CORA Cork Open Research Archive
Cartlann Taighde Oscailte Chorcaí

Title	Causal framework through retroduction and retrodiction
Authors	McAvoy, John;Butler, Tom
Publication date	2017-06-01
Original Citation	McAvoy, J. and Butler, T. (2017) 'Causal framework through retroduction and retrodiction', Proceedings of the 25th European Conference on Information Systems (ECIS 2017), Guimarães, Portugal, 5-10 June, pp. 1314-1326. Available at: https://aisel.aisnet.org/ecis2017_rp/85/ (Accessed 28 January 2019)
Type of publication	Conference item
Link to publisher's version	https://aisel.aisnet.org/ecis2017_rp/85/
Rights	© 2017, the Authors. This material is brought to you by the ECIS 2017 Proceedings at AIS Electronic Library (AISeL). It has been accepted for inclusion in Research Papers by an authorized administrator of AIS Electronic Library (AISeL). For more information, please contact elibrary@aisnet.org
Download date	2026-11-17 05:56:42
Item downloaded from	https://hdl.handle.net/10468/7367



University College Cork, Ireland
Coláiste na hOllscoile Corcaigh

Association for Information Systems
AIS Electronic Library (AISeL)

Research Papers | ECIS 2017 Proceedings

Spring 6-10-2017

CAUSAL FRAMEWORK THROUGH RETRODUCTION AND RETRODICTION

John McAvoy
University College Cork, Ireland, j.mcavoy@ucc.ie

Tom Butler
University College Cork, Ireland, tbutler@ucc.ie

Follow this and additional works at: http://aisel.aisnet.org/ecis2017_rp

Recommended Citation
McAvoy, John and Butler, Tom, (2017). "CAUSAL FRAMEWORK THROUGH RETRODUCTION AND RETRODICTION". In Proceedings of the 25th European Conference on Information Systems (ECIS), Guimarães, Portugal, June 5-10, 2017 (pp. 1314-1326). ISBN 978-989-20-7655-3 Research Papers.
http://aisel.aisnet.org/ecis2017_rp/85

This material is brought to you by the ECIS 2017 Proceedings at AIS Electronic Library (AISeL). It has been accepted for inclusion in Research Papers by an authorized administrator of AIS Electronic Library (AISeL). For more information, please contact elibrary@aisnet.org.

A CRITICAL REALIST METHOD FOR IS RESEARCH: THE CAUSAL FRAMEWORK THROUGH RETRODUCTION AND RETRODICTION

Research paper

McAvoy, John, University College Cork, Ireland. j.mcavoy@ucc.ie

Butler, Tom, University College Cork, Ireland. tbutler@ucc.ie

Abstract

While the discussion in the IS research community has moved from describing critical realism as simply a compromise philosophy between positivists and interpretivists to its acceptance in its own right, it is still lacking in a choice of methods or processes for the IS researcher to utilise. This paper presents a proposed method that can be used by IS researchers following the critical realist paradigm.

The suitability of a critical realist approach to IS research is discussed, and the importance of the combined ontological and epistemological elements described. The relevance of the search for causal mechanisms is shown and the benefits of the processes of retroduction and retrodiction in this search. A 'causal framework' is proposed as an artefact in the IS critical researcher's "toolkit" and an example provided to show how it can be used. A three step process is described which uses causal frameworks the guide the analysis.

Keywords: Critical Realism, Retroduction, Retrodiction, Causal Framework

1 Critical Realism in Information Systems Research

The use of critical realism in information systems, as in other domains, is growing although it is noted that the majority of papers published on critical realism (in information systems and other disciplines) are predominantly theoretical, without fieldwork (de Vaujany, 2008). There are, however, some examples of critical realist 'field work' and discussions of its benefits (cf. Carlsson, 2009, Dobson and Love, 2004, Longshore-Smith, 2006, Easton, 2010, Volkoff et al., 2007, Gharavi et al., 2007). Recently there has been a move (if limited) towards providing guidance to those conducting critical realist IS research. Zachariadis (2013) shows how recent work has seen some papers that provide a set of principles for IS critical realist research and a method of conducting critical realist research, although Bygstad et al. (2016) and Wynn and Williams (2012) argue that there is still a paucity of details of how to identify causal mechanisms and general methodological guidance. It is the goal of this paper to provide a method of conducting IS critical realist research through the use of an artefact called a causal framework. This is done through a three step process which creates and uses the artefact as part of the process.

1.1 Critical Realist Ontology and Epistemology

The most influential writer on, and creator of the philosophy of, critical realism is Roy Bhaskar (Carlsson, 2009), although it is acknowledged that his books are complex and difficult to read (Carlsson, 2009, Robson, 2002). The 2013 special issue of MIS Quarterly on Critical Realism (Volume 37, Issue 3) provides detailed descriptions of the elements of critical realism, so they will not be expanded on here; rather the specific elements that are of relevance to the causal framework proposed herein will be discussed.

The ontological and epistemological underpinnings of critical realism are expressed by the statement that "*things exist and act independently of our descriptions, but we can only know them under particular descriptions. Descriptions belong to the world of society and men; objects belong to the world of nature*" (Bhaskar, 1978, p.250). The question for researchers wishing to undertake research using the critical realist philosophy is how to align the ontological and epistemological foundations with an actual research method. To determine a method to use in critical realist research, it is necessary to appreciate the domains and causal powers described in the critical realist philosophy.

1.2 The Critical Realist Domains

For critical realists, the real world is a complex one, hierarchically structured into layers. Bhaskar (1978) describes this stratification and argues that we need to build our knowledge of a strata by examining the underlying strata, the mechanism of which explains the strata above. So when a stratum of reality has been adequately described, the next step is to investigate the mechanisms responsible in the stratum of reality below. Although critical realism in the natural sciences has mechanisms such as gravitation or air pressure, in social settings it may not be possible to see or physically touch what the concepts represent (Danermark et al., 2002): examples of these are norms and roles (Danermark et al., 2002), personality and attitude (Sayer, 1992), and culture (Manicas, 2006). In the social world, these mechanisms pre-exist, independent of our investigation of them, but themselves are both transformed and reproduced by humans (Manicas, 2006, Yeung, 1997, Sayer, 1992). For the researcher, therefore, a critical realist based IS research methodology would need to examine these mechanisms.

For the critical realist, reality is separated into three domains: the domain of the empirical is part of the domain of the actual, while the domain of the actual is part of the domain of the real (Dobson and Love, 2004, Mingers, 2004a, Archer, 1998). The real domain comprises generative mechanisms and relations, events, and experiences. These mechanisms (structures and relations) are independent of the events but are capable of producing them. Behaviours and events are in, and occur in, the domain of the actual. Experienced events reside in the domain of the empirical. Mechanisms can lead to events and are independent of them, while events can occur independently of our experience of these events. As such, the domains can be 'out of phase' with each other (Bhaskar, 1978, Carlsson, 2009, Morton, 2006); this is most prevalent in an open system, typically investigated in IS research, as opposed to a closed such as a laboratory where all aspects would be the control of the researcher (Robson, 2002, Outhwaite, 1983, Dobson, 2001).

1.3 Causal powers

Taking the positivist view of causality, strong correlations are useful for prediction but not explanation; they explain that something is likely to occur but not necessarily why (Manicas, 2006, Longshore-Smith, 2006). The critical realist view of causality is one of mechanisms (Sayer, 1992) instead of relationships between events. These mechanisms are associated with causal powers and liabilities such as the power or ability to perform a function or the liability or inability to work in a certain environment. Bhaskar (1998) specifically notes that social structures can both enable and constrain social activities, while themselves being changed by the activities. The goal, therefore, of critical realist research is to explain the mechanisms and structures rather than the events, while acknowledging that the mechanisms can be blocking an event, such as a change or outcome (Robson, 2002). Most importantly, the causal power or liability does not imply that it will occur, rather that it has the potential to enable or constrain (Volkoff and Strong, 2013): those which occur with some, or partial, regularity are referred to as demi-regs (Lawson, 1998) and imply that this is not an accidental or random occurrence (Manicas, 2006). This would make replication of research difficult for the IS researcher as the power or liability may not be exercised in the same way in further studies, although replication of research is still of value in

confirming or denying the mechanisms at play (Robson, 2002). Manicas (2006) and Sayer (1992) do not discount the usefulness of empirical regularities (traditional cause and effect research) but its use is only in highlighting the objects whose causal powers may be playing a part, and to provide further details on the mechanism (Wynn and Williams, 2012). So the question for the IS critical realist researcher is how to acknowledge the argument that the causal power or liability will not necessarily occur in the empirical domain.

1.4 The use of retroduction and existing theory

The critical realist method of science is that of retroduction, where the goal is to discover the interacting mechanisms and structures which generate a phenomenon (Mingers, 2004a, Olsen, 2004). These mechanisms, or structures, "*could be physical, social or psychological, and may well not be directly observable except in terms of its effects (eg. social structure)*" (Mingers, 2000, p.1262). The goal of critical realist research is to determine these proposed mechanisms then to eliminate some while supporting others: this is the process of retroduction (Aaltonen and Tempini, 2014, Bygstad, 2010, Zachariadis, 2013).

The importance of retroduction in identifying and explaining mechanisms is seen in Wynn and Williams (2012) who describe it as one of the five principles, or requirements, of critical realist research in Information Systems. These principles are acknowledged as a "landmark for critical realism in IS research" (Bygstad et al., 2016, p.86), but further details are required, specifically on a methodological process to identify mechanisms. Bygstad et al. (2016) describe a framework for critical realist data analysis, and again recognise the relevance and importance of retroduction; they provide a more detailed and specific description of the process of retroduction. Retroduction has been described as a creative and less structured process (Tsang, 2015, Wynn and Williams, 2012, Mingers, 2004b). We do not necessarily believe that it was the authors' intention with this description, but it might imply that it cannot be formalised or structured. We agree with Bygstad et al. (2016) who argue that this creativity can be improved through a formalised methodological approach; our method of helping or formalising the creativity is admittedly different than that of Bygstad et al. (2016) where the use of existing theories takes place after examining the event seen through observation, if they are used at all. Bygstad et al. (2016), in their six step methodological framework describe retroduction as occurring as the fourth of six steps: it is preceeded by the description of events observed, the identification of key objects of a case study, and exploring different theories to explain the events. Although this description of retroduction occurring after observations is the first time it has been formalised into a methodological process, it is a common theme among writers on critical realism in Information systems (and other domains). In fact, Aaltonen and Tempini (2014) specifically state that retroduction starts with empirical observations.

This is the departure between the method proposed herein and existing research on retroduction. The relevant question here is when existing theory is used in critical realist research. As described above, the typical description is that it is used after observations. We argue, though, that there are two situations where a priori theory is needed before observation takes place, and it is this argument which guides our proposed research approach using the causal framework. This departure is not a suggestion that Wynn and Williams (2012) principles or Bygstad et al. (2016) framework needs to be amended. Both of these are landmark publications in IS critical realism; this is our opinion and acknowledged by other researchers. Rather, we propose that in certain situations a modified approach is required. There are two specific situations where we argue for a different approach; the different approach being the causal framework and three step process proposed herein. The two situations are:

1) When it is unlikely that events will be observed or there is uncertainty as to what will be observed, a priori theory can help the researcher to avoid "fumbling in the dark" for events.

2) In research where a structured approach is required with a theoretical framework generated before entering the field.

There is no guarantee with critical realist research that the researcher will observe events with underlying mechanisms. Mechanisms may not be activated (Wynn and Williams, 2012, Archer, 1998) and, if they are, are rarely observed (Aaltonen and Tempini, 2014). Additionally, even if a mechanism is activated, its interaction with other mechanisms can alter it and ultimately change the effect (Morton, 2006), which leads to complexity for analysis (Gharavi et al., 2007). So if the researcher enters the field looking for events to occur, there is the possibility that they will either not observe events as the mechanism did not activate, or the activation of the mechanism interacts with other mechanisms creating an event that is difficult to pin down and examine. The mechanisms exist but observation may not be the optimum way to propose their existence. Structures predate action (Volkoff and Strong, 2013) so we argue that it is beneficial to have some understanding of the structures before attempting to observe the events that are triggered by them. It is argued herein that entering the field with existing theory as a lens to guide the research can help to overcome this specific situation. For the second situation, where a structured approach is required with a theory based literature review guiding the research and data gathering, this would be the case with a large proportion of PhD students conducting research for their thesis. Again, in this second situation, the researcher would enter the field guided by existing theories. This suggested use of a priori theory aligns with the description of over-coded retroduction (Bertilsson, 2004, Tsang, 2015) where existing theories suggest possible mechanisms and the researcher selects the most plausible one; as such, the theories are 'on trial'.

1.5 Retrodiction

Critical realism also has a concept of retrodiction, which while following the same premise as retroduction, does differ. Retrodiction in our proposed causal framework is a further point of departure from the principles of Wynn and Williams (2012) and the framework of Bygstad et al. (2016). While it is argued herein that retroduction provides theoretical explanations which are empirically assessed, retrodiction is concerned with applied explanations by resolving conjunctions – from resolved components to antecedent causes (Lawson, 2009). Retrodiction, for example, is used in the medical field to trace back through medical history of a patient or group (Byrne, 2004), although the move from effects to cause uses retroduction to explain the structures involved (Hartwig, 2007). The two terms are brought together in the argument that while retroduction identifies the mechanisms, retrodiction analyses how the mechanisms interact in actual events (Elder-Vass, 2007), ultimately further describing the cause of an effect (Hartwig, 2007). Further, researchers often use the term retroduction to cover both retroduction and retrodiction, and sometimes neither term are used even if the principles are being followed; this is common in critical realist research in Information Systems (cf. Gharavi et al., 2007, Carlsson, 2003). For example, in one of the few papers that provide a specific method to use in critical realism, Henfridsson and Bygstad (2013) describe part of their process as going from outcomes to causes and then causes to outcomes. Although the terms are not used, this is retroduction and retriduction; as is common in critical realist research, Henfridsson and Bygstad (2013) use the single term of retroduction to define both. One different view point between their method and the method proposed herein is that they used retroduction (actually both retroduction and retrodiction) on the same data and findings. It is argued herein that retrodiction is better performed, and gives better value, through cross-case analysis using the data and findings of more than a single case study.

2 Applying Retroduction and Retrodiction in IS Research through the use of a Causal Framework

Given the two specific situations described above, a modified approach is required. It is proposed herein that retroduction should be the basis of the research, with retrodiction applied in cross case analysis. Theory should be used to create the empirical domain: this represents the researcher's view of the reality they are investigating. By combining existing theories (the transitive domain) a theoretical model can be proposed describing the proposed mechanisms acting in the various strata. The next stage of the research would be to either support or eliminate the proposition of these mechanisms, and the use of both retroduction and retrodiction can support the researcher.

The steps in the research process are:

1) Create an a priori causal framework which represents the intransitive domain. This framework describes what existing theories suggest would be the mechanisms that might be involved, the events that would identify the activation of these mechanisms, and the contexts which might align to activate the mechanisms.

2) Through a process of retroduction, guided by the causal framework, determine if the causal framework provides a good explanation for the observations of events that actually occurred, the mechanisms that led to the events, and the context which created these events. Differences between what was observed and what was predicted by the a priori causal framework are represented in a new causal framework (there is one causal framework created for each case examined). The difference between the outcomes that were expected and the outcomes that transpired is useful in showing the differences between what is believed and what the nature of the mechanism actually is (Wynn and Williams, 2012).

3) Through a process of retrodiction, the individual causal frameworks created for each case, are merged to explain differences and to create a single combined framework which is used to determine the most viable explanation of the mechanisms, how they are activated (or not), and what impact the mechanisms have.

These steps are further elaborated below.

2.1 Causal framework

As an example of how retroduction and retrodiction can be used by an IS researcher, the proposed critical realist research process is now described in more detail. Further details behind the research used as an example can be seen in McAvoy and Butler (2009). In that paper, the research is presented as philosophy neutral: an ontology or epistemology is not formally presented. What is now described is how the critical realist philosophy was used from both an ontological and epistemological viewpoint. The goal of the research was to examine potential failures in an Agile adoption. More detail is available in the original paper but, in summary, a successful Agile adoption was equated with double loop learning: for an Agile adoption to succeed requires double loop learning from the Agile team and management. Double loop learning would be observable as events: events that should have occurred if the underlying mechanism was activated. In order to achieve this objective, it is necessary to determine the underlying factors which can lead to ineffective learning in an Agile context. An example of a research question which the a priori causal framework could represent would be "how can the context

in which Agile software development operates negatively impact on the double loop learning required in a successful Agile adoption."

Figure 1 below is representation of a framework to enable the IS critical realist researcher to present their ontological "beliefs" – the real domain. The most appropriate name for such a framework is a 'causal framework'. This represents a summation of existing research and theory which have formed the real and actual domain of the research. The example mechanisms in Figure 1 are from McAvoy and Butler (2009). It is created by the traditional literature review phase of research which examines a priori theories and is presented as an a priori causal framework. The framework aligns with, what Zachariadis (2013) describes as, a strong emphasis on ontology, by depicting the intransitive domain initially in the a priori framework. This is the output of step 1 of the process.

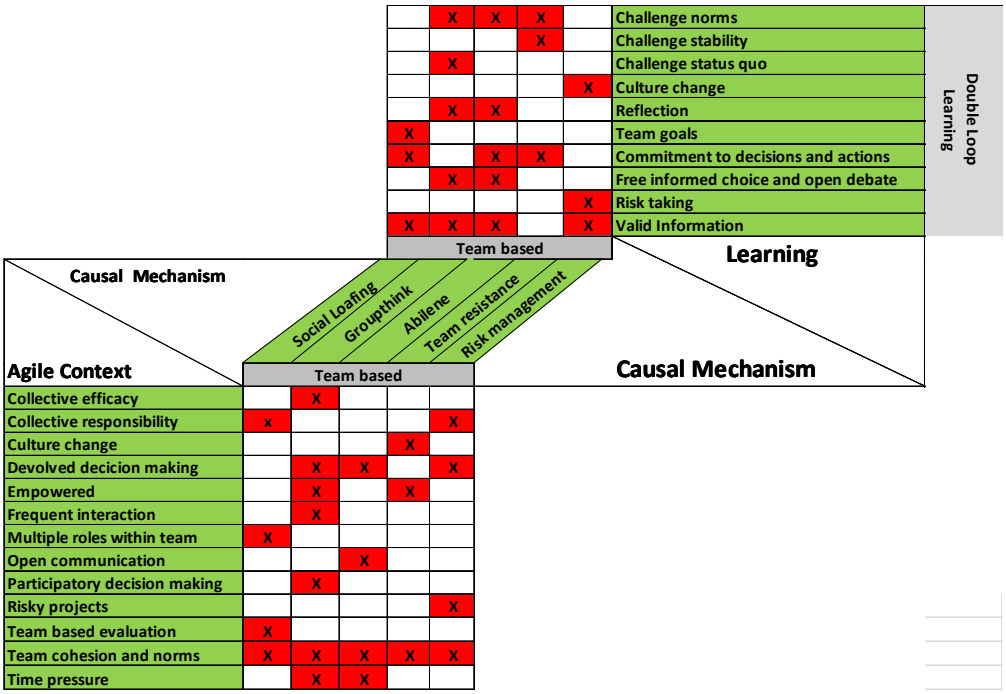


Figure 1. An a priori causal framework

This a priori causal framework proposes that the context in which Agile software operates in can give rise to causal mechanisms which in turn can negatively impact on the double loop learning required in a successful Agile adoption. It represents both the real domain, which is shown as the proposed causal mechanisms (i.e. social loafing), and the actual domain, what context can create these causal mechanisms and the impact they can have. The intersection of the agile context and the causal mechanisms, and the causal mechanisms and double loop learning are represented by a blank cell or a red cell with an 'X'. An X represents a theoretically based proposed activation: for example, 'collective responsibility' is one of the contexts which is proposed as activating the 'social loafing' causal mechanism. A blank cell represents the lack of existing theory suggesting a connection between the two intersecting elements. To follow the 'flow' through the causal framework from a critical realist perspective, an example would be:

- 'Collective responsibility' is a core element of the Agile context.
- Existing theory suggests that this (working together with 'multiple roles within team', 'team based evaluation', and 'team cohesion and norms') can give rise to 'social loafing'.
- 'Social loafing' is a causal mechanism which may negatively impact on double loop learning (specifically 'team goals', 'commitment to decisions', and 'valid information'). These elements of double loop learning are the events which can be observed (if the relevant mechanisms activate as predicted).

While figure 1 shows the ontological alignment with the research question, it is necessary to determine an epistemological fit. The framework is specifically a priori and requires research to validate if it is an accurate representation of the empirical domain. Whether theory is used a priori, after the event is observed, or not at all, once a potential mechanism has been identified the next step used by writers on critical realism (cf. Wynn and Williams, 2012, Williams and Karahanna, 2013, Bygstad, 2010) and the approach used in this paper is to use empirical evidence to corroborate the mechanisms.

From a critical realist perspective, and from the perspective of the research objective of the example of research herein, case studies offer two main benefits. Case studies are a suitable method for researching causal processes (Hammersley et al., 2000, Wynn and Williams, 2012), and critical realist research aims at uncovering the underlying structures and mechanisms at play in a context. In addition, while exploratory case studies are the norm, explanatory case studies are also used. In such case studies, events are described and theories are presented to explain the event (Benbasat et al., 1987). There is a concern with the alignment between case studies and critical research. Researchers in case studies have less a priori knowledge of the variables of interest (Benbasat et al., 1987), and a priori specification of constructs is uncommon in case studies (Eisenhardt, 1989). This would appear to be problematic as the research herein presents an a priori causal framework developed before case studies would begin. Actually, this is not a concern, as the "rule" concerning a priori knowledge and construct specification is not a hard rule. Benbasat et al. (1987, p.370) acknowledges that researchers can have a "*prior notion of certain critical variables*", while Eisenhardt (1989) accepts that it can be beneficial. In fact, Yin (2003, p.13), one of the major proponents of case studies, argues that a case study "*benefits from the prior development of theoretical propositions to guide data collection and analysis*."

In the critical realist perspective, the output from case studies makes up the empirical domain, where observations from the case studies are used to determine the adequacy of the proposed alignment between the Agile context, the causal mechanisms, and learning (the context, the real domain, and the actual domain). The results from the empirical domain, through retroduction, are therefore used to confirm or modify the real and actual domains represented in the a priori causal framework (figure 1). An example causal framework for one of the cases examined in (McAvoy and Butler, 2009) in shown below in figure 2. This is the output of step 2 of the process. (It should be noted that there will be a causal framework created for each case in a multi-case study.

Figure 2 is minimalised for the purpose of this paper (parsimony with page count) with only the relevant elements displayed. The symbols in the causal framework are used to show how the a priori framework has changed. The X in the a priori framework (figure 1) represented an expected connection/activation. Its meaning remains the same here but some cells have an additional O. An X still represents a predicted finding but if there is an X+O it means that it was eXpected and Observed. An X on its own represents something that was predicted as relevant but was not observed as impacting. In the example below, a priori theory predicted that groupthink would negatively impact on interdependence and trust within the team, but there were no observations of problems with this in the team. Therefore an X on its own represents a divergence from existing theory (while still acknowledging that the mechanism may simply have not activated). A new symbol is also added – an 'O' on its own represent something that had been predicted as occurring/impacting but it was observed in a manner

that did not confirm the prediction. For example, 'time pressure' was predicted in the a priori framework as a context that could lead to the activation of the 'groupthink' mechanism. While time pressure was observed as occurring in the case, it did not impact on groupthink as a priori theory suggested it would. There is a further symbol which is an 'O' but coloured green to differentiate it from the 'O' in striped red. It does not appear in figure 2 as it is not part of this minimised version of the much larger full causal framework, but it can be seen in figure 3 where all the causal frameworks from the individual case studies are combined. Both 'O's represent an observation that was different than expected. The striped red 'O' represents an activation of a mechanism (either cause or effect) which had been predicted but was observed as not being consistent with the prediction. For example, frequent interaction was predicted as being part of the activation of groupthink; this was based on existing theory. It was observed that team members who worked remotely and who interacted less with the team still succumbed to groupthink. An 'O' in green represents an observation that there is a new factor that was not predicted as relevant by existing theory. An example of this is where existing theory suggested that an empowering leadership style was expected to have a positive impact on the team's commitment to decisions. As the causal framework represents mechanisms that inhibit learning, it was not included in the a priori causal framework. Through observations, in one case study, it was found that team believed that empowerment should mean that they had full control over decisions. While the manager did empower the team, he did occasionally have to overrule some of their decisions. This led to the team second-guessing what their manager would have wanted when they made decisions, and they therefore were not fully committed to their decisions. This observation necessitated an addition to the a priori causal framework to show a new impact of a mechanism and a new activation of the mechanism.

	X+O	Challenge norms	Double Loop Learning
	X+O	Challenge status quo	
	X+O	Reflection	
	X+O	Free informed choice and open debate	
	X	Interdependence and trust	
	X+O	Valid Information	
Causal Mechanism / Agile Context	Groupthink	Learning / Causal Mechanism	
Collective efficacy	X+O		
Devolved decision making	X+O		
Empowered	X+O		
Frequent interaction	O		
Participatory Decision Making	X+O		
Team cohesion and norms	X+O		
Time pressure	O		

Figure 2. A causal framework from one case study

The symbols, as can be seen are also colour coded. This is to present an immediate visualisation of the differences between the theory-based predicted mechanisms (their impact and contributing contexts) and what was observed. The red cells (X+O) show the researcher the areas of existing theory that were confirmed. For the researcher, these are not the most interesting areas. The most interesting areas are in white (X), which show where the predicted elements did not occur/impact, and striped red or green (O), which shows where what was predicted occurred but not as expected. These are the areas that require further examination by the researcher to explain the mechanisms, and are further examined through retrodiction.

2.2 Retrodiction in multiple case studies

The individual case studies in this multi-case research project used the critical realist process of retroduction to create a new framework that represent each individual case's empirical domain. The goal of each individual case study is, as Mingers (2004a) argues, to discover the interacting mechanisms and structures which generate a phenomenon. The a priori framework can then be updated for the case study to show if the causal mechanisms activated, what activated the causal mechanisms, and what the causal mechanisms impacted on. An important element of the critical realist philosophy has a bearing at this point, when the individual case studies observations are complete and a causal framework created for each one. The critical realist philosophy argues the causal mechanisms occurrence or absence is not a finding on its own. This goes back to the argument of Lawson (1998) that the demi-reg nature of mechanisms implies that their absence does not imply that they will always be absent. Similarly, the occurrence of a causal mechanism and its impact in a single case study cannot be taken to imply causality (in the positivist interpretation of causality). This furthers the argument for the use of multiple case studies which, although they can never provide definitive generalizable proof, they can increase the 'likelihood' of a finding. A section of the combined framework of the individual case studies is presented below in figure 3. The benefit of the juxtaposition of the individual case studies is that the differences between cases become clear.

Retroduction is used to build the frameworks representing the empirical domain for each case study; now retrodiction is used as part of the cross-case analysis. The aim is to explain differences between the case studies and to determine what differences in the contexts are causing the differences (if any) between the case studies. Contexts and causal mechanisms can now be determined as impacting or not impacting and new contexts included to explain differences between the findings (empirical domain) of the case studies.

The final framework is presented below and is based on both retroduction and retrodiction of the individual case studies and their combination to show commonalities and differences. Figure 3 is a minimalised version of the full cross case analysis framework, created through retroduction and retrodiction.

It is minimalised for the purpose of this paper (parsimony with page count) but the researcher also minimises it to remove data no longer relevant (removing impacts on and of causal mechanisms that were predicted as not occurring and were observed as not occuring). The main benefit to this combination of the causal frameworks from the individual causal frameworks is that differences become clear and highlight the need for further examination and explanation. The word 'differences' must be used carefully as it must be accepted that differences can occur simply because a mechanism did not activate in some cases (or none).

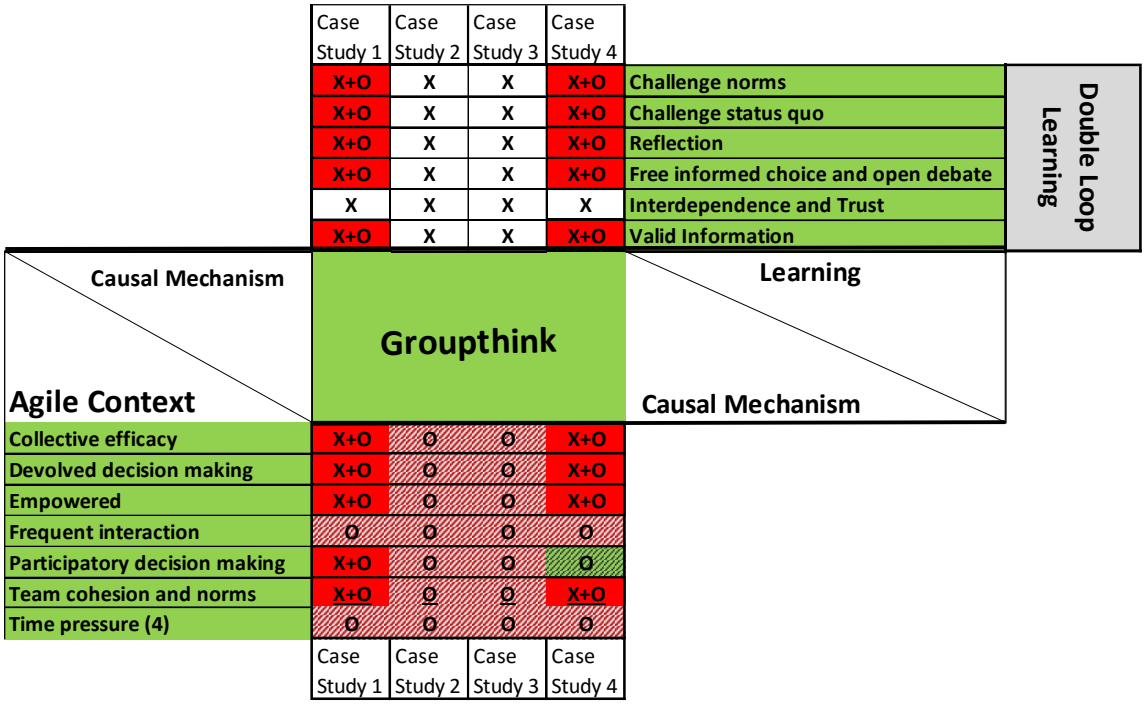


Figure 3. Cross case analysis using a causal framework

The example in figure 3 shows the benefit that retrodiction can bring to a multi-case critical realist study. In the figure, only one mechanism is shown and it is minimised to only show the contexts and impacts (double loop learning) that were predicted or found to be relevant. The most obvious contexts that stand out in the visualisation are frequent interaction and time pressure: in all four case studies, both were observed as present. Using time pressure as an example, in the observations there was considerable time pressure on the team and this was confirmed through observations, an examination of the project gannt charts, and interviews with senior management in the company who acknowledged that the time pressure on the teams studied was greater than in other teams. Despite this time pressure, there was no observable impact on groupthink in any of the case studies. While accepting the possibility that the impact on the groupthink mechanism may occur if future cases were studied, further examination showed that for Agile teams, the impact of time pressure is minimised by Agile processes which explains why an Agile team is different than teams described in the groupthink literature. It is the visual impact of seeing the lack of impact across all four cases that ensures that the researcher must delve further into the groupthink mechanism to determine why there are differences with existing theory and to explain these differences.

Similarly, participatory decision making stands out visually as a context as two cases observed it but found it impacting differently than predicted (striped red 'O'), one case found that it impacted on groupthink as predicted by existing theory (red 'X+O'), while another case found a new impact that was not predicted by existing theory (green 'O'). It was therefore necessary to delve further into the context, its theoretical description, and predicted impact. By examining participatory decision making in all four cases it was found that there were subtle differences between the cases. In the Agile literature, participatory decision making describes where the manager takes part in decision making as one of the team rather than enforcing their view. Based on the subtle difference between the cases, it was found that 'devolved decision process' was a better description of the impacting context. The difference between the two is that participatory decision making implies that the manager will always be part of

the decision making process. It was found that the managers in the four cases were actually involved in the decision making process to differing degrees. Devolved decision making process is therefore a better description which was seen to have an impact on groupthink and also takes into account the differing levels of management participation.

3 Conclusion

Wynn and Williams (2008) present the principles of critical realist research and Bygstad et al. (2016) build on this by describing a process or framework which can be used to conduct critical realist research. These authors are to be commended for their work as it is ground breaking in the Information Systems field. There are situations, though, where their recommendations may not be fully realised and two specific situations are described: where the non-activation or alternative activation of a mechanism makes observation needed for retroduction difficult; and where the research process dictates a more formal structured approach. In both the scenarios the use of a priori theory as part of the retroduction process can be beneficial. The existing theory can be represented in an artefact called a causal framework which can guide and assist the researcher.

Retrodiction is a term rarely used by critical realist researchers (being usually described as part of retroduction or not described at all). By differentiating retrodiction from retroduction, a further benefit for critical realist researchers can be actualised. The retroduction process allows the researcher to identify mechanisms, what activates them, and their impact. Retrodiction allows the researcher to combine the retroduction from individual cases into a multi-case explantion of the mechanisms. The visual impact of the cross-case causal framework directs the researcher to areas that need further explanation or refinement. This new process for critical realist research is show below in figure 4.

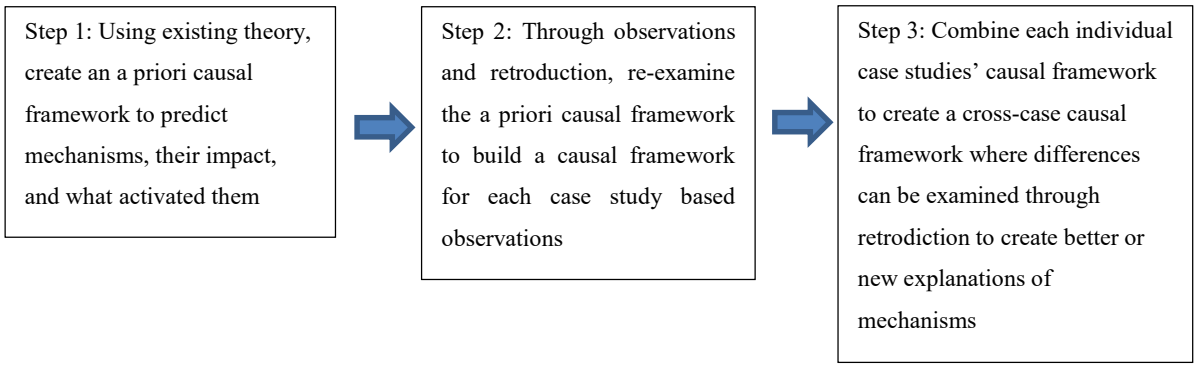


Figure 4. A critical realist research process

This use of causal framework artefacts, with both retroduction and retrodiction, provides the researcher with a further process to assist critical realist researchers.

References

AALTONEN, A. & TEMPINI, N. 2014. Everything counts in large amounts: a critical realist case study on data-based production. *Journal of Information Technology,* 29**,** 97-110.

ARCHER, M. 1998. Realism in the social sciences. *In:* ARCHER, M., BHASKAR, R., COLLIER, A., LAWSON, T. & NORRIE, A. (eds.) *Critical realism: Essential readings.* London, UK: Routeledge.

BENBASAT, I., GOLDSTEIN, D. & MEAD, M. 1987. The case research strategy in studies of Information Systems. *MIS Quarterly,* 11**,** 369-386.

BERTILSSON, T. 2004. The elementary forms of pragmatism: On different types of abduction. *European Journal of Social Theory,* 7**,** 371-389.

BHASKAR, R. 1978. *A realist theory of science,* Hassocks, UK, Harvester Press Limited.

BHASKAR, R. 1998. Philosophy and scientific realism. *In:* ARCHER, M., BHASKAR, R., COLLIER, A., LAWSON, T. & NORRIE, A. (eds.) *Critical realism: Essential readings.* London, UK: Routeledge.

BYGSTAD, B. 2010. Generative mechanisms for innovation in information infrastructures. *Information and Organisation,* 20**,** 156-168.

BYGSTAD, B., MUNKVOID, B. & VOLKOFF, O. 2016. Identifying generative mechanisms through affordances: a framework for critical realist data analysis. *Journal of Information Technology,* 31**,** 83-96.

BYRNE, D. 2004. Complex and contingent causation - the implications of complex realism for quantitative modelling. *In:* CARTER, B. & NEW, C. (eds.) *Making realism work: Realist social theory and emperical research.* London, UK: Routledge.

CARLSSON, S. 2003. Advancing information systems evaluation (research): A critical realist approach. *Electronic Journal of Information Systems Evaluation,* 6**,** 11-20.

CARLSSON, S. 2009. Critical realism. *In:* DWIVEDI, Y., LAL, B., WILLIAMS, M., SCHNEBERGER, S. & WADE, M. (eds.) *Handbook of Research on Contemporary Theoretical Models in Information Systems.* PA, USA: IGI Global.

DANERMARK, B., EKSTROM, M., JAKOBSEN, L. & KARLSSON, J. 2002. *Explaining society: Critical realsim in the social sciences,* Abingdon, UK, Routledge.

DE VAUJANY, F. 2008. Capturing reflexivity modes in IS: A critical realist approach. *Information and Organisation,* 18**,** 51-72.

DOBSON, P. 2001. The philosophy of critical realism - An opportunity for information systems research. *Information Systems Frontiers,* 3**,** 199-210.

DOBSON, P. & LOVE, P. 2004. Realist and postmodernist perspectives on Information Systems research: Points of connection. *Australasian Journal of Information Systems,* 12**,** 94-102.

EASTON, G. 2010. Critical realism in case study research. *Industrial Marketing Management,* 39**,** 118-128.

EISENHARDT, K. 1989. Building theory from case study research. *Academy of Management Review,* 14**,** 532-550.

ELDER-VASS, D. 2007. Social structure and social relations. *Journal for the Theory of Social Behaviour,* 37**,** 463-477.

GHARAVI, H., MADY, T. & DWIVEDI, Y. A critical realist perspective on the adoption of internet technologies in the travel sector. *In:* ÖSTERLE, H., SCHELP, J. & WINTER, R., eds. Fifteenth European Conference on Information Systems, 2007 St. Gallen, Switzerland. 2295-2306.

HAMMERSLEY, M., GOMM, R. & FOSTER, P. 2000. Case study and theory. *In:* GOMM, R., HAMMERSLEY, M. & FOSTER, P. (eds.) *Case study method.* Surrey, UK: Sage.

HARTWIG, M. 2007. *Dictionary of Critical Realism,* NY, USA, Routledge.

HENFRIDSSON, O. & BYGSTAD, B. 2013. The generative methods of digital infrastructure methods. *MIS Quarterly,* 37**,** 907-931.

LAWSON, T. 1998. Economic science without experimentation. *In:* ARCHER, M., BHASKAR, R., COLLIER, A., LAWSON, T. & NORRIE, A. (eds.) *Critical realism: Essential readings.* London, UK: Routeledge.

LAWSON, T. 2009. Applied economics, contrast explanation and assymetric information. *Cambridge Journal of Economics,* 33**,** 405-419.

LONGSHORE-SMITH, M. 2006. Overcoming theory-practice inconsistencies: Critical realism and information systems research. *Information and Organization,* 16**,** 191-211.

MANICAS, P. 2006. *A realist philosophy of social science,* Cambridge, UK, Cambridge University Press.

MCAVOY, J. & BUTLER, T. 2009. The role of project management in ineffective decision making within Agile software development projects. *European Journal of Information Systems,* 18**,** 372-383.

MINGERS, J. 2000. The contribution of critical realism as an underpinning philosophy for OR/MS and systems. *The Journal of the Operational Research Society,* 51**,** 1256-1270.

MINGERS, J. 2004a. Re-establishing the real: Critical realism and information systems. *In:* MINGERS, J. & WILLCOCKS, L. (eds.) *Social theory and philosophy for information systems.* Chichester, UK: Wiley & Sons.

MINGERS, J. 2004b. Real-izing information systems: critical realism as an underpinning philosophy for information systems *Information and Organization,* 14**,** 87-103.

MORTON, P. 2006. Using critical realism to explain strategic information systems planning. *Journal of Information Technology Theory and Application,* 8**,** 1-20.

OLSEN, W. 2004. Methodological triangulation and realist research: An Indian exemplar. *In:* CARTER, B. & NEW, C. (eds.) *Making realism work: Realist social theory and empirical research.* Abingdon, UK: Routledge.

OUTHWAITE, W. 1983. Towards a realist perspective. *In:* MORGAN, G. (ed.) *Beyond method: Strategies for social research.* CA, USA: Sage.

ROBSON, C. 2002. *Real world research: A resource for social scientists and practitioner-researchers. Second Edition,* Oxford, UK, Blackwell Publishers.

SAYER, A. 1992. *Method in social science: a realist approach* London, UK, Routledge.

TSANG, E. 2015. Case studies and generalization in information systems research: A critical realist perspective. *Journal of Strategic Information Systems,* 23**,** 174-186.

VOLKOFF, O. & STRONG, D. 2013. Critical realism and Affordances: Theorizing IT-associated organizational change processes. *MIS Quarterly,* 37**,** 819-834.

VOLKOFF, O., STRONG, D. & ELMES, M. 2007. Technological embeddedness and organizational change. *Organization Science,* 18**,** 832-848.

WILLIAMS, C. & KARAHANNA, E. 2013. Causal explanation in the coordinating process: A critical realist case study of federated IT governance structures. *MIS Quarterly,* 37**,** 933-964.

WYNN, D. & WILLIAMS, C. 2008. Critical realm-based explanatory case study research in Information Systems. *29th International Conference on Information Systems (ICIS 2008)* Paris, France: Associatioin for Information Systems.

WYNN, D. & WILLIAMS, C. 2012. Principles for conducting critical realist case study research in information systems. *MIS Quarterly,* 36**,** 787-810.

YEUNG, H. 1997. Critical realsim and realist research in human geography. *Progress in Human Geography,* 21**,** 51-74.

YIN, R. 2003. *Case Study Research: Design and Method,* CA, USA, Sage Publications.

ZACHARIADIS, M. 2013. Methodological implications of critical realism for mixed-methods research. *MIS Quarterly,* 37**,** 855-879.