A Meta-theoretic Approach to Theory Integration in Information Systems

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Abstract

This research presents a meta-theoretic analysis of a nomological net for the purpose of identifying potential pathways for theory integration and multi-level theory development. Success in these two areas holds the potential to reduce theory clutter in IS and related social sciences. As a proof-of-concept, we identify theory domains that share ancillary variables or functional/structural components, using a 20-year sample of construct-based quantitative research published in core journals of the IS discipline. Identification of shared variables provides possible extension and integration development that will reduce theory fragmentation and may lead to discovery of fundamental unifying processes that underlie phenomena across disciplines.

1. Introduction

Interest in explaining human behavior is evidenced by the number and diversity of behaviorally-oriented theories across disciplines. Many phenomena are underlain by similar behavioral drivers and researchers have tended to dissect phenomenon into narrow theoretical accounts rather than seek more broadly scoped theories. Most social science research is "notoriously fragmented" [7] by disciplinary and sub-disciplinary boundaries and additionally by researchers' focus on specific levels of analysis [18, 8]. The proliferation of constructs, models, and theories in Information Systems (IS) results in "a clutter of partially articulated, partially tested theories in the information systems discipline that leads to 'overload' and 'disarray'" [29, p. 17]. As a result, researchers strain to grasp the whole narrative, leading to a "concerning fragmentation of science; a world of missed opportunities for collaboration" [5, p. 808]. Thus the integration of theories within and between disciplines and between levels of the same phenomenon continues to challenge researchers.

In this research we focus attention on the disciplinary nomological net [13, 10, 3] as the landscape in which phenomena and their theoretical accounts can be integrated. Assembling what is known about a given theory, meta-theory, of which the nomological net is a form, produces

"an enhanced theory description ... that allows the synthesis of multiple theories within a nomological framework for simultaneously understanding them. A meta-theory outlines an ontological network of constructs and relationships applicable over several areas of investigation" [6, p. 20].

Integration has the potential to identify overarching theory which explains broad classes of behavior, such as goal setting [2], and the relationships of low-level individual phenomena to high-level emergent organizational phenomena [8]. By locating the boundaries of domains of theory in the disciplinary nomological network it becomes possible to identify pathways for theory integration and for multi-level theory development.

One obstacle to integration of theory domains is construct identity. As constructs are social constructions intended to measure attributes of things that are not directly observable, consistent definitions are problematic. Constructs have proliferated as the volume of behaviorally-oriented research in Information Systems (IS) and in other disciplines has increased [23, 22]. As researchers seek novelty in theoretical contributions, previously measured constructs are sometimes missed in literature reviews and many constructs are renamed with slight or no variation in the measurement instrument. This results in unintentional repetition of research and reduces the ability of researchers to compare results across studies. In this research, variable definitions, instruments and theoretical associations [29] were extracted from all quantitative construct-based research published in MISQ and ISR between 1990 and 2009. The complexity of these data was reduced through manual categorization to produce the nomological net for this data set.

A second obstacle to integration is theory identity. We are not entering the debate regarding theories versus models, strong versus weak theory, or the constituents of theory. Instead we chose the more general term *theoretical model* to indicate an "account for some subset of phenomena in the real world" [29, p.4] as an identifiable outcome of the research process. There are no generally accepted demarcation points at which a specific instantiation

of a theoretical model (e.g. Technology Acceptance Model) becomes a different theoretical model (e.g., TAM2) as constructs are added or removed or as dependent variables are changed (e.g. from *behavioral intention* to *actual use*). In this research the *domains* of highly researched theories in a selected set of IS research literature were determined through expert-evaluation of similarity or correspondence in the focal phenomenon as represented by the dependent variables. Thus theory domains are the accounts for "like" phenomena (e.g., *use-oriented* theories; *organizational success-oriented* theories) as represented in a set of publications. Identification of overlaps or proximity of nomological nets for specific theory domains provide pathways for integration of domains and for integration across levels of analysis (e.g., individual, group and organizational). All significant hypotheses between constructs within each of these classes were visualized in a large–scale nomological network. Shared constructs among domains of theoretical contributions are proposed as identifying structural entities and/or processes that underlie causal linkages [16] between effects and provide a starting point for integration. Because theory identity is an unresolved problem, integration within or between disciplinary fields may be between the theory domains that account for classes of phenomena (e.g., use, satisfaction, or number of ideas generated) or between theory domains that account for levels of phenomenon (e.g., individual, group, or organizational). Meta-theoretic analysis within the discipline is a process which may lead to inter-field theory integration.

This paper proceeds as follows. We first outline the theory landscape provided by nomological nets. The problems of construct and theory identity are discussed and we briefly describe the data collection and classification used to identify theory domains and to visualize the nomological network of the research sample. Intra-field and multi-level approaches to theory integration are described and the results of visualizations are discussed. We conclude with a discussion of research implications and the potential they provide for inter-field theory development.

2. Nomological Networks

When Cronbach and Meehl introduced their enormously influential concept of construct validity [10], the linchpin of the concept was the nomological network. It was envisioned the nomological network would serve the dual functions of 1) providing implicit definitions of constructs based on their related constructs, and 2) generating the underlying construct of validity itself through evaluation of a network of meaning vs. empirical data [5]. The concept of the nomological network also underpins Benbasat and Zmud's [3] argument for an IS core identity, as well as research on interfield theory development [18, 11], and the IS nomological network [13].

This current research posits that nomological networks provide a landscape for comparing and potentially integrating theories within a field and across levels of analysis. The variables from which theories are composed [29] may be either observable attributes which can be directly measured (e.g., age, gender, education), or unobservable *constructs*. Each construct is an "attribute in general of some class of things in its domain" [29, p. 7]. Constructs of interest in IS are frequently cognitive attributes (e.g., attitudes, beliefs, motivations) or emotions (e.g., anxiety, negative affectivity). As such, they are not directly observable and quantification requires a measurement instrument, frequently composed of a set of survey questions. In this research the *association* between constructs represents the hypothesized or statistically significant corroboration. Furthermore the association "implies the existence of causality or shows a time relationship among changes in the values for instances of the constructs–for instance, changes in the value for an instance of one construct cause a change in the value for an instance of the other construct, or a change in the value for an instance of one construct precedes a change in the value for an instance of the other construct" [29, p. 9].

Thus a nomological net is the set of interlocking "law-like" relationships that relate theoretical variables and constructs to each other. We adhere to the original conceptualization of a nomological network as comprised of all the associations among constructs. The nomological network in this research is restricted to the IS field as represented by two top IS journals.

2.1. The Construct Identity Problem

As the volume of behavioral research has increased and become more specialized, there has been an "ever-increasing proliferation of labels that are sometimes offered as synonyms, sometimes presented as specific aspects of the subsuming construct, or, more often, simply loosely used to refer to the related constructs without self-conscious attempts at a more precise or consensual usage" [1, p. 315]. The proliferation of constructs which have different names but measure the same latent phenomenon (synonymy) and constructs which have

the same name but measure different phenomenon (polysemy) contribute to fragmentation and unintentional replication of research [22, 23].

Clearly defined constructs contribute to theory quality [29] and reducing synonymy is a critical step in visualizing the nomological net in any large sample. Determining synonymy allows constructs that measure the same latent variable to be combined thus reducing the complexity of the nomological network and potentially identifying areas where theories overlap [22]. Although research on the automatic identification or categorization of variables has previously been undertaken [23] this research developed a manually categorized variable set for purposes of training and evaluation which we have here used for visualization of the nomological net.

2.1. The Theory Identity Problem

The identification of the location of a *theory* in a nomological net is also problematic. Theories evolve over time as variables are added or subtracted or as the focal variable is extended.

To identify a specific theory, we adhere to Weber's terminology [29]. The *domain* of the theory is the phenomenon in the world for which a theory provides an account. The *focal phenomenon* is the attribute of the class of things for which the theory accounts–the dependent variable. The *ancillary phenomena* are the independent variables, or attributes of the class of things within the theory's domain. For the purpose of our analysis, we define the domain of the theory as the class of phenomenon represented by specific dependent variables and the ancillary variables which have law-like associations in the sample of published literature. The claim that support for a theory "grows when its powers of prediction and/or explanation remain robust across different tests of the theory" [29] is in agreement with our claim that a specific theory may appear in multiple publications despite the addition or removal of variables.

3. Methods

3.1. Construct and Hypothesis Extraction

Although one goal of this research stream is to automatically extract and categorize *variables* and to *automatically* extract hypothesized associations among variables, this research used a manually extracted sample set. A team of advanced undergraduate and master-level students at a large U.S. research university performed the data collection. Team members were selected based on

high academic achievement and high performance on a construct extraction test after a two-hour training session. Only 3% of applicants were hired and they received further extensive training in the extraction protocol. All articles were first extracted by a research assistant and then audited by a senior research assistant.

The variables for this project were collected from two top IS journals, MIS Quarterly and Information Systems Research. These journals are listed in the IS senior scholars' "basket of six" and are widely considered the best journals in the IS discipline. The journals' status infers an expectation for breadth of research coverage suggesting that the constructs in these journals are likely to represent a construct set representative of the interests of many researchers in the discipline. Every article published during the 20-year 1990 to 2009 period was examined with 327 articles found to contain at least one construct. For each article, all variables were collected along with their definitions, items (if applicable), and construct citations (e.g., citations suggesting the origin of a construct). Concurrent with the variable extraction, the associations between variables were extracted. Of the initial sample of articles, 228 were found to contain hypotheses, for a total of 1,713 hypotheses. In aggregate represent 4,241 variable relationships are represented, including direct relationships, mediated relationships, and moderated relationships. Hypotheses were coded for independent, dependent, mediating, and moderating relationships, directionality and significance. In this current analysis only direct relationships were considered.

3.2. Construct Categorization

Variables that did not fit in the classifications of constructs, demographics, and behaviors, were excluded. To reduce the complexity of a nomological net showing the 3,300 + associations, the variables were categorized based on the *correspondence* of each variable with all other variables. In other words, variables which were judged by the expert panel to be measuring highly overlapping variables (e.g. *time in job* and *tenure*) or the same latent construct (e.g. *usefulness* and *performance expectancy*) were placed in the same category. To facilitate the manual categorization a definition of construct correspondence was established:

We define a construct, C', to be correspondent to another construct, C, if some construct measurement items for C' could also be used to measure the latent construct measured by C.

Operationally, a construct C' will be judged as correspondent to another construct C if the domain experts determine that one or more construct measurement items for C' could also be used to measure the latent construct measured by C. The basis for such determination might include the similarity between construct measurement items, definitions, names, citations, unit of analysis, and other evidences for the two constructs. Given that items are "closer" to latent constructs than definitions and undergo rigorous testing, in discrepant cases, experts were asked to review such items. For non-construct variables, the process of determining whether two variables are correspondent was generally easier, because variables such as age and gender are relatively straightforward. A team of experts, consisting of faculty members, doctoral candidates, and senior research assistants used a large room to move sheets constructs tokens labeled with names, definitions, and items for each variable into correspondent categories. The goal was to categorize constructs that were similar enough that knowing about construct A's relationships would provide some knowledge about relationships involving A*. This is not to claim that the classification would withstand the scrutiny of factor analysis. The categorization process resulted in a data set of 744 unique categories with inter-rater agreements at 85% and 90% with resulting Cohen's Kappas [9] of 0.68 and 0.79, both agreement levels considered substantial with one close to almost perfect [21].

3.3. Theory Domain Identification

A theory is an account of a class of phenomenon in the world that specifies the explanatory ancillary and focal variables and the relationships among them [29, 15]. We selected the categories of focal variables (dependent variables) that are terminations of directional relationships (e.g. the variables within each category infrequently appeared in any paper as an ancillary, or independent variable). The total number of hypotheses that terminated in the categories of focal variables was used to identify the *verisimilitude* or degree to which *evidence-for* an association has been established [24]. As social science theories are not amenable to strong falsification [29, 25, 24], verisimilitude is an indication of a substantive theory domain. Two experts then examined the focal variable categories and focal variables that are frequently interchangeable were combined (e.g. *behavioral intention* and *actual use*). For the purpose of clarity, the top seven resultant theory domains were selected for visualization (Table 1). The names of the theory

domains do not reflect any specific theory in the domain but were selected to represent the focal phenomenon for which each domain provides an account.

Table 1: The most highly corroborated theory domains (MISQ-ISR 1990-2009)

	Theory Domain	Number of papers examined[1]	Number of significant associations
1	Use	49	601
2	IS development	9	241
3	Satisfaction with Technology	8	70
4	Organizational assimilation	3	76
5	Business performance	2	22
6	Sourcing	3	28
7	Creativity	5	32

The theory domain was then determined by extracting all ancillary (independent) variables and hypotheses from every published paper that included that category of focal variable. This provided the complete network of associations for each focal variable. Within this network, hypotheses were coded for significance allowing visualization of corroborated associations in addition to hypothesized (but non-significant) associations.

4. Theoretical Integration

Information systems phenomena are broadly recognized to be complex, multi-modal, and to occur at multiple levels of analysis. Theories in behavioral IS research frequently focus on socio-technical accounts of the phenomenon created when humans and technological systems interact [6]. The value of theory integration has been argued in IS [27, 2], in management [26], and in science in general [15, 11, 7].

The theoretical knowledge of the field includes testable hypotheses and models (e.g., the Technology Acceptance Model), general social theories and frameworks, and paradigms (e.g., Structuration Theory; Actor Network Theory) [17]. But the focus on theory development of a narrow set of IS phenomena puts fruitful discipline-wide communication at risk and increases research segregation and specialization [26, 17]. Bridging silos of knowledge and "highlighting areas of overlap or complementarity, as well as sites of

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[1] Due to space restrictions these papers have not been referenced. References are available upon request.

contradiction… can lead to theoretical integration or resolution" [12, p. 6].

Theory integration is desirable when two types of interconnections occur: explanatory reductions or extensions, and in cases of supervenience of higher level phenomenon on lower level phenomenon. In the first case, structural or functional theories may be reduced through recognition of more fundamental ancillary variables common to each theory or may be extended through recognition of the influence of concepts in one theory on another theory. Many theory domains have sought to pursue parsimony over theoretical depth, and provide simple models of human behavior across a wide range of technologies, contexts, and decision strategies [2]. Intra-field integration provides a path for discovery of fundamental unifying processes that underlie phenomena.

In the second case, a focal phenomenon emerges as a result of other phenomenon, and explanation of complex situations requires integration of theoretical perspectives at different levels of analysis. Application of variables across levels requires careful construction and configuration of constructs which represent emergent phenomena [20, 8].

As a step toward inter-field integration, this research identifies two types of theory integration of interest to researchers: integration within the IS field that bridge theory domains and integration of theory domains residing at different levels of analysis to facilitate development of multi-level theory.

4.1. Intra-field Theory Integration

Although specialization and narrowing of theories has enabled dense streams of research (e.g., TAM) to flourish [2], it has also resulted in less insight into the interactions which drive the deeper issue of human-technology interactions. As noted by Bagozzi [2], the termination of TAM at the *use* variable obscures the goals that *use* of a technology is intended to obtain. Many IS theories emphasize phenomenon focused on the technology as focal phenomena while other theories focus on behavior/social phenomena. Only through integration of these theory domains can the field realize socio-technical theorizing [6].

Reasons for theory integration include: 1.) a shared interest in explaining different aspects or stages of the same phenomena, 2.) combining structural and functional accounts of the same entity or process, and 3.) recognizing causal linkages between theory domains where ancillary phenomena are causally associated with multiple focal phenomena [11]. In this case, an overarching focal

phenomenon may be developed to provide a broader theoretical account.

4.2. Multi-level Theory Development

A fundamental interest in IS is the design and implementation of information systems intended to influence individual, group, and organizational phenomenon. Thus many information systems are intended to function as integrative, multi-level systems. But historically the IS discipline's approach has been to segment research into levels of analysis (organization, group, and individual) with each level becoming a silo of theories, approaches, and reference literature. Information systems may be integrative systems, but IS research frequently is not.

A multi-level perspective stands in contrast to the macro-micro focus of a majority of the research in organizations and IS [20, 8]. Organizational level phenomena occur because of the actions of individuals, and individual behaviors are frequently affected by high-level variables [20]. The development of multi-level theory posits that "micro phenomena are embedded in macro contexts and .... macro phenomena often emerge through the interaction and dynamics of lower-level elements" [20, p.7].

All phenomena can be classified in terms of levels. The concept of emergence recognizes that complex high level systems are a result of their low level components and of the organizing principles of these components. Changing the composition of a system or changing the structure of the components changes the properties of the whole [7].

Developing theory across levels, however, requires an understanding that high-level phenomena can emerge from low-level phenomena through associative and combinatorial processes. Associative emergence is described by the processes among lower-level properties that form collective phenomena [20]. In combinatorial emergence, the constituent parts are combined or fused such that the properties of the whole are distinct from the properties of the parts. In this form, the properties of the parts undergo transformations [7, 19, 20], while combining to produce novel emergent properties. The development of Burton-Jones and Gallivan's research on the *system usage* construct for multi-level theorizing about technology use provides an example [8]. The focus of their paper is on "system usage as the aggregation of individual behaviors" [8, p. 659] and the authors provide guidance for the identification of collective usage. They note that high-level phenomena may emerge in distinct ways at the collective level. But prior to determining how

individual data can be aggregated into an organizational construct, it is necessary to identify construct categories at different levels of analysis within theory domains.

As some current theories in IS have well defined constructs, this research posits that identification of different analytic levels of theory domains which have categories of constructs in common, provide a starting point for the development of multi-level theory. In addition, noting where theory domains have been segregated into levels of analysis provides an opportunity to pursue multi-level constructs as suggested by Burton-Jones and Gallivan [8].

5. Visualizing the Nomological Net

The complexity and density of the nomological net of all construct categories and hypotheses renders it difficult to interpret in the context of theory integration. This is due, in part, to 33% of the associations between construct categories being reported only once in these data. A majority of the theory domains in these data have received little or no replication. This suggests that the search for novelty has resulted in fragmentation of research efforts rather than strong replication of existing associations and support for theories. The two exceptions are the *use* theory domain (1) which accounts for 22.5% of the total hypotheses in the data set and the IS development theory domain (2) which accounts for 7% of the total hypotheses. The dominance of research in these two theory domains shows a dramatic focus on a narrow range of IS research as represented by the selected journals.
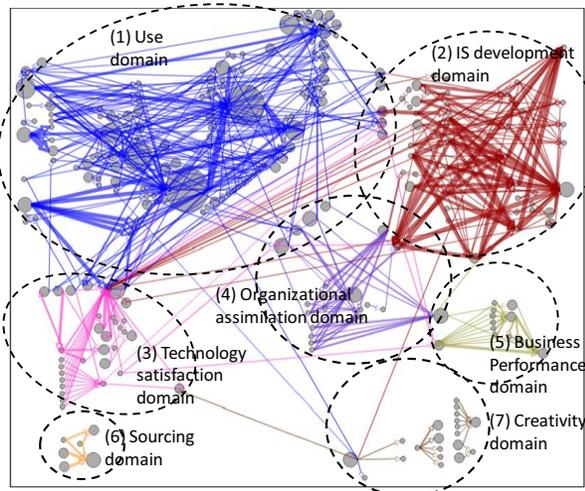

Figure 1. Nomological Net of Select IS Theory Domains

Visualizing the theory domains that have the highest research interest, provides a clear picture of

the degree to which theory domains are interconnected though construct categories (Figure 1). All significant associations within each theory domain are shown, and the boundary of each theory domain is delineated with dashed lines. The number of variables in a construct category is represented by the relative size of the category circles. The relative width of the association lines represents the number of hypotheses among constructs category pairs. Notable is the dominance of research interest in the domain of *use* theory (1) relative to all other research areas.

Removal of low verisimilitude (e.g. only a single corroborating test) associations between construct categories reveals how influential these associations are in interconnecting the nomological network (Figure 2). Replication of research has largely occurred within the established theory domains, suggesting significant opportunities for intra-field theory integration.

The visualization in Figure 2 displays three groupings of construct categories that span theory domain boundaries. These categories contain correspondent constructs that, as a group, affect more than one theory domain. Of particular interest is the satisfaction with technology construct category (A), which contains variables from four distinct theory domains. Other categories (B and C) provide limited theory domain connections.
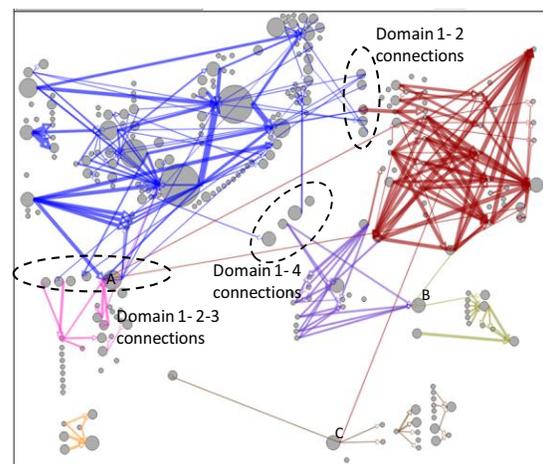

Figure 2. Primary Overlaps Between Select IS Theory Domains

The significant associations that occur more than once are displayed. Comparing Figures 1 and 2 reveals a greater number of low verisimilitude associations between theory domains. We now turn to discussion of how meta-theoretical analysis can support theory integration.

5.1. Theory Domain Interconnections

The two visualizations (Figures 1 and 2) of the nomological net of seven theory domains indicate that categories of correspondent variables that bridge theory domains exist. The variables within these categories are correspondent ancillary variables associated with multiple focal variables. As potential causal linkages, they may provide an integration path between theory domains resulting in a more comprehensive theoretical account of specific phenomena. Although Figure 1 includes hypotheses that have low verisimilitude (e.g. have only been reported as significant once), it is apparent that some construct categories have connections to three different theory domains (e.g. 1-2, 1-4; 1-2-3). Meta-theoretic analysis allows the synthesis of multiple theories into theory domains within a nomological framework. Visualizing multiple domains and the construct categories which bridge domains, provides potential directions for theory integration. For example, this visualization reveals that there are five categories of constructs that provide direct functional or structural relationships between the domain of *use* theory and the domain of IS development theory. It would seem intuitive that the processes of IS development and the *use* of developed information systems would be causally related. Yet there is a research gap in identifying *IS development* antecedents that influence information system *use*. The constructs that relate the two theory domains provide a potentially fruitful research direction to integrate related phenomena. It is important here to recognize that, while informative, the existence of a paper bridging two domains, does not necessarily suggest a conscious effort to bridge domains, and as such will likely provide clues, rather than answers, about how to integrate domains.

5.2. Multi-level Theory Domains

A second type of theory integration focuses on locating ancillary variables that connect theory domains at different levels of analysis. Many information systems are developed to influence phenomena at individual, group and/or organizational levels. But individual papers tend to focus on one or at most two levels of analysis. Figure 3 displays a detailed meta-theoretic analysis of all significant associations in theory domains 1, 2, and 4. The construct categories are categorized by level of analysis from the top of the figure (individual), middle (group), to the bottom (organizational).
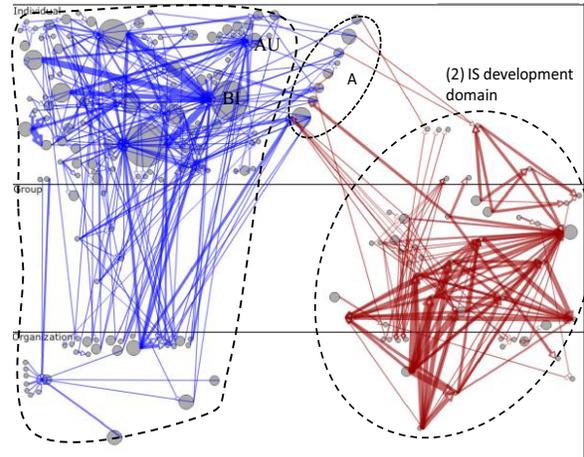

Figure 3. Distribution Across levels of Selected IS Theory Domains

The dense focus in the *use* theory domain (1) is readily apparent from the number and relative size of the construct categories and the density of significant associations. In addition, the difference in level of analysis is visible within the *use* theory domain (e.g. the focal variables of *behavioral intention* (BI) and *actual use* (AU)) are at the individual level of analysis but a large number of construct categories are at the organizational level. In contrast, the majority of constructs in the IS development domain (2) exist at the group and organizational level of analysis, with few categories at the individual level.

Labeled as A in Figure 3, are construct categories which have significant associations between the two domains and between levels of the theory domains. These connections alone do not integrate the theories but they do identify constructs that may serve to extend or integrate the theories. As *use* theory and *IS development* theory are likely to be related (e.g., some of the ancillary variables of the *use* theory domain are outcomes in the IS development theory domain) research that integrates these theories is warranted. Finally, if the goal is to integrate these domains at different levels (e.g., can IS development practices influence organizational level adoption?), it is possible that IS development could serve as the stepping-stone needed to integrate individual and organizational levels of the *use* domain.

5.3. Integrating Unconnected Theory Domains

Meta-theoretic analysis of theory domains also allows identification of interconnections among constructs in theory domains that have no directly shared constructs.
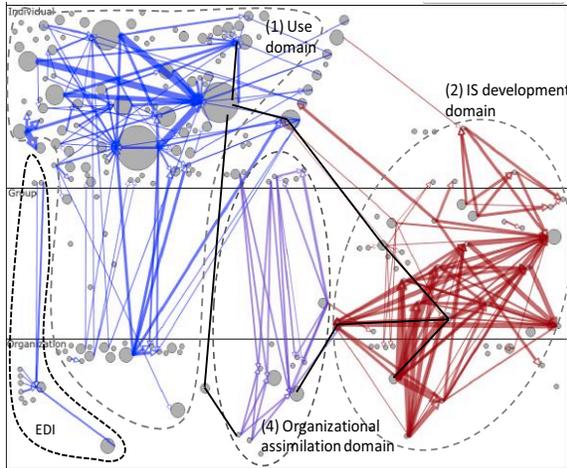
Figure 4. Multi-domain interconnections

Figure 4 illustrates one instance in which possible extensions to the theory domains can be identified using inference regarding established relationships. The nomological meta-analysis shows connections of domain 1-2-4 through constructs shared by each domain pair (for clarity the highest verisimilitude path has been emphasized). Although the 'path' from domain 4 to domain 1 has a mediating role for variables in domain 2, it also identifies uncorroborated direct associations. The uncorroborated relationships (not visible here) between domains 4 and 1 may give the researcher pause, but given that *organization assimilation* should be related to use, the connections through domain 2 may help the researcher develop a strategy for integration. Further, by having access to all the organization-level variables in domains 1 and 4, a researcher should be able to formulate a better search strategy going beyond MISQ and ISR.

In addition, the visualization in Figure 4 reveals a sub-domain of theory regarding the adoption of Electronic Data Interchange (EDI) that is unconnected to the densely corroborated domain of *use* theory. This is surprising as it indicates that some organizational adoption theory relies on ancillary variables that are distinct from the variables used in the domain of *use* theory. That only one category of constructs, *usefulness to organization,* provides an interconnection with the *use* theory domain represents a potential research gap.

6. Discussion

Visualizing construct categories and the significant associations among them in a nomological network (Figures 1-4) illustrates how theory domains can be identified. These visualizations further suggest how theory domains may be integrated and how

levels of analysis may be integrated within theory domains. For example, it seems surprising that the *use* theory domain (1) is only weakly connected with the IS development domain, given that systems development is intended to create systems which are used. This apparent research gap disappears as we focus on the difference between the focal phenomenon and recognize that the theories are about fundamentally different phenomena. IS development theory provides an account of project success, not system success or actual use. While IS researchers may satisfy themselves by this distinction, it arguably points to a major research opportunity perhaps, enabling an integration of the U.S.-centric *use* domain research with the traditional European-centric *IS development* domain.

The visualization of the nomological network identifies potential linkages through which *IS development* domain could be extended and integrated with the *use* domain of theory. In a simplified example, chains of nomological associations can be identified that suggest interconnections between ancillary variables in the IS development domain (2) and variables in the *use* theory domain (1) (Figure 5).
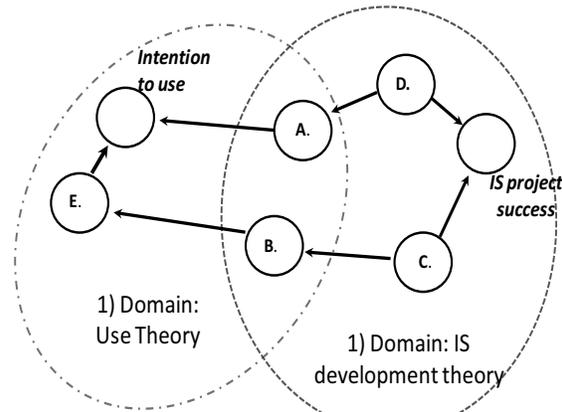
A. -- construct category "satisfaction with technology"
B. -- construct category "objective task: complexity"
C. -- construct category "software methodology type"
D. -- construct category "requirement unanalyzability"
E. -- construct category "ease of use"

Figure 5. A simplified theory domain integration

This intra-field integration would require reframing of IS development theory to focus on *use* as a measure of success and also require *use* theory to consider development processes as factors contributing to actual use. It may also suggest how redesign during use can inform IS development [28, 14]. This reframing would challenge the established orthodoxy, but would also extend our comprehension of the broader IS development phenomena [2]. For

clarity only the strongly corroborated associations between construct categories are displayed. Many additional connections exist when non-significant associations and unreplicated associations are included, suggesting that inter-domain research may be a risky task.

This meta-theoretic approach to theory integration does not directly identify or develop theory [29]. Simply identifying associations to boundary spanning constructs is not an adequate means of theory building. Rather, this approach identifies variables that provide potential pathways of causal inference to focal phenomena of interest. Identifying factors of the *IS development* domain that affect the *use* theory domain would be a valuable theory extension. Identifying the factors affecting *use* and *IS development* which account for goal attainment would represent theory integration [2].

This research presents, as a proof-of-concept, a meta-theoretic approach to identifying inferential pathways to theory integration. Using verisimilitude to identify the major theory domains in these journals sets aside a majority of the papers and low verisimilitude domains. Future research may reverse the search logic to identify novel integrative theories. These theories might contain ancillary variables from multiple theory domains and demonstrate associations to focal phenomenon that bridge the dominant domains in these journals to date.

6.1. Limitations

The data were limited to quantitative studies for which sufficient information on variable definitions and association directionality was provided. Even in this sample of two journals, the complexity of the nomological network requires data reduction to be comprehensible. The manual categorization of variables into correspondent categories relies on the consistent application of a coding scheme. As with any coding scheme, the process of categorization imposes specific assumptions on the data, which may be questioned. The classification of the categories into levels of analysis further simplifies the richness of the data. Finally, the limitation of the analysis to the most densely researched theory domains, as represented by the number of direct hypotheses to specific focal variables, potentially under-represents the connections provided by mediating and moderation associations and from novel, but unreplicated research. This assumption is justified by reference to the verisimilitude obtained by corroboration of associations through multiple trials of the associations among construct categories. This limitation exposes a potentially fruitful area for further application of this meta-theoretic approach.

7. Concluding Remarks

This research presents a meta-theoretic analysis of mainstream IS research as represented by quantitative research published in two core journals of the discipline. The analysis is a proof-of-concept for identifying theory domains that share causal linkages or functional/structural components of theories. The areas of overlap provide opportunities for potential theory extension or integration.

The research informs IS theory development in three ways: First it highlights the opportunities for theory integration and development within the discipline. Integration may provide a more comprehensive account of a phenomenon in the world by identifying constructs and focal phenomena which underlie multiple theories. Integration may also provide accounts of the emergence of high-level phenomenon from lower-level phenomenon.

Second, the research illuminates the most comprehensive nomological meta-analysis for IS to date. By addressing the construct and theory identity problems, and including all of the variables and hypotheses in the sample, we display the distribution and concentration of research efforts as well as the verisimilitude of the associations and constructs, in the scientific landscape represented in a nomological network. Visualization of the disciplinary effort provides valuable information to researchers about opportunities to address gaps in knowledge and where research effort may be saturated. Understanding whether the knowledge gaps represent a research opportunity or natural demarcations in the nomological net remains a judgment for future work.

Finally, this research offers an approach to inter-field theory development [22, 15, 11]. By using automatic methods for construct extraction and categorization [4] and for hypothesis extraction [23] along with the visualization techniques developed in this research, it is possible to develop broad nomological networks from related disciplines. The networks will allow meta-theoretic analyses potentially leading to resolution of conflicts among theories, development of theories which transcend disciplinary boundaries, and a greater understanding of the causal inferences that underlie socio-technical research.

8. References

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