

Complementarily Applying Activity Theory Concepts for Data Analysis in Research

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Abstract: This paper aimed to propose a complementary approach for applying the activity theory's (AT) concepts of contradiction, activity hierarchy, and activity systems model for data analysis in research. The approach is a two-step process that must be applied in parallel. The first part of the approach entails three levels consisting of micro, meso, and macro, which are apprehensive of social reality, in data analysis. For this purpose, the document (collection and selection) analysis technique was followed. This complementary-based approach brings a fresh perspective to the application of AT. The paper contributes to the reflection and discussion on applying activity theory's concepts. Additionally, the study helps to gain a better understanding of socially constructed reality in studying complex phenomena.

Keywords: Activity Theory, Activity System, Activity Hierarchy, Complementary Approach, Contradiction.

1. Introduction

Activity theory (AT) is a sociotechnical theory that focuses on human activities and how social contexts influence them (Dennehy et al, 2023). The theory is primarily concerned with human consciousness, making human reasoning a critical aspect of social context and activities (Hashim & Jones, 2007). Given its interconnectedness with human activities and actions, the theory is consistently and increasingly applied in various fields such as education, management, and information systems (IS) (Kamanga & Alexander, 2020; Nonthecumjane & Johansson, 2022). According to Iyamu (2024), AT has been used more than three million times across disciplines. Dennehy et al (2023) list some of the benefits of using AT as a lens for understanding the context in which words are used, focusing on an activity system. Nonthacumjane and Johansson (2023) argued that AT has been employed to understand the interaction between humans and technology. It is important to note that AT can be used in both qualitative and quantitative studies, particularly because it offers a holistic, contextual approach.

From a qualitative and interpretative research standpoint, Hashim and Jones (2007) argued that the theory provides a holistic and contextual way for researchers. In its holistic approach, AT is used as a lens for both data analysis and interpretation of findings (Murphy & Rodriguez-Manzanares, 2008). Additionally, AT draws its strengths from historical and cultural contexts, which envelop how activities and objectives are rapidly changing (Weeger et al, 2021). Increasingly, the theory is used as a lens in the research domain (Iyamu, 2024). An activity is a collection of actions that are performed by human beings from both historical and cultural contexts. The theory consists of concepts such as the activity model, hierarchical structure, and contradictions (Engeström et al, 2024; Jones, 2014). In Iyamu's (2024) empirical submission that the theory has been applied in over 3 million studies, it is the activity model that is most applied. The hierarchical structure is growing in popularity. The concept of contradictions is scant in its use.

From the activity model perspective, Nyikana and Iyamu (2024) explained how objects utilise tools to achieve a specified outcome. Kamanga and Alexander (2020) suggested how activities can be assessed at three levels, activity, actions and operations by applying the activity hierarchy concept. The activity model consists of six interrelated components: subject, object, tools, rules, community and division of labour (I). The activity hierarchy is embedded with three hierarchical levels: activity and motive (level 1), action and goal (level 2), and operation and conditions (level 3) (Leont'ev, 1981). The concepts, such as the activity model and the activity hierarchy, are used as lenses to guide data analysis and interpretation of findings in research. In applying either, the activity model or the hierarchical structure, there are contradictions, which this study explores.

Generally, the term contradiction has a negative connotation, which often creates disadvantage in social structures and systems. In many quarters, contradictions refer to tensions, inconsistencies, which manifest themselves as problems, gaps or conflicts (Weeger et al, 2021). In contrast, in AT,

contradiction indicates and embraces the richness of data, flexibility, as well as the capability of an activity to develop in a network of human activity systems. (Karanasios et al, 2017). In AT, four contradictions have been identified and discussed in the literature, which include primary, secondary, tertiary, and quaternary contradictions (Gedera & Williams, 2013). Engeström (1987) proposes the contradictions as: primary contradiction happens within a single element of the activity; secondary contradiction happens between two elements of a single activity system; tertiary contradiction happens between older and newer versions of activities; and the quaternary contradiction happens between activities that are related in a network. |

From a more optimistic angle, Kamaga and Alexander (2022) suggest that it helps to identify contradictions that may occur to inspire change and ultimately develop theories that explain and encourage changes over time. Despite the numerous works that have been done to increase researchers' interest in how to apply the concept of contradiction, challenges persist, which can be attributed to various factors, such as a lack of understanding and confusion. Consequently, the activity model remains the commonly used concept. This limits the advancement of applying the theory in research. We therefore explored how richness, flexibility, and capability can be embedded into the concept of contradiction to advance the use of AT for data analysis and interpretation of findings in research. The study is intended to improve the ease of understanding and applying the concept of contradictions of AT in research. However, the concepts seem to be applied, either in learning or research. This study provides details about the concepts, starting from a review of the literature. |

2. Literature Review

The concepts, such as the activity model and activity hierarchy, are increasingly applied in research but separately. This study focuses on the complementary application of the three concepts, activity hierarchy, activity model and contradiction.

2.1 Activity Hierarchy

The activity hierarchy was developed in a quest to understand the motivation and the consciousness structure (Hashim & Jones, 2007). According to Camargo-Henríquez and Silva (2022), the hierarchy has three levels and two columns as shown in Figure 1: activity, actions and operations, motive, goal, and condition.

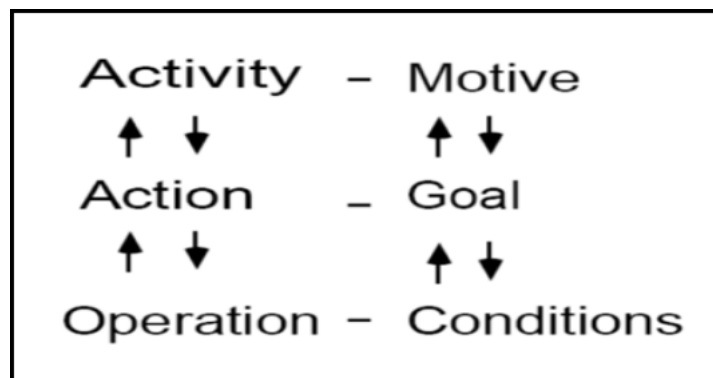


Figure 1: Hierarchical levels of an activity (Leont'ev, 1981)

The activity hierarchy comprises three core levels, namely activity, action and operation (Camargo-Henríquez & Silva, 2022). The collective hierarchical system should have a motive (Kamanga & Alexander, 2021). An activity consists of different actions, and each action determines the operation (Iyamu, 2024). Russell (1997) lists the following (i) an activity system is linked to a motive, and a collective subject (ii) Actions are linked to a specific goal and to individuals or groups, and (iii) operations are linked by conditions, constraints and affordances, also linked to individuals or groups.

2.2 Activity System

The activity system model consists of six components, as shown in Figure 2, namely, tools, subject, rules, community, division of labour, and object (Hashim & Jones, 2007). In AT, the subject is a human with consciousness (Engeström & Sannino, 2021). The subject and object are mediated by tools (Kuutti, 1995; Karanasios et al, 2021). This means that by indication, the human actions are mediated by tools (Nonthacumjane & Johansson, 2023). Gedera and Williams (2013) emphasised that an activity must be

understood in the context of cultural and historical environments. This means that within the context of a community, rules apply. Thus, Dai et al (2024) suggest that community, rules and division of labour are referred to as social components. It has been emphasised that human activity cannot be merely explained through the mediations but should rather include all the elements of the activity system (Karanasios et al, 2021). Thus, an activity system can be described as a social structure that focuses on collectivism, where tools, rules, and division of labour mediate.

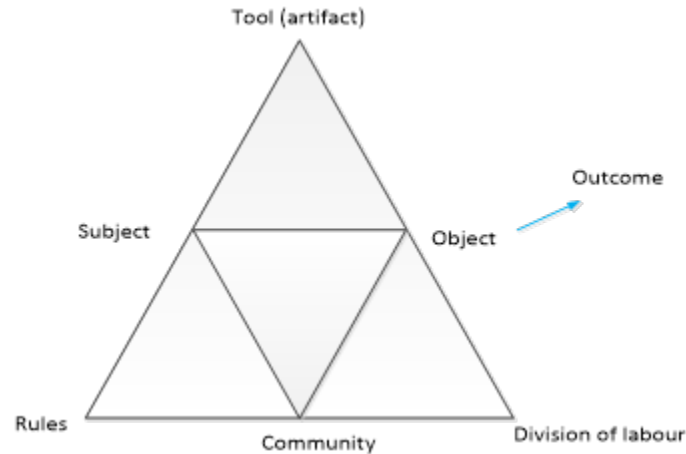


Figure 2: Activity Model (Engeström, 1999)

The AT model focuses on the structure of the activity system with six components, as shown in Figure 2. The object defines what the activity is and determines the meaning of the preceding actions. The subject is the individual performing the actions. Tools can form part of either actions or operations. The following components provide the social context of the activity system. Which is made up of the rules shapes the operation as it specifies what is allowed or not. The community are groups or people working towards a common motive. The division of labour determines who is doing what and how the tasks are distributed amongst the community.

2.3 The Concept of Contradictions in Activity Theory

The concept of contradiction has been used multiple times in research, across different fields (Karanasios et al, 2017), including the fields of information systems, management sciences, and education (Keegan et al., 2022; Qu et al, 2022; Mwogosi & Mambile, 2024). Contradictions are deeply embedded structural tensions that occur within a system from an AT perspective (Dennehy et al, 2023). Contradictions are a basic principle of AT that manifest themselves as problems, conflict or tensions in an activity system (Gedera & Williams; Weeger et al, 2021). According to Satijadi et al. (2024), contradictions can occur at any stage of an activity system. Additionally, the contradictions are consistently evolving and transforming (Keegan et al., 2024). Qi et al. (2022) state that contradictions are not always a bad thing. Through the identification process, it creates an opportunity to find solutions (Engström et al, 2024).

Thus, contradictions could assist in development, innovations and change of the activity system (Aldaremi, 2022). It is important to note that contradictions may not be obvious, and it could be culturally and politically challenging to approach (Keegan et al, 2024). There are four levels of contradictions: (i) primary, (ii) secondary, (iii) tertiary, and (iv) quaternary (Engeström, 1987). Primary contradictions occur with a component of the activity system (Qi et al, 2022). Secondary contradiction happens between different components of the activity system (Gedera et al., 2023). Tertiary contradiction is described as the tension within an activity system (Keegan et al, 2024). Quaternary contradictions occur between different activities (Nonthacumjane & Johansson, 2023).

A study by Aderemi (2022) reported poor and inaccurate interpretation of certain terminology and elementary concepts when using the concept of contradiction. Similarly, Karanasios et al (2017) noted that there was no clear meaning of terms in the literature on contradictions. Keegan et al (2014) explained that contradictions are not consistently visible or discussed openly and therefore, may not always be resolved. In addition to the argument in the literature, Adamide (2023) states that the application of the concepts could be limited, and researchers may only uncover surface-level contradictions or merely identify the problems that exist in an activity system. It maybe that researchers need to identify the activity, understand the components of AT and identify and explain the levels of contradictions. It could be because the process of data analysis is iterative

and multi-layered. The concept of contradiction could serve as a conceptual tool, not restricted to identifying and analysing, but also to explaining the different theoretical roots (Weeger et al, 2021). Adamides (2023) explained that using AT and the concept of contradiction is methodologically complex and may require an expert to apply correctly in the real world. It could also suggest a need for a guide to apply the AT model with contradictions.

3. Research Approach

Qualitative document analysis is a systematic procedure used to review or evaluate documents it could either printed or electronic (Morgan, 2021). This is an analytic approach which seeks to study, examine and interpret documents to create meaning and produce knowledge (Okoko, Tunison & Walker 2023). This approach is important tools for deeper comprehensive analysis across different disciplines. According to Wood, Sebar and Vecchio (2020) explains the interpretive process is reflexive and recursive as researchers move between development of concepts, data collection, analysis of data and interpretation. The collection of peer-reviewed articles was guided by the aim of the study to complimentarily apply AT concepts for data analysis in research. Thus, articles that have used of applied contradictions were collected. Scholarly databases such as google scholar, Scopus, Springer. The following keywords were used to search for the articles; activity theory, activity system, activity hierarchy, activity model levels of contradictions. the key words were chosen in line with the aim of the study. The themes were created based on the different AT tenets such as the activity hierarchy, activity system model and the concept of contradictions. AT was also used a lens for both data analysis and interpretation of this study. Content analysis provides flexibility in the pursuit for meaning and understanding as opposed restrictive procedures and rigid parameters (Wood, Sebar & Vecchio 2020). The written documents are crucial in qualitative study because of low cost of access, it provide different perspectives from scholars, and provides historical context (Okoko, Tunison & Walker 2023).

4. Activity, Hierarchy, Model and the Four Contradictions

An activity is a collection of actions that are performed by human beings against objects utilising tools to achieve a specified outcome (Nyikana & Iyamu, 2024). According to Johanssen and Rohrer-Murphy (1999), activity needs to be consciously applied in a relevant context. The hierarchy describes how an activity (driven by motive) is composed of actions (driven by a goal), which are made up of operations (driven by condition) (Kuutti, 1996). The hierarchy is not rigid but is flexible. The activity hierarchy cuts across the activity model.

The activity model signifies an overall activity system which does not happen in isolation (Nyikana & Iyamu, 2024). Bawa (2023) explains that the AT model, identifiable by the triangular shape, which shows the interconnectedness of the components, helps to understand the overall activity system in a social and cultural context (Camargo-Henríquez & Silva, 2022). The level of contradictions is structural tensions within the activity system, which inspire change and innovation (Aldaremi, 2022). Therefore, the hierarchy relates to how things are done within the structure (Kamanga & Alexander, 2021). While the model illustrates the systematic context in which the hierarchy operates. The contradictions are the tensions that could occur within the model, which disturb the correct performance of the hierarchy.

Table 1: Complementary use table

Levels of Contradictions	Complementarity	Activity Model Components
Primary contradictions	Primary contradictions which could occur within components of the activity system (Gedera & Williams, 2014; Hasan & Kazlauskas, 2014). For example, primary contradiction can occur within an object, a tool, a subject, rules, a community or division of labour (Qi et al, 2022).	Can occur within any of the AT components, such as tools, subject, object, rules, community and division of labour Contradictions on this level occur in one component. For example, within a tool, inefficiencies in the use of the tool may occur
Secondary contradictions	According to Gedera et al (2023), secondary contradictions happen between components of the activity system. For example, secondary contradictions could occur between a technology(tool) and the organisation's rules (Kelly, 2017).	Secondary contradictions occur between activity components (Kamanga & Alexander, 2021). Examples: Between subject and tools; Between subject and rules; Between tools and object; Between object and rules; Between community and division of labour; Between rules and division of labour; and between community and object

Levels of Contradictions	Complementarity	Activity Model Components
Tertiary contradictions	These contradictions are potential problems resulting from the relationship between an existing system and an evolved object or system (Keegan et al, 2024). For example, in a study by Geder et al (2023), tertiary contradiction took place when the participants had to use an advanced technology to achieve their objective.	Tertiary contradictions occur within the same activity. Occurs between the new and old as a way of reform and the resistance of change (Nonthacumjane & Johansson, 2023). For example: Subject vs new rules; Object vs tools; Old tool and new tool; Community vs division of labour; and Division of labour vs object
Quaternary contradiction	Quaternary contradictions occur between the related activities in an activity system (Nonthacumjane & Johansson, 2022; Qi et al, 2022).	Happens between activity systems. This could be between the interconnected activity systems. Indicates that it occurs between the central activity system and the neighbouring activity systems (Qi et al, 2022).

5. Complementarily Applying the at Concepts for Data Analysis

This paper proposes that the activity model, activity hierarchy, and contradiction can be complementarily applied in the analysis of data in research, in fields such as information systems and business sciences, including education. Figure 3 illustrates the relationship between the hierarchy, the activity model and the contradictions. Complementarily, the concepts can be applied at three levels, micro, meso, and macro, as shown in the model (Figure 3). The levels are indicated using colours: black, blue, and green for micro, meso, and macro, respectively.

An activity does not occur in isolation, but there may be multiple interactions between the system and the existing hierarchy (Shaanika & Iyamu, 2025; Mwogosi & Mambile, 2024). Various interactions influence and shape activity within context and relevance (Adamides, 2022). Engeström & Sannino (2011) clarify that organisational changes follow a sequence of events. This allows for data analysis (Houssin, 2025). These are consistent with our proposed approach that entails a two-step process. The two-step (Figure 3 and Table 2) must be applied in parallel.

5.1 Step #1

The first level, the *micro*, focuses on individual interconnectedness and interactions mediated by tools, rules, and division of labour associated with a community and an object to determine an outcome. It therefore enables the analysis of the nuances which exist in interactions, to examine how actors perceive and assume reality and respond. The *meso* is the intermediate level. It bridges the micro and macro levels in an analysis. At this level, it demonstrates how social structures influence interactions between actors' activity and motive, action and goal, and operation and conditions. This includes how social processes, such as norms, operate within communities. The *macro* level focuses on the "big picture". It is concerned with a community as a whole (large-scale), such as social systems or structures and institutional patterns. This is to gain an understanding of widespread disparity and social trends. From the complementarity, there are manifestations, labelled *MF* in Figure 3 (complementary model). The manifestations are discussed below.

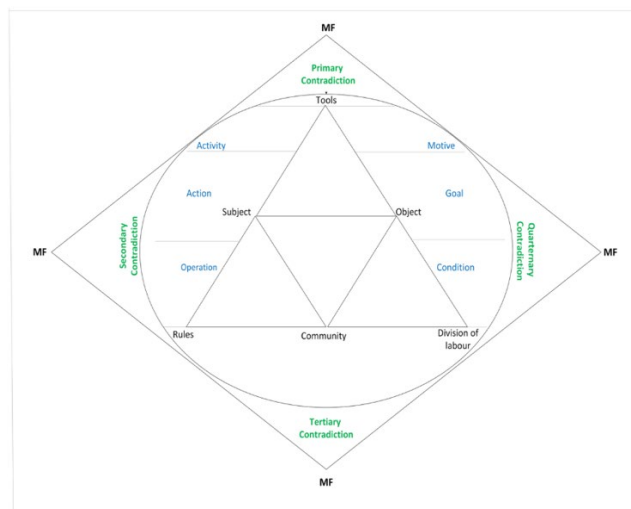


Figure 3: Complementarity-based Approach of AT Concepts

An activity occurs because there is a motive. In achieving the motive, tools, rules and division of labour are used to mediate towards an object, and subsequently, reach an outcome. In the midst, contradictions happen between the mediators, hierarchy (e.g. activity and action, motive and goal), or

The manifestations catalyse transformation. This is attributed to the movement in an activity or motive, the action or goal, and the conditions of operations. This is where a community is impacted by due to perceived differences (Russell, 1997). As the movement progresses, layers of contradiction emerge, reflecting the adaptation of the original activity to suit the objectives of the phenomenon being studied. Schön (1983) suggests that reflexivity enables practitioners to reflect on their actions (knowing-in-action) and view problems as matters of choice and decision (reflection-in-action) rather than as given situations. This can help in units of analysis in achieving research objectives. This is because it is a process that entails interplay between actors and processes, including technology solutions. Reflexivity is an integral aspect of the socially constructed reality, which assists in gaining practice-based insights (Armour, 2013).

Some of the challenges manifest from unspoken or unwritten influences of actors in an activity or motive, during action or goal. Communication challenges arise from an act of misunderstanding, delayed responses, or passiveness. In this instance, conflicting opinions are conveyed with hesitation between individuals or within a person's discourse (Houssin, 2025). Individuals who engage in an activity often encounter conflicting motives, influenced by the mediators, such as the ideals of the tools, rules interpretation, and biased interest in assigning tasks in the division of labour. This brings about reflexivity, which Archer (2010) defines as the capacity to introspect on thoughts and conversations. Consequently, this shapes actions towards a goal and enacts operations that are bound by conditions.

Table 2: Levels of analysis

Level of Analysis	Manifestation	Possible Contradiction	AT Hierarchy	Activity System Model	Examples
Micro	What are actions identifiable? What words are used? Do the actions or words enable or hinder the activity?	Primary or secondary	Operations Actions	Single components Subject or individual mediated actions	Is the tool functioning as intended?
Meso	As the six components interact what can be observed, are there any breakdown, disturbances, conflicts, or Deviations?	Primary Secondary, Tertiary	Actions Activity	Collective activity system	How a collective activity system functions or interests the actors
Macro	Is the object shared amongst the activities? Are the object conflicting?	Quaternary contradictions	Activity	Multiple activity system activities with shared object	When there are two neighbouring activity systems sharing an object

5.2 Step #2

Researchers could apply the elements of analysis. Iyamu (2024) argues that the elements of analysis are the foundation for coming up with answers during data analysis. Using what, who, when, why and where for assessing a system in qualitative research.

Table 3: Elements of analytics

Elements	Description
<i>What</i>	Clarifying the object, subject or tools used or applied in an activity within a context and relevance. This reduces or eradicates the structural tension which exists between actors, processes, and technological solutions involved in an activity such as the analysis of a phenomenon under study. The clarification entails that the situation cannot be resolved by an individual alone (Russell, 1997). Thus, determine whether any contradictions exist, and what contradictions exist within the activity system (Iyamu 2024).

Elements	Description
<i>Who</i>	Identify the actors that showing an interest and participating in an activity. This includes their roles, boundaries, and interactions. This removes any conflicting opinions conveyed with hesitation between individuals or within a person's discourse (Houssin, 2025). This helps to gain a better understanding of the level of the contradiction that exists (Iyamu, 2024).
<i>How</i>	In effect, determine the interconnectedness of the actors that are involved in the activity. Additionally, define the use of the mediators towards goals and operations, and how the contradictions happen (Iyamu, 2024). This includes the conditions of operandi associated with the goal and motive.
<i>When</i>	Defines the context or period where the activity takes place. Establish when the contradictions occur (Iyamu, 2024)
<i>Where</i>	The geographical location provides a boundary or scope identified and explained. Define time and space in identifying the components of an activity, such as tools, subject, rules, and community (Adamides, 2023).
<i>Why</i>	Assist in identifying factors (components) that enable and constrain an activity system. Thereafter, examine why the contradiction happened (Iyamu 2024). Actions rely on the operations, which are the routine process, and depend on the conditions within the activity system (Jonassen & Rohrer Murphy, 1999).

6. Implications

Comprehensive and logical flow assists the researcher in narrating what the data is saying without leaving out details that may be important to report on. This entails having a good understanding of the components of an activity (Iyamu & Shaanika, 2019).

Some of the gaps relating to AT contradictions is that contradictions are not consistently visible or discussed openly and therefore, may not always be resolved (Keegan et al., 2014). Thus, the application of the contradiction concept could be limited in uncovering surface-level contradiction or merely identify the problems that exist (Karanasios et al, 2017). Adamides (2023) explained that using AT and the concept of contradiction is methodologically complex and may require a expert to apply correctly in the real world. It could also suggest a need for a complementary use of the AT concepts. However, Weeger et al. (2021) suggested that contradictions could serve as a conceptual tool for explaining different theoretical roots. Hence, it is important to highlight the implications of the concept.

One of the implications from their study is that a collective activity system is highly vulnerable to conflict, as sub-orientated actions are explicitly or implicitly characterised by ambiguity, surprise, interpretation, making sense and potential for change. (Keegan et al, 2024). A study by Tan et al (2023) illustrates that the tensions and contradictions in a system may create opportunities for change, emphasising the importance of context as an influencer on how components interact with the system. This study offers a holistic detail that help with understanding of activity systems, contextualised interpretation of data, multiple levels of analyses of the activity hierarchy and the activity system, and the levels of contradictions.

7. Conclusion

Applying the complementary-based approach proposed in this paper for data analysis enables researchers to linearise the order of equations, deconstruct an activity, and overcome many of the uncertainties in socially constructed reality that research seeks to unpack.

The use of socio-technical theories to underpin studies brings fresh perspectives into information systems and information technology studies. When it comes to Activity Theory (AT), its six components are mostly applied as a lens rather than as a hierarchical structure. This is primarily because it is difficult to find studies that have applied the hierarchy structure mechanism of the AT guiding analysis. The AT hierarchy structure provides a sequential process for understanding activity systems. However, without a guide on how to apply the hierarchical structure, researchers will continue to be challenged, missing the wholeness that AT provides. This study developed a model on how to apply the activity hierarchy as a lens for data analysis. The model provides a step-by-step guide that can be employed by researchers to understand information systems activities. Fortunately, the model is not tested, thus it remains a theoretical contribution.

However, our analysis carries typical limitations of an exploratory study. The model has not been assessed using an empirical study in the IS field. The present study focuses only on how to employ the hierarchy structure for analysis in IS research. It excludes how to complementarily use the activity model and hierarchy structure. The limitations notwithstanding, the study is a huge step toward a theoretical and methodological approach for a

systematic analysis using the hierarchy of activity theory. In the future, the proposed model needs to be tested and validated by researchers in IS and other fields of study.

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