unfamiliar topics such as the “standard model” of particle physics. Table 3 lists a topic or issue from physics that is associated with each FDTP topic, thereby providing a partial demonstration of the analogies that led to the FDTP.

Topic in the FDTP	Topic in physics that suggested an analogy to the related topic in the FDTP
1) rationale	Empirical results justifying the “standard model of particle physics”
2) domain	Attempts to integrate across what seem like separate domains in physics: Newtonian mechanics, quantum mechanics, and the Big Bang
3) omissions	The “standard model” of particle physics includes electromagnetism, the weak nuclear force, and the strong nuclear force but ignores gravity, dark matter (70% of the mass-energy in the universe), and dark energy.
4) entity types	Fermions (quarks and leptons) are matter particles. Bosons are force-carrying particles. Quarks, leptons, and bosons include more detailed entity types.
5) special cases	Quarks are divided into six types of quarks in three generations: 1) up and down quarks, 2) charm and strange quarks, 3) top and bottom quarks
6) facets	The weak force and electromagnetism are really 2 facets of a single force
7) portrayals	Light can be viewed (portrayed) as a wave or as a particle (a photon)
8) functions	Force-carrying gauge bosons transmit 3 of the 4 known forces.
9) interactions	Feynman diagrams describe interactions between subatomic particles.
10) overlaps	Force-carrying bosons can be in the same place at the same time
11) characteristics	Characteristics of quarks include mass, charge, spin, color, and flavor. (Color and flavor are unrelated to everyday meanings of those terms.)
12) performance variables	Predictions produced using the standard model of particle physics have been demonstrated correct to more than 1 part per billion.
13) phenomena	The photoelectric effect
14) events	Movement of an electron from one orbit to another
15) trajectories of change	Feynman diagrams describing the many different trajectories through which subatomic particles can interact.
16) forces	Electromagnetism, weak nuclear force, the strong nuclear force, gravity.
17) axioms	Noether’s theorem (1915) connecting symmetries to conservation laws
18) design principles	Design principles for colliders and detectors used in physics experiments.
19) frameworks	The periodic table of elements is a framework
20) theories	Einstein’s Theory of relativity. Dirac’s equation, in essence a theory that predicted the existence of antimatter.
21) models	Bohr’s model of the atom (with electron orbits) replaced Rutherford’s model.
22) metamodels	The elements of Feynman diagrams for modeling particle interactions are somewhat analogous to metamodels.
23) methods	Methods for performing experiments and analyzing results to confirm the existence of subatomic particles of specific types
24) uncertainties	Estimates of uncertainties in experimental results.
25) indeterminacies	The Heisenberg Uncertainty Principle says that a particle’s position and momentum cannot be determined simultaneously. Specifically, the error in position measurement (Δx) times the error in momentum (Δp) is always greater than or equal to $h/4\pi$ where h is Planck’s constant (6.6×10^{-34}) .

Table 3. Demonstration that the 25 topics in the FDTP are also relevant in physics