Advancing the Theory of Effective Use through Operationalization

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ADVANCING THE THEORY OF EFFECTIVE USE THROUGH OPERATIONALIZATION

Research paper

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Abstract

Despite rigorous conceptualization, quantitative investigations of effective use are largely lacking. This, in part, may be due to the complexity in operationalizing and measuring the construct. Moreover, failure to effectively measure the construct could result in erroneous findings. Recognizing this challenge, we sought to understand how effective use can be operationalized and measured. In doing so, we proposed two approaches: a formative multidimensional approach and a first-order approach with relationships between the dimensions of effective use. We drew upon seminal effective use research, and refined a survey instrument for measuring effective use. Our analysis provides support for both operationalizations with nomological validity established. We believe this research will help advance the theory of effective use and will enable researchers and practitioners to assess how effectively systems are being used.

Keywords: Effective Use, Survey, Operationalization, Individual Impact

1 Introduction

With effective use serving as the lynchpin through which benefits are obtained from systems, the ‘theory of effective use’ (e.g., Burton-Jones and Grange, 2013) has the potential to be a pivotal, native theory with implications for research and practice. Fulfilling repeated calls for research to shift from use to effective use, the theory explicated the complexity of effective use decomposing it into measurable dimensions. This rigorous conceptualization of effective use serves as the starting point of the journey to understand “what effective use actually involves, [which] is a complex challenge, [where] the route is long and difficult” (Burton-Jones and Volkoff, 2017, p. 117). Nevertheless, despite rigorous conceptualization, empirical investigations particularly of a quantitative nature are lacking and when quantitative assessments are performed the measures are often idiosyncratic with content validity issues. To progress the theory, guidance into how to operationalize and measure effective use is paramount. Without guidance there is the potential for cumulative research efforts to stall (as per Chin et al. (1997), Salisbury et al. (2002)), and for inappropriate recommendations to be made to practice if the operationalisation and measurement is not in keeping with the intent of effective use.

The ‘theory of effective use’ defines effective use as “using a system in a way that helps attain the goals of using the system” and conceptualizes it to consist of three dimensions: transparent interaction, representational fidelity, and informed action (Burton-Jones and Grange, 2013, p. 633), which were grounded on representation theory (Wand and Weber, 1995). When conceptualising effective use, Burton-Jones and Grange (2013) provided hints into the construct’s operationalization and measure-
ment, however they do not quantitatively assess the theory rather quantitative assessment is left to future research.

In terms of operationalization, Burton-Jones and Grange (2013, p. 643) state effective use “is an aggregate construct formed by its dimensions”. This indicates that effective use can be operationalized as a multidimensional formative construct (Law et al., 1998). However, it is also specified that the dimensions are “hierarchically related”, indicating an omission of a second-order construct with relationships between first-order dimensions¹ (which we refer to as first-order for brevity) (Burton-Jones and Grange, 2013, p. 644). Subsequent research building on the theory of effective use, has not determined the appropriateness of when to use each approach. Early research has favoured the first-order approach with little justification, whereas the formative approach has seemingly been left unnoticed.

In terms of measurement, some example measurement items are provided in the seminal work (Burton-Jones and Grange, 2013). However, these are seldom applied. While some have quantitatively assessed effective use (e.g., Haake et al., 2018, Marchand and Raymond, 2017), their measurement items do not completely reflect the meaning of the underlying dimensions. The potential content validity issues surrounding the measurement of effective use is expected, as these papers represent much needed first attempts at exploring how to measure such a complex and under-researched topic. Yet, it is imperative that these measurement concerns are resolved in future research. As Burton-Jones and Grange (2013, p. 653) note “researchers need instruments to test the relationships in [the] model, and practitioners need instruments to assess how effectively systems are being used”.

Due to the importance of effective use, the multiple ways it can be operationalized, coupled with issues surrounding measurement, this research seeks to provide insights into the following: “How can effective use be operationalized and measured?” and provide areas for future research. As such, we conduct a survey examining the effective use of enterprise systems. To support the operationalization and measurement we examine the nomological validity (see: Straub et al., 1995, Cenfetelli and Bassellier, 2009) of effective use with individual impact, which is a relationship long proffered but never empirically investigated. We believe this research will help advance the theory of effective use by providing empirical support behind its measurement and modes of operationalization. From a practical perspective, our measurement instrument can be used to better measure effective use, which will help practitioners to identify where investments need to be made to improve how the system is used which will ultimately improve the benefits obtained from their information systems investments.

This paper is structured as follows: Next, we provide a brief overview of effective use literature. Subsequently, we describe two operationalizations of effective use and hypothesize their relationships with individual impact. Then, the method and measurement items are detailed. Following, we present the results and discuss how our findings enhance effective use literature.

2 Background Literature on Effective Use

This section provides an overview of the current state of the theory of effective use (e.g., Burton-Jones and Grange, 2013) and subsequent related research drawing upon Dubin’s (1978) components of theory building. To engender cumulative research, Dubin (1978, pp. 7-8) specifies seven components that a theory requires: i) Units are the constructs that form the model; ii) Relationships are the laws of interaction among the units; iii) Boundary conditions to which the model holds true; iv) System states are areas in the boundary conditions that differ to the rest of the model; v) Propositions are the truth statements of the model; vi) Empirical indicators are the measures for determining the value of a unit; and vii) Testable hypotheses in which the proposition is broken into a series of testable statements.

¹ The term “hierarchical” can refer to a multidimensional construct. However, in the theory of effective use, the relationship was depicted as separate relationships between transparent interaction, representational fidelity, and informed action.
The focal unit of the theory is effective use, which is defined as “using a system in a way that helps attain the goals of using the system” (Burton-Jones and Grange, 2013, p. 633). In conceptualising effective use, Burton-Jones and Grange (2013) drew upon representation theory (see: Wand and Weber, 1995, Wand and Weber, 1990) which asserts that any information system consists of three structures: physical, surface, and deep structure. The physical structure, refers to the hardware and infrastructure; the surface structure refers to the user interface and the format of outputs, and deep structure represents the phenomenon that the system is designed to model (Eden and Burton-Jones, 2018). Central to representation theory is that users need to interact with the physical and surface structures to access the representations in the deep structure, however these representations are not infallible (Eden and Burton-Jones, 2018). Rather the users need to be able to determine the faithfulness of representations they leverage before they act on the information in the deep structure. This view on information systems is central to effective use, and resulted in Burton-Jones and Grange (2013, p. 642) conceptualising effective use to consist of three dimensions (i.e., units):

- **Transparent Interaction:** “The extent to which a user is accessing the system’s representations unimpeded by its surface and physical structures.”
- **Representational Fidelity:** “The extent to which a user is obtaining representations from the system that faithfully reflect the domain being represented.”
- **Informed Action:** “The extent to which a user acts upon the faithful representations he or she obtains from the system to improve his or her state.”

Due to its underpinning of representation theory, the theory of effective use is largely technology agnostic in nature, where the dimensions are purported to apply to any information system. However, some have argued the need to conceptualise the dimensions based on the context under investigation. For instance, in the healthcare context Burton-Jones and Volkoff (2017) conceptualised effective use to consist of the dimensions accuracy, consistency, and reflection in action. In the context of emergency management Bonaretti and Piccoli (2019) conceptualised effective use to consist of the dimensions promptness, currency, and responsiveness. In this study, we focus on the dimensions in the original theory of effective use, with a goal to develop a foundation for cumulative research efforts.

As indicated in the Introduction, in terms of relationships, effective use is an “aggregate construct formed by its dimensions” that are hierarchically related (Burton-Jones and Grange, 2013, p. 643). As such, there are two approaches for the relationships: (i) multidimensional formative construct formed by its dimensions; and (ii) Relationships between the first-order dimensions. Research has tended to focus on the latter approach (e.g., Trieu, 2013, Marchand and Raymond, 2017, Haake et al., 2018), seldom is the formative approach examined (Eden et al., 2019). Moreover, scholars typically do not recognize these multiple approaches nor do they justify their approach. Given how a construct is operationalized has both theoretical and practical implications (see: Coltman et al., 2008) it is important to understand and assess the appropriateness of each approach.

In terms of boundary conditions, which examines the applicability of effective use across contexts, according to Burton-Jones and Grange (2013, p. 650), “a full analysis of context is a major undertaking outside [their] scope”. Initial research provides support in contexts including healthcare (Eden et al., 2019), marketing (Campbell and Roberts, 2019), finance (Haake et al., 2018), and emergency management (Bonaretti and Piccoli, 2019). Within boundary conditions, system states exist which delineate specific areas within the boundary that differ to the rest of the model. In the social sciences it is common for there to be only one system state present in a theoretical model (Dubin, 1978, Sedera et al., 2013). Currently, no specific system states have been identified in past literature on effective use.

The overarching propositions in the theory of effective use, is that people can take several steps to improve their effective use of systems, and the effective use of systems can influence their performance. Testable hypotheses were not provided in the seminal paper on the theory of effective use, however some have hypothesised relationships between the dimensions (Trieu, 2013), between individual dimensions with performance (Campbell and Roberts, 2019), and between the overarching effective use construct with performance (Eden et al., 2019).
To test the hypotheses empirical indicators are necessary, and guidelines have been provided by Burton-Jones and Grange (2013). However, in many instances these guidelines have not been followed and some content validity issues have arisen. For instance, transparent interaction is often assessed in terms of perceived ease of use, which does not link to whether content is impeded due to hardware and user interfaces as Burton-Jones and Grange (2013) recommend. For representational fidelity, in some cases information quality measures are used without anchoring them in usage behaviour as per Burton-Jones and Grange (2013). For informed action the measures largely inappropriately represent impacts from use. Inappropriate measurement can ultimately impede the cumulativeness of the theory (Mohr, 1982) and result in inaccurate recommendations (Salisbury et al., 2002).

To summarise, there are many areas for future research required to progress the theory of effective use in terms of Dubin’s (1978) guidelines. In this research, we focus on providing clarity into both: (i) the units and their measurement, as well as (ii) the relationships between the units. We believe this will provide the foundation necessary for cumulative research to extend the boundary conditions.

3 Operationalizing Effective Use and Theorizing its Relationships

When operationalizing a construct, it is imperative to establish nomological validity, which “reflects the extent to which predictions about constructs and their measures are accurate from the perspective of reasonably well established theoretical models” (Straub et al., 1995, p. 1331). A prominent native information systems nomological net developed by Benbasat and Zmud (2003), highlights the necessity for systems to be used for impacts to be experienced. This relationship is also central to the Information Systems Success model (DeLone and McLean, 1992, Delone and McLean, 2003), which proposes a relationship between use and impacts at multiple levels. Nevertheless, many have argued against use being a necessary and sufficient condition for benefit attainment (Seddon, 1997) rather the use must be effective (Trieu, 2013, Marcolin et al., 2000, Burton-Jones and Grange, 2013). Drawing on these bodies of literature, we assess the nomological validity of both operationalizations of effective use (i.e., multidimensional formative construct, first-order dimensions with relationships between dimensions) with individual impact, which is defined as: “the extent to which the IS has influenced the capabilities and effectiveness, on behalf of the organization, of key users” (Gable et al., 2008, p. 389). In the following sections, we discuss each operationalization in turn.

3.1 Model I: Multidimensional Formative Operationalization of Effective Use

The first operationalization treats effective use as an “aggregate construct formed by its dimensions” (Burton-Jones and Grange, 2013, p. 643). As such, effective use is operationalized as a multidimensional second order formative construct, comprised of transparent interaction, representational fidelity, and informed action, whereby the removal of any dimension changes the underlying meaning of the construct (Figure 1).
Little empirical research has assessed the relationship between the multidimensional construct of effective use and individual impact. Hence, we first look at use literature and then integrate conceptual and qualitative effective use research to support the relationship. As previously specified the nomological nets of Benbasat and Zmud (2003) and the Information Systems Success Model (DeLone and McLean, 1992) support the relationship between use and individual impact. Empirical evidence has also supported the relationship, for instance: in a meta-analysis, the positive relationship between use and individual impact is widely supported (Petter and McLean, 2009). Moreover, Sedera et al. (2013), Lin et al. (2006), and Fan and Fang (2006) all reported a positive, statistically significant relationship between use and impact. Many argue that use is not sufficient for benefit attainment and rather the effectiveness of use should be considered as a necessary and sufficient condition (Burton-Jones and Grange, 2013). Qualitative research has evidenced a relationship between the effective use of systems and concepts related to individual impact. For example, Burton-Jones and Volkoff (2017) identified that effective use can improve decision making. In line with the positive relationships between use and impacts coupled with literature highlighting the utility of effective use over use as well as findings from qualitative studies, we hypothesize:

H1: Effective use positively influences individual impact

### 3.2 Model II: First-Order Operationalization of Effective Use

The second approach focuses on the dimensions of effective use being “hierarchically related” (Burton-Jones and Grange, 2013, p. 644) and decomposes effective use into its dimensions, which influence each other (Figure 2). Unlike, the multidimensional formative approach in which a higher order construct is formed, in Model II the relationships between the dimensions need to be hypothesized.

![Figure 2. Model II – First-Order Operationalization of Effective Use with Individual Impact](image)

When interacting with systems, users should be able to interact with the surface and physical structures (e.g., user interfaces and supporting hardware) in an unimpeded manner (i.e., transparent interaction). Surface and physical structures offer users with sensory and physical affordances that enable users to both sense and do things (Burton-Jones and Grange, 2013). For instance, positioning and labelling of fields and checkboxes accompanied with asterisks denoting mandatory fields provide users with guidance on both the data to input and how it should be inputted. Improving transparent interaction should facilitate users entering in more accurate data in the system and as a result the system should more accurately represent the domain that the data pertains to, improving the fidelity of representations users input and extract from the system. Therefore, in line with Trieu (2013) and Haake et al. (2018), we hypothesize:

H2: Transparent interaction positively influences representational fidelity

In accordance with Burton-Jones and Grange (2013), being able to obtain representations that faithfully reflect the domain enables individuals to effectively act. Trieu (2013) also asserts that improved fidelity of representations will help decision makers make better informed decisions. This is substantiated by Marchand and Raymond (2017) who highlights representational fidelity enables users to informate. Therefore, we hypothesize:

H3: Representational fidelity positively influences informed action.

When operationalizing effective use, with the first-order approach, scholars need to consider which specific dimension of effective use accounts for variation in performance outcomes, in this case indi-
vidual impact. In accordance with Burton-Jones and Grange (2013) transparent interaction is an enabler of representational fidelity, which is an enabler of informed action. We are conscious that users must make these informed decisions for productivity improvements and efficiency gains to be realized. For instance ill-informed actions can result in errors, decreasing efficiency, whereas when those actions are informed, users will be less likely to make errors. Therefore, we hypothesize:

$$\text{H4: Informed action positively influences individual impact}$$

4 **Survey Method**

To test the operationalization of effective use and its dimensions the survey method was used. The survey method is appropriate as we seek to empirically test a series of hypothesized relationships at the individual level of analysis, which the survey method facilitates (Gable, 1994). In this section, we first provide details into the measurement and operationalisation of the constructs in the study, we then provide details of the organization where the survey was distributed.

4.1 **Measurement and Operationalization of Constructs**

To develop the instrument, where possible existing scales were adapted from literature and contextualized if necessary (Froehle and Roth, 2004). For effective use, we used the measures proposed by Burton-Jones and Grange (2013) as the starting point as they clearly represent the meaning of each dimension. We opted for this approach as despite these items not being previously validated, we felt this would be a useful starting point to maintain content validity. However, we did not use this as the only way for establishing content validity rather additional steps were performed to ensure “developed instruments are measuring what they are supposed to be measuring” (Straub, 1989, p. 150), including pretesting, pilot testing, and preliminary interviews to understand the context.

As per the guidelines of Rubio et al. (2003) the survey was pre-tested to assess its face validity. Face validity is a form of content validity, whereby the instrument is assessed by an expert panel consisting of between three to ten experts (Rubio et al., 2003) who examine the instrument for potential empirical, theoretical, and practical issues (Hair et al., 2010). We pre-tested the survey, with eight respondents, including experienced academics and PhD students familiar with the domain. The respondents provided guidance to improve the understandability of the items and the overall format of the survey.

After the pretest, we conducted a pilot study. The pilot was conducted in a small and medium organization operating in the mining industry in Australia. In total 17 employees, who were operational users of an enterprise system participated. Due to the low number of respondents, quantitative assessment was limited. Notwithstanding, in accordance with Hunt et al. (1982) as the sample was between 12 and 30 the pilot was adequate. We identified participants were unsure on the negatively worded items originally associated with transparent interaction, as such we reworded these items.

In formulating the measurement items, we were conscious of the nature (i.e., formative versus reflective) and dimensionality (i.e., unidimensional versus multidimensional) of the constructs as this has implications for measurement (Coltman et al., 2008). Constructs can be reflectively or formatively measured (Shin and Kim, 2011). In reflective models “covariation among measures is explained by variation in an underlying latent factor” (MacKenzie et al., 2005, p. 711). Therefore, the direction of causality is from the construct to the measurement items, as such the items all measure the same facet, are interchangeable and need to covary (MacKenzie et al., 2005, Petter et al., 2007). Whereas, in formative models “the measures jointly influence the composite latent construct, and meaning emanates from the measures to the construct” (MacKenzie et al., 2005, p. 712). Thus, the direction of causality is from the measurement items to the construct, as such the items all measure different facets and form the constructs definition (MacKenzie et al., 2005, Petter et al., 2007). As previously high-

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2 For brevity, the interviews are not reported in this papers. Details of the interviews are provided in Eden et al. (2017)
lighted, in Model I transparent interaction, representational fidelity and informed action combine to form effective use. Therefore, while the dimensions are reflectively measured, the multidimensional construct of effective use is formative in nature. As such, effective use is considered a first order reflective-second order formative construct. Due to the formative nature of effective use a global measurement item for effective use was included in the survey (Hair et al., 2016). Figure 3 depicts the measurement model of effective use. In accordance with Gable et al. (2008) individual impact is a first-order formatively measured construct. As such, it also requires a global indicator.

![Effective Use Measurement Model](image)

The refined measurement items are present in Appendix 1. All items were measured on a 7-point Likert Scale ranging from strongly disagree to strongly agree. In addition, to understand the sample, demographic characteristics were also collected, including gender, age, job role, and experience.

Both IBM SPSS and SmartPLS were used to analyze the data. IBM SPSS was used to clean and transform the data, and SmartPLS was used to analyze the formative measurement model and structural model. SmartPLS is an appropriate data analysis tool to use for formative measurement models, and 84% of publications examining formative constructs use the tool (Polites et al., 2012).

4.2 Field Setting

We distributed the survey at a single case organization, while this limits generalizability, it provides the opportunity to have an in-depth understanding of the use context, through preliminary interviews, and provides the opportunity to ensure the survey is worded in a way respondents can understand. The organization is a large tertiary education provider in Australia with over 12,000 staff employed across 17 divisions. The organization implemented the enterprise system, Oracle Financials, in the 1990s. Since its implementation it has undergone several updates and is beyond the shakedown phase, which makes it an ideal case study to understand the use and impacts of the system (Markus and Tanis, 2000). The enterprise system includes both self-service and standard modules, providing functionality into asset management, accounts payable, accounts receivable, general ledger, and purchasing. To identify the individuals in the organization who used the enterprise system, user logs were analysed with managerial staff in the organization assisting in identifying the relevant participants. Specifically, we surveyed users who used the system in an operational capacity to complete finance related tasks. This included some management users as they also completed similar tasks in the system.

5 Results

Of 393 potential respondents, 250 surveys were returned (response rate: 63.81%). Of the 250 surveys returned, 213 surveys were considered usable (response rate: 54.2%). This is greater than the average response rate observed for physically distributed surveys (Baruch and Holtom, 2008). The sample demographics are summarised in Table 1. In the following sections, we provide validity and reliability assessments of the measurement models and analysis of our structural models.
Gender | Job Role | Experience (average years) | Age (average)
---|---|---|---
Male | 51 (23.9%) | 188 (88.3%) | 9 | 41.6
Female | 162 (76.1%) | 25 (11.7%) | 7 |
Table 1. Respondent Demographics

5.1 Measurement Model

Prior to analyzing the structural model, reliability and validity assessments of the constructs were performed following the guidelines of Hair et al. (2016). Reflectively measured constructs (i.e., transparent interaction, representational fidelity, and informed action) were assessed for: internal consistency reliability, convergent validity, and discriminant validity. Formatively measured constructs (i.e., effective use, individual impact) were assessed for convergent validity, multicollinearity, and relevance of formative indicators/dimensions.

For effective use, we first analyze the validity and reliability of the reflectively measured dimensions, followed by the second-order formative construct. All effective use dimensions exhibited discriminant validity, composite reliability, and convergent validity (table 2, appendix 2) (Hair et al., 2016). In addition, indicator reliability for transparent interaction and representational fidelity was established. One informed action item (IA3) did not exhibit indicator reliability, however, it was retained as composite reliability and convergent validity are above the required threshold (Hair et al., 2016).

<table>
<thead>
<tr>
<th>Construct</th>
<th>Items</th>
<th>Indicator</th>
<th>Reliability*</th>
<th>Composite Reliability**</th>
<th>Convergent Validity***</th>
</tr>
</thead>
<tbody>
<tr>
<td>Transparent Interaction</td>
<td>TI1</td>
<td>0.883</td>
<td>0.937</td>
<td>0.833</td>
<td></td>
</tr>
<tr>
<td></td>
<td>TI2</td>
<td>0.955</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>TI3</td>
<td>0.899</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Representational Fidelity</td>
<td>RF1</td>
<td>0.883</td>
<td>0.933</td>
<td>0.776</td>
<td></td>
</tr>
<tr>
<td></td>
<td>RF2</td>
<td>0.925</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>RF3</td>
<td>0.822</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>RF4</td>
<td>0.890</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Informed Action</td>
<td>IA1</td>
<td>0.914</td>
<td>0.835</td>
<td>0.642</td>
<td></td>
</tr>
<tr>
<td></td>
<td>IA2</td>
<td>0.918</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>IA3</td>
<td>0.496</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note: In accordance with Hair et al. (2016):

*Indicator reliability established when outer loadings are greater than 0.708. However outer loadings between 0.40 and 0.70 can be considered acceptable if composite reliability and AVE above threshold.

**Composite reliability of construct established when composite reliability is between 0.70 and 0.95.

***Convergent validity established when average variance extracted is greater than 0.50

Table 2. Reliability and Validity of Reflectively Measured Effective Use Dimensions

In terms of the second-order formative perspective of effective use, as evident in Model I, it needs to be assessed for convergent validity, multicollinearity, and relevancy of dimensions. For convergent validity a redundancy analysis was performed where the path weight between the formatively measured effective use and the reflective global measure of effective use was analyzed. The path weight (β

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3 Our prior interviews (Eden et al., 2017) and analysis of the demographic questions in our survey indicated that the operational and managerial users used the system in similar ways in terms of tasks performed and time spent using the system.
= 0.627) was below the recommended threshold, and as such convergent validity could not be established. There were no multicollinearity issues with effective use, with Variance Inflation Factor (VIF) values below 10 (MacKenzie et al., 2011). Bootstrapping was performed to assess the relevancy of the dimensions. All dimensions were statistically relevant, representational fidelity was the strongest (β = 0.543), followed by transparent interaction (β = 0.432), and informed action (β = 0.223). In sum, there may be potential issues with the convergent validity of effective use as a multidimensional construct, however this could be due to the global indicator as no other issues were present.

Due to the formative nature of individual impact, it needs to be assessed for convergent validity, multicollinearity, and relevancy of indicators. Using a similar approach to effective use, convergent validity was established, and no multicollinearity issues were present. Two indicators did not have a significant outer weight but as per Hair et al. (2016) they were retained as past research supports the measures (Gable et al., 2008).

To provide further evidence that the constructs possessed convergent and discriminant validity a confirmatory factor analysis was performed (Appendix 3). All items loaded onto their respective construct, with a factor loading of greater than 0.50 and no cross loadings above 0.40 (Hair et al., 2010).

### 5.2 Model I Analysis – Multidimensional Formative Operationalization of Effective Use

For the multidimensional operationalization, we hypothesized that effective use influences individual impact (H1) this is statistically significant (β = 0.682, P<0.001), with effective use accounting for 46.5% of the variance in individual impact, with a large effect size (f² = 0.869) (Figure 3).

![Figure 3. Structural Equation Model of Model I](image)

### 5.3 Analysis of Model II – First Order Operationalization of Effective Use

Figure 4 illustrates the results of the first order approach. H2 was supported (β = 0.670, P<0.001) with a large effect size (f² = 0.813) with transparent interaction accounting for 44.9% of the variance in representational fidelity. H3 was supported (β = 0.375, P<0.001), with a medium effect size (f² = 0.164), with representational fidelity explaining 14.1% of the variance in informed action. H4 was again supported (β = 0.474, P<0.001), with a medium effect size (f² = 0.290), with informed action explaining 22.5% of the variance in individual impact.

![Figure 4. Structural Equation Model of Model II](image)

Following Cepeda et al. (2017), we also performed additional exploratory mediation analyses:
An examination of whether representational fidelity mediates the relationship between transparent interaction and informed action.

A multiple mediation analysis examining whether representational fidelity and informed action mediates the relationship between transparent interaction and individual impact.

For the first analysis, we identified representational fidelity completely mediated the relationship between transparent interaction and informed action ($\beta = 0.234, P < 0.05, [95\% \text{ CI}: 0.074, 0.418]$).

For the multiple mediation analysis we examined the indirect effects on individual impact. As detailed in Table 3, we found an indirect relationship may exist between transparent interaction and individual impact through representational fidelity through informed action. However, examination of the VAF indicated that no mediation was present (VAF < 20%). Rather, the path was better explained from transparent interaction through representational fidelity to individual impact (VAF = 25.7%) (Hair et al., 2017). During this analysis we also identified that direct relationships between transparent interaction and representational fidelity existed with individual impact.

<table>
<thead>
<tr>
<th>Direct Effects</th>
<th>Path Weight</th>
<th>95% Confidence Interval</th>
<th>VAF</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\text{TI} \rightarrow \text{RF}$</td>
<td>$\beta = 0.667, p&lt;0.01$</td>
<td>0.584 - 0.738</td>
<td>NA</td>
</tr>
<tr>
<td>$\text{TI} \rightarrow \text{IA}$</td>
<td>$\beta = 0.170, p&gt;0.05$</td>
<td>-0.008 - 0.333</td>
<td>NA</td>
</tr>
<tr>
<td>$\text{TI} \rightarrow \text{II}$</td>
<td>$\beta = 0.390, p&lt;0.01$</td>
<td>0.235 - 0.541</td>
<td>NA</td>
</tr>
<tr>
<td>$\text{RF} \rightarrow \text{IA}$</td>
<td>$\beta = 0.265, p&lt;0.01$</td>
<td>0.114 - 0.419</td>
<td>NA</td>
</tr>
<tr>
<td>$\text{RF} \rightarrow \text{II}$</td>
<td>$\beta = 0.249, p&lt;0.01$</td>
<td>0.091 - 0.409</td>
<td>NA</td>
</tr>
<tr>
<td>$\text{IA} \rightarrow \text{II}$</td>
<td>$\beta = 0.205, p&lt;0.01$</td>
<td>0.062 - 0.344</td>
<td>NA</td>
</tr>
<tr>
<td>Indirect Effects on II</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$\text{TI} \rightarrow \text{RF} \rightarrow \text{IA} \rightarrow \text{II}$</td>
<td>$\beta = 0.037, p&lt;0.05$</td>
<td>0.008 - 0.077</td>
<td>5.9%</td>
</tr>
<tr>
<td>$\text{TI} \rightarrow \text{IA} \rightarrow \text{II}$</td>
<td>$\beta = 0.035, p&gt;0.05$</td>
<td>-0.002 - 0.082</td>
<td>NS</td>
</tr>
<tr>
<td>$\text{TI} \rightarrow \text{RF} \rightarrow \text{II}$</td>
<td>$\beta = 0.162, p&lt;0.01$</td>
<td>0.060 - 0.273</td>
<td>25.7%</td>
</tr>
<tr>
<td>Total Indirect Effect</td>
<td>$\beta = 0.234, p&lt;0.05$</td>
<td>0.138 - 0.342</td>
<td>31.6%</td>
</tr>
</tbody>
</table>

*TI: Transparent Interaction; RF: Representational Fidelity; IA: Informed Action; II: Individual Impact; CI: Confidence Interval; VAF: Variance Accounted For; NS: Non significant

| Table 3. Multiple Mediation Analysis |

6 Discussion

Overall, our research provides support for the effective use dimensions, and established nomological validity for two operationalisations of effective use: multidimensional and first-order relational. In this section, we first reflect on the dimensions and their measurement followed by the operationalisations.

In terms of the units (i.e., dimensions), our analysis demonstrates that transparent interaction, representational fidelity, and informed action are all statistically significant dimensions of effective use. We also provide initial evidence validating the measures of effective use based on the measures proposed by Burton-Jones and Grange (2013). There are some limitations with the measures as detailed in appendix 1, as such we recommend future research performs additional face validity assessments (see: Hardesty and Bearden, 2004). Additionally, research should triangulate the self-reported measures of effective use with independent assessments.

Our analysis identified the appropriateness of the dimensions in a single context, which was the operational use of an enterprise system to complete finance-related tasks. According to Burton-Jones and Grange (2013), these dimensions are considered to be applicable across all system types, including network IT, functional IT, and enterprise IT (see: McAfee (2006)). Therefore, rather than the dimen-
sions of effective use being informed in an inductive context-driven manner, elements of the system use context – user, task, system (Burton-Jones and Straub, 2006) – are embedded in the measurement items. However, these dimensions are informed by representation theory, where the underlying assumption is that the purpose of any information system is to provide an accurate representation of some phenomenon (Wand and Weber, 1990, Wand and Weber, 1995). Yet, this may not be the case for all systems. For instance, understanding representations within social media contexts may go beyond simple representational fidelity criteria such as completeness and correctness (Emamjome, 2014). This suggests there is value in performing a grounded approach to understanding effective use in different contexts. However, when grounding the dimensions, it is important that they still faithfully reflect the overarching definition of effective use for appropriate conclusions to be drawn. Recognising this Burton-Jones and Volkoff (2017) provide guidelines into how to contextualise effective use. We recommend, further research be performed into examining the efficacy of both the context agnostic (Burton-Jones and Straub, 2006) and context specific (Burton-Jones and Volkoff, 2017) perspectives of effective use.

In terms of relationships, based on Burton-Jones and Grange (2013), we proposed two operationalizations of effective use: multidimensional and first-order relational. Our research supports both approaches, yet is limited in its ability to explain causality. Our findings extend current literature by demonstrating the appropriateness of the multidimensional approach to effective use (e.g., Eden et al., 2019), and supports nascent empirical research examining the first-order approach (e.g., Trieu, 2013, Marchand and Raymond, 2017, Haake et al., 2018). However, we acknowledge that neither approach on its own is perfect as traditional measurement models fall short in their ability to demonstrate the combination of a multidimensional construct with relationships between its first order dimensions. Nevertheless, given both operationalisations are statistically significant the choice of which operationalisation to use should be based on the theoretical considerations informed by the study’s objective. We provide some initial insights below.

When the objective of the research is to understand the consequences of effective use, it is likely to be more appropriate to use the multidimensional approach as it enables a holistic representation of complex phenomena in a comparatively simple abstraction (Polites et al., 2012). It also offers key advantages including retaining parsimony, allowing for insightful explanations, and maintaining theoretical implications (Petter et al., 2007). However, the ability of a multidimensional construct to provide insights is limited to how rigorously the underlying dimensions have been formulated.

Alternatively, when the objective of the research is to understand how to improve effective use, the first order relational approach is especially useful. For instance, different mechanisms can be enacted to improve transparent interaction, representational fidelity, and informed action. The exploratory examination of the first order relational model also highlighted some nuanced relationships. For instance, we identified all dimensions directly impacted individual impact. When comparing the direct effects for each dimension, transparent interaction had the strongest influence on individual impact, and an indirect effect through representational fidelity – yet no indirect effect through informed action. We believe this is the result of our user cohort being largely operational users. Traditionally, operational users complete highly fragmented, routinized tasks, with limited ability to make decisions, whereas managerial and strategic level users typically make informed decisions on the data present in the system (Wickramasinghe and Karunasekara, 2012). This could suggest that different dimensions of effective use may be more relevant for different user groups. Therefore, future research should conduct a multi-group examination of effective use.

Another potential way to determine which operationalization should be investigated is based on whether the objective of the research is to develop a process or variance theory (e.g., Mohr, 1982). A variance approach to theorizing examines causal relationships between constructs and, as such, is built on the assumption that the relationship between constructs is necessary and sufficient (Mohr, 1982, Burton-Jones et al., 2015). Alternatively, a process approach to theorising examines the sequence of events, where an outcome event is only probabilistically reached if the sequence of events occur in that specific order (Mohr, 1982, Seddon, 1997, Lyttyinen et al., 2008). As such, the assumption of a process approach is that the relationship between constructs is necessary but insufficient (Burton-Jones
et al., 2015). In terms of the operationalization of effective use, the multidimensional formative approach (Model I) best aligns with a variance perspective when examined in conjunction with its consequences, whereas the first-order approach (Model II) is more in keeping with a process approach.

To summarise, we provide some initial insights to improve the foundations of the theory of effective use, to minimise model instability and to help foster a cumulative research tradition. We call for further research to be performed into critically understanding the operationalisation of effective use as well as for future research to expand the nomological network surrounding effective use.

7 Conclusion

In conclusion, this research sought to provide insights and initial guidance into the operationalization and measurement of effective use. We demonstrated two approaches to operationalizing effective use: (i) second-order formative, first-order reflective construct, and (ii) decomposed into its dimensions with relationships between. In addition, we refined the measurement items of effective use. This research is timely as few studies have quantitatively assessed effective use, and those studies that have quantified effective use have questionable measurement items raising measurement concerns. Future research on effective use can draw upon our refined items and operationalizations.

8 Appendix

8.1 Appendix 1. Measurement Items

<table>
<thead>
<tr>
<th>Construct</th>
<th>Item*</th>
<th>Descriptives</th>
</tr>
</thead>
<tbody>
<tr>
<td>Transparent Interaction</td>
<td><strong>TI1</strong>: When using [System], I have seamless access to the content that I need to complete my job task.</td>
<td>Mean: 4.44</td>
</tr>
<tr>
<td></td>
<td><strong>TI2</strong>: When using [System], I have difficulty obtaining the content I need to complete my job task because of [System]'s interface.</td>
<td>St. Dev: 1.42</td>
</tr>
<tr>
<td></td>
<td><strong>TI3</strong>: When using [System], I have difficulty obtaining the content I need to complete my job task because of the physical characteristics of the device I use to access [System].</td>
<td>Range: 1-7</td>
</tr>
<tr>
<td>Representational Fidelity</td>
<td><strong>RF1</strong>: When completing my job task using [System], the information provided is complete.</td>
<td>Mean: 4.91</td>
</tr>
<tr>
<td></td>
<td><strong>RF2</strong>: When completing my job task using [System], the information provided is clear.</td>
<td>St. Dev: 1.22</td>
</tr>
<tr>
<td></td>
<td><strong>RF3</strong>: When completing my job task using [System], the information provided is correct.</td>
<td>Range: 1-7</td>
</tr>
<tr>
<td></td>
<td><strong>RF4</strong>: When completing my job task using [System], the information provided is meaningful.</td>
<td></td>
</tr>
<tr>
<td>Informed Action</td>
<td><strong>IA1</strong>: When I obtain information from [System], I look for the relevant aspects that I can act upon to improve my task performance.</td>
<td>Mean: 4.92</td>
</tr>
<tr>
<td></td>
<td><strong>IA2</strong>: When I obtain information from [System], I seek ways to leverage</td>
<td>St. Dev: 1.19</td>
</tr>
</tbody>
</table>

Even though in this research we examined the first-order relational approach using a variance perspective (although causal inferences could not be drawn), it may be more applicable to use a process perspective. This is to an extent also implied by Burton-Jones and Grange (2013) as each dimension is considered necessary but not sufficient for the higher level dimension. For instance, transparent interaction *enables* users to determine representational fidelity yet it does not directly *cause* representational fidelity to occur.

Future research could seek to further refine the informed action items, so they reflect the extent to which appropriate, relevant, and accurate information is acted upon. For instance: When I obtain information from [System], I look for the relevant aspects and act on that information to improve my task performance.
<table>
<thead>
<tr>
<th>Construct</th>
<th>Item*</th>
<th>Descriptives</th>
</tr>
</thead>
<tbody>
<tr>
<td>Effective Use</td>
<td>GEU: Overall I effectively use [System] to complete my job tasks.</td>
<td>Mean: 5.42</td>
</tr>
<tr>
<td>Global Item</td>
<td></td>
<td>St. Dev: 1.19</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Range: 1-7</td>
</tr>
<tr>
<td>Individual Impact</td>
<td>II1: I have learnt much through the presence of [System].</td>
<td>Mean: 4.55</td>
</tr>
<tr>
<td></td>
<td>II3: [System] enhances my effectiveness in the job.</td>
<td>Range: 1-7</td>
</tr>
<tr>
<td></td>
<td>II4: [System] increases my productivity.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>GII: Overall, the impact of [System] on me has been positive</td>
<td></td>
</tr>
</tbody>
</table>

*Effective Use and Individual Impact measures from Burton-Jones and Grange (2013) and Gable et al. (2008).

8.2 Appendix 2. Fornell Larker discriminant validity assessment

<table>
<thead>
<tr>
<th>Construct</th>
<th>Informed Action</th>
<th>Representational Fidelity</th>
<th>Transparent Interaction</th>
</tr>
</thead>
<tbody>
<tr>
<td>Informed Action</td>
<td>0.801</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Representational Fidelity</td>
<td>0.377</td>
<td>0.881</td>
<td></td>
</tr>
<tr>
<td>Transparent Interaction</td>
<td>0.343</td>
<td>0.6700</td>
<td>0.913</td>
</tr>
</tbody>
</table>

8.3 Appendix 3. Factor Analysis

<table>
<thead>
<tr>
<th>Item</th>
<th>Transparent Interaction</th>
<th>Representational Fidelity</th>
<th>Informed Action</th>
<th>Individual Impact</th>
</tr>
</thead>
<tbody>
<tr>
<td>TI1</td>
<td>0.818</td>
<td>0.194</td>
<td>0.156</td>
<td>0.290</td>
</tr>
<tr>
<td>TI2</td>
<td>0.787</td>
<td>0.399</td>
<td>0.064</td>
<td>0.312</td>
</tr>
<tr>
<td>TI3</td>
<td>0.782</td>
<td>0.379</td>
<td>0.072</td>
<td>0.191</td>
</tr>
<tr>
<td>RFI1</td>
<td>0.350</td>
<td>0.806</td>
<td>0.128</td>
<td>0.121</td>
</tr>
<tr>
<td>RFI2</td>
<td>0.348</td>
<td>0.798</td>
<td>0.054</td>
<td>0.304</td>
</tr>
<tr>
<td>RFI3</td>
<td>0.151</td>
<td>0.759</td>
<td>0.201</td>
<td>0.243</td>
</tr>
<tr>
<td>RFI4</td>
<td>0.180</td>
<td>0.816</td>
<td>0.172</td>
<td>0.266</td>
</tr>
<tr>
<td>IA1</td>
<td>0.244</td>
<td>0.116</td>
<td>0.857</td>
<td>0.118</td>
</tr>
<tr>
<td>IA2</td>
<td>0.127</td>
<td>0.156</td>
<td>0.842</td>
<td>0.186</td>
</tr>
<tr>
<td>IA3</td>
<td>-0.055</td>
<td>0.083</td>
<td>0.577</td>
<td>0.093</td>
</tr>
<tr>
<td>II1</td>
<td>0.170</td>
<td>0.291</td>
<td>0.052</td>
<td>0.861</td>
</tr>
<tr>
<td>II2</td>
<td>0.113</td>
<td>0.275</td>
<td>0.175</td>
<td>0.863</td>
</tr>
<tr>
<td>II3</td>
<td>0.335</td>
<td>0.193</td>
<td>0.208</td>
<td>0.774</td>
</tr>
<tr>
<td>II4</td>
<td>0.362</td>
<td>0.153</td>
<td>0.249</td>
<td>0.674</td>
</tr>
</tbody>
</table>

6 While Informed Action had adequate composite reliability and convergent validity, it did not demonstrate indicator reliability. In examining the items, we believe this could stem from the use of the word ‘avoid’. For instance, if one avoids acting on irrelevant information it does not mean they act on correct information. As such, we propose the following item: “when I obtain information from [System], I use key parts of it to find solutions for problems encountered in my work.”

7 All dimensions of effective use were relevant and no collinearity issues present. However, there was an issue with the redundancy analysis, this is likely due to an issue with the global item used. For instance, respondents may perceive effective use to be simply the inputting of data and running of reports rather than the use of the output. As such, we propose the following item: Overall, I effectively use [system] and the output that it provides to complete my job tasks.
References


Wickramasinghe, V. and M. Karunasekara (2012). "Perceptual differences of enterprise resource planning systems between management and operational end-users". *Behaviour & Information Technology* 31 (9), 873-887.