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Systematic Assessment of Information Technology Capability Definitions

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Abstract—**Examining the relationship between IT capability and firm performance has received ample attention of researchers. However, a sound understanding of how to define IT capability remains underrepresented in existing literature. We extend and modify an existing definition analysis method derived from the Social Sciences and divided each definition in four components: central phenomenon, context, action and consequence. The components serve as basic requirement that help to identify causal explanations from a definition. We analyzed 24 definitions and weighted the relevance of each component using the five-year mean impact factor derived from the Association of Business Schools. To check the robustness of our results, three alternative weights were applied: journal grade, equal weights and citation per article. Our results show that researchers do not define all four components and, contrary to earlier studies, our definition analysis method is able to utilize all words of a definition.**

Keywords—IT capability; Definition-analysis; Axial coding; Open coding; Association of Business Schools; Journal five-year mean impact factor; Journal grade; Citations

I. Introduction

The process through which information technology (IT) can be used to build firm-specific capabilities has received ample attention of researchers [9, 14, 18]

While the urgency to understand the relationship between IT capability and firm performance has increased, a sound understanding of how to define IT capability remains underrepresented in existing literature [4, 5]. As a consequence, researchers relied on divergent indicators when operationalizing IT capability. For instance, [7] operationalized IT capabilities with nine multidimensional aspects (e.g. architectural planning, vendor development, informed buying), whereas [3] used one binary aspect (IT leaders versus non-IT leaders).

The divergent operationalization of IT capability calls for careful investigation of existing IT capability definitions. Therefore, the objective of this paper is to understand what constitutes definitions of IT capability.

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Following that objective, we aim to answer: *What are the components of which definitions of IT capability exists?*

Existing definition-analysis methods fail to consider definitions in their context. For this reason, we extended and modify these methods with coding techniques borrowed from Social Sciences [20]. Thus, this study contributes to existing literature by extending and modifying an existing definition analysis method derived from Social Sciences and identifying defining components of IT capability.

II. Related Work

A. *Prior definition analysis studies*

To understand and develop robust definitions, researchers have performed content and thematic analyses. Content analysis involves labeling text into components and counting the number of instances. Thematic analysis is similar to content analysis, but allows researchers to combine frequency with meaning in context [10]. Though these methods are not new, information system scholars rarely apply them.

A notable definition-analysis was conducted by [6]. The researcher analyzed 34 definitions of corporate social responsibility. These definitions were gathered through a literature review and analyzed using content analysis. The relevance of each component, short phrases identified through content analysis, was determined by utilizing the frequency counts derived from Google's search engine. The rationale behind Google frequency counts was simple: a higher frequency count in Google's search engine suggests a higher importance of that definition. All of the definitions referring to a specific component were added to calculate the relative usage of each component.

Also using content analysis, [8] explored the differences and similarities between two epileptic definitions by identifying key components (words or short phrases). The components were then compared within three clinical domains based on frequency. The usage of the different components was established through a discussion of existing literature.

In a recent study, [17] asked respondents to write down their definition of satisfaction through a survey. Based on thematic analysis, the researchers coded and sorted the text on three hierarchical levels, but the differences between identified components were not assessed.

Besides content and thematic analysis, [15] examined definitions of recovery solely through theoretical reasoning.

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III. Research Approach

The overview of definition analysis studies described in the previous section is not meant to be exhaustive, but elaborates on the dominant approaches applied to study definitions. Our research approach is divided in three steps: gathering definitions, coding definitions and analyzing definitions.

A. *Gathering definitions*

For the literature review the three-step selection procedure of [21] was followed to iteratively select the source material. Multiple information system scholars utilized this method to conduct a literature review [13].

We only included definitions if that stemmed from a peer-reviewed process. This is desirable since journals have a strict quality process in place to judge the importance of scientific research [11]. Definitions from journal papers were included if explicitly defined or if existing definitions were reused. Duplicates (e.g. multiple papers using the exact same definition) were included, to reflect the prevalence of that particular definition. Definitions were excluded when they were quoted, but not endorsed by the authors (e.g. because the definition was criticized), or when partial sentences of definitions were presented.
We discarded definitions from websites, because in general their quality process, if any, is less strict.

B. *Coding definitions*

In this study a quantitative approach was taken that involved counting frequency of words. To get a rich understanding of the components underlying IT capability, we extended our content analysis with open and axial coding procedure of [20]. These coding techniques are used for doing qualitative analysis (e.g. analyzing transcripts of interviews).

Open coding is used to identify themes from line-by-line analysis of each transcript. Sentences are summarized in one or two words (in this study called a *representation*). Axial coding identifies relationships between the identified representations. We fitted these representations within a predefined coding model. The coding model helps to identify the causal explanations and consists of six components: central phenomenon, causal condition, context, intervening conditions, action strategy and consequences [20]. The c*entral phenomenon* refers to the core idea, event or happening. Other components are related to this component. *Causal conditions* are the events that lead to the development of the central phenomenon. *Context* refers to the environment where the central phenomenon is observed. *Intervening conditions* refers to the conditions that affect the central phenomenon. *Action strategies* are the responses that occur as the result of the central phenomenon. Finally, the outcomes of these actions are referred to as *consequences*.

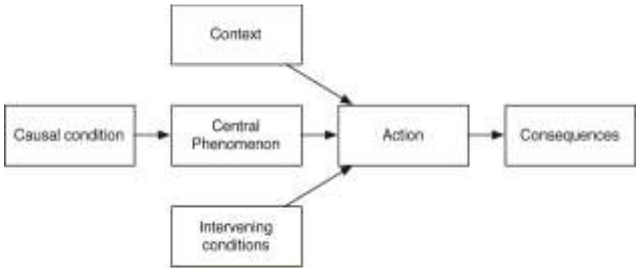

Figure 1. Coding model

Fig. 1 provides a schematic overview of the coding model, which enables the researcher to think systematically about data and relate them in complex ways [16]. The model proved useful in studying phenomena in multiple studies [16, 19].

Because of the nature of our data, we deviated slightly from the coding procedure prescribed by [20]. The rationale behind this choice was guided by the nature of our dataset; we were not analyzing interview transcripts, but definitions. As a consequence, our data is less rich (i.e. a definition consists of one sentence instead of several pages of transcripts) and contains no additional information. If open coding were performed as first step, directly on a definition, then that definition would be summarized in one or two words. An example hereof can be found in [6]. By doing so, all other words within that definition are left unaccounted. Thus, by identifying themes directly from the definition [6] eliminated potentially useful data. To avoid this, we switched open coding with axial coding.

C. *Definition analysis*

The definitions were analyzed using content analysis instead of thematic analysis. The rationale behind this choice was determined by the nature of our data.

To ascertain the relevance of each component formulas can be used [6]. The relevance of a component can be determined by calculating a representation score. The relevance of a representation score is determined by using search engine frequency as input (e.g. Google, Yahoo and Bing). Multiple researchers have used search engines to examine frequency or impact of scholarly research [2, 12]. A representation score is calculated by adding the frequency counts of each definition categorized to the representation.

As [6], we applied (1) to ascertain the relevance of each component

$$RS_i = \sum(\text{component}_i * \text{frequency}_j) \quad (1)$$

where

RS_i= representation score for a definition within component$i$
$\sum$ = adds the result of representations for component$i$ multiplied by the frequency$_j$.
Frequency$_j$ = frequency count for representation$i$ categorized to frequency$j$

This calculation method complements counting instances used by [8] and [17], by determining the relevance of a definition based on an external source (search engines).

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To evaluate the relative use of each representation per component, the representation score is divided by the sum of representation scores for each component [6]. The relative representation (RR) score was calculated by applying (2).

$$RRi = (RSi / \sum RSi) * 100\%$$

where
RR_i = representation ratio for component i
RS_i = representation score for a definition within component i
$\sum RS_i$ = total number of representation scores for component i

IV. Results

A. Gathering definitions

In total 24 definitions made it through the selection process. The definitions included were published between 1994 and 2012. The definitions that made it through the process stemmed from 13 journal of various fields (e.g. information management, marketing, strategic management, operation research and management science). Journal of Management Information Systems and Management Information Systems Quarterly were the most popular outlets for IT capability definitions.

B. Axial coding

A coding procedure was developed to ensure reliable coding. The definitions were coded after repeated reading of written definitions. When multiple coded definitions supported a representation, it became eligible for defining one of the four components that constituted IT capabilities.

We deviated slightly from the axial coding model (Fig. 1), because two out of the six components were consistently empty. It concerned components that required additional information (i.e. causal condition and intervening condition). The two empty components were eliminated, leaving four components behind.

Table 1 provides an example of how the words of a definition were distributed along the remaining four components. Detailed results of each step are available from the authors upon request.

TABLE I. ADJUSTED AXIAL CODING EXPAMPLE

	Central phenomenon	Context	Action	Conse-quence
"a firms ability to mobilize and deploy IT-based resources in combination or co-present with other resources and capabilities" [a]	Firm	Ability	Effective deploy-ment of IT resources	Not mentioned

[a] Definition derived from [1]

C. Open coding

Since we switched open with axial coding, our next step was open coding. To compare the definitions with each other, we abstracted away from the content of a particular component by identifying a higher level of representation. Table 2 contains phrases from definitions that were coded to representations.

TABLE II. REPRENSENTATIONS DERIVED FROM DEFINITION PHRASES

Components	Example phrases from definitions	Representations
Central phenomenon	"focuses mainly on the ability of" "refers to the routines within the IT function"	Ability Bundle of skills and routines
Context	"is defined as the firm-wide"	Firm
Action	"effectively deploying IT resources" "support the use of IT"	Effective deployment of IT resources Support
Consequence	"deliver IT services to the organization" "provided desired results"	Helps the business Achieve results

D. Applying definition weights

In prior research Google frequency counts is used to indicate the difference in significance between definitions [6]. We adjusted this step, because this step did not yield usable results for our research. The obtained search results had two drawbacks. First, the search engine of Google (Yahoo or Bing) did not recognize most of the definitions. Second, if the search results were recognized, they were not related with IT capability. We also searched for frequency counts within Google Scholar. Here, the results were related with information technology, but were not always associated with their respective authors.

Instead, we used 'five-year mean impact' factor from the Association of Business Schools (ABS), to attach weights to each definition [1]. The rationale behind our choice for the five-year mean impact (FYMI) factor was guided by a general rule of thumb: high-impact journals attract high quality contributions [12]. Moreover, using impact factor instead of article citation evades: homographs, cronyism and self-citing [12].

With the above-mentioned adjustment, the formula for calculating the weight of the representation per component is reformulated as follows (3).

$$RS_i = \sum(\text{representation}_i * \text{weight}_j) \quad (3)$$

where
RS_i = representation score for component i
weight_j = journal impact factor for representation i categorized to impact j
$\sum$ = total number of representations categorized to representation i.

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E. *Definition analysis*

The representation scores (RS) and representation ratios (RR) are presented in Table 3. In some occasions, the definition provided no input for a specific component. This was the case for both context and consequence, hence they include the representation: Not mentioned.

The consistency between the definitions can be studied by examining the variations of the RR-score for their respective component. We observed a large difference within consequence (78% - 7% = 71%). This suggests that the definitions, in general, do not address an outcome of IT capability. By contrast, there is less consensus on the representations within action (57% - 43% = 14%). Judging from Table 3 'Ability', 'Firm', 'Support' and 'Not mentioned' have the highest RR-score for their respective components. Therefore these representations become eligible for defining IT capabilities.

To check the robustness of our results, we have calculated three alternative weights; journal grade (JG) as rated in 2010, equal weighting (EW) and a weigh based on the number of citations per article (CPA). The journal grade of 2010, is the grade assigned and collected by the Association of Business Schools [1].

A grade ranges from four to one for each research field, where four is the highest grade and one the lowest grade. Equal weighting is a neutral alternative where all journals are considered equal. The citations per article were derived from Google Scholar and corrected for duplicates. We weighted the citation per article based on the total number of citations received of all articles. A summary of the RR-scores per component and calculation method (e.g. FYMI, JG, EW and CPA) is presented in Table 4. Due to rounding, percentages may not add up to 100%.

Three representations show robust results; 'ability' (associated with the central phenomenon), 'firm' (associated with context) and 'not mentioned' (associated with consequences). These representations score the highest on each calculation method. For other component, action, the results are inconclusive.

TABLE III. REPRESENTATION SCORES (RS) AND REPRESENTATION RATIO (RR) PER COMPONENT

Components	Example phrases from definitions	RS	RR
Central phenomenon	Capability Ability Bundle of skills and routines	0.7 18.8 12.7	2% 58% 39%
Context	Firm Organization Business Not mentioned	21.2 2.9 4.9 3.2	66% 9% 15% 10%
Action	Support Effective deployment of IT resources	18.5 13.7	57% 43%
Consequence	Helps the business Achieve results Not mentioned	4.9 2.3 25	15% 7% 78%

TABLE IV. REPRESENTATION SCORE (RS) AND REPRESENTATION RATIO (RR) PER COMPONENT

Components	Example phrases from definitions	*FYMI*	*JG*	*EW*	*CPA*
Central phenomenon	Capability Ability Bundle of skills and routines	2% 58% 39%	6% 51% 42%	8% 50% 42%	12% 56% 32%
Context	Firm Organization Business Not mentioned	66% 9% 15% 10%	37% 12% 31% 21%	33% 13% 33% 21%	49% 10% 28% 13%
Action	Support Effective deployment of IT resources	57% 43%	49% 51%	46% 54%	40% 60%
Consequence	Helps the business Achieve results Not mentioned	15% 7% 78%	31% 15% 54%	33% 17% 50%	32% 5% 63%

These mixed results indicate that there is still much haziness surrounding the definition of IT capability. Our conjecture becomes tangible when glancing at Table 5. This table presents the most observed representations of all four-calculation methods. It becomes clear that three out of four components can be interpreted as follows:

TABLE V. COMPONENTS THAT DEFINE IT CAPABILITY

Central phenomenon	Context	Action	Consequence
Ability	Firm	Inconclusive	Not mentioned

V. Discussion

The objective of this paper was to understand what constitutes definitions of IT capability. Current methods of existing definition analysis studies failed in answering this research question properly. Where [6] left out many words that make up a definition, we modified the method such that is able to use all words by incorporating coding procedures in a specific order (e.g. first axial then open coding). To understand the context, we divided each definition in four components: central phenomenon, context, action and consequence.

We believe that addressing these components is a basic requirement to understand any definition. Therefore, we were surprised to find that ample 50% of the definitions did not describe a consequence. This means that researchers define an event but fail to address the outcome of that event. We speculate that the divergent operationalization of IT capability may be related to these inconsistencies in defining IT capability.

A. *Contribution*

We conclude that three out of four components that define IT capabilities can be interpreted as 'ability', 'firm' and 'not mentioned'. For the remaining component (action) more research is needed to identify robust representations.

Although our research results are not fully able to explain all four components that define IT capability, this paper contributes to existing research with an extension and modification of the definition analyses method of [6].

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B. *Limitations*

Our study is subject to several limitations. First, since we relied on the five-year mean impact factor, provided by the Association of Business School [1], we excluded definitions that were found in conference papers. By doing so, definitions published in conference articles or conference articles that referred to existing definitions were excluded from this study. Furthermore, impact factors are bounded to time, in our case five years. However, we analyzed definitions from 1994 up to 2012. Therefore, the results from this particular calculation method should be interpreted with caution. We mitigated these restrictions by applying alternative calculation methods (e.g. citation per article).

Second, since one coder coded the data manually, common method bias might be a potential threat to validity. To ensure reliability of our study we maintained an evidence database that allows for reconstruction of data analyses procedures.

Third, although we spent considerable time gathering data, relatively few studies explicitly define IT capability. Moreover, only definitions that stemmed from peer-reviewed journals were included within this study. As consequence, we analyzed 24 definitions. To increase the number of definitions, future studies can consider including definitions from websites and non-refereed journals. By including more definitions, different representations and their respective RR-score may be observed.

C. *Future research*

This study focuses on researchers' definition of IT capability, rather than practitioners' understanding of the term. We do not know if the researchers' definition represents colloquial understanding of the concept. To build a solid body of knowledge about IT capability, exploring colloquial understanding may be addressed by future studies.

Researchers may consider conducting interviews with IT or business related stakeholders (e.g. industry practitioners, academics and consultants). By doing so, representations such as 'not mentioned' may be avoided. Finally, interviewing several stakeholders could validate the representations that emerged from this study.

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