

A Proposed Model for the Fourth Generation of Activity Theory to be Applied on the Smart City Research

Research-in-Progress

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Abstract

Smart City topic is under investigation by many researchers globally. Smart City research arena is covering multidimensional aspects such as Business Processes and Information Systems for Smart Cities and Enterprise Architecture (EA) for Urban IoT and Smart Cities. One can argue that the starting point of research can be the activities in the research scope, which can be investigated by analysing the activities constructs that can be found in the Activity Theory. This paper describes an ongoing research into the development and evolution of Activity Theory (AT). It represents the three generations of AT and then argues that there is room for improvement. This paper suggests the fourth generation of AT. It is aimed that the new proposed model can open the researchers' eyes to more helpful aspects that can be taken into consideration when using AT in their research such as in the Smart City research arena.

Keywords: Activity Theory (AT), smart city research, Cultural-historical activity theory (CHAT)

Introduction and Historical Background of Activity Theory

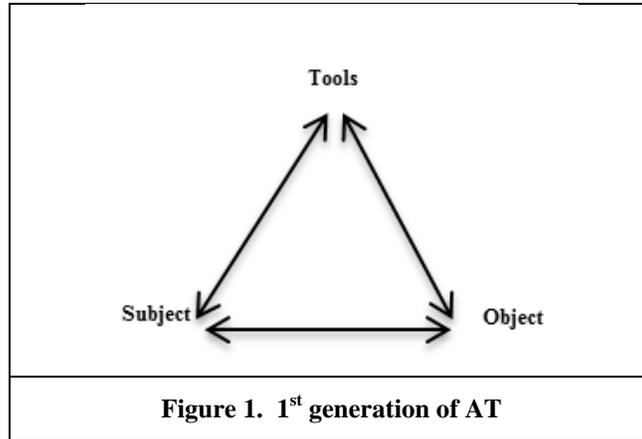
Activity theory (AT) is based on the cultural-historical school that drew largely upon the works of Vygotsky (1978) (Karanasios et al. 2015). AT has been described by Leontiev (1977) as “*the substance of consciousness*” (Bakhurst 2009, p.1 98). It is sometimes suggested that AT represents a useful Russian philosophy for researchers. However, as a theory, AT is still evolving and developing. This research takes a critical look at AT and attempts to address some of its problems and weaknesses. This paper proposes a fourth generation of AT development which can be utilised by researchers in both the field of science and humanities

Three Generations of Activity Theory

AT proposes that human activity is directed toward an object, mediated by tools and socially constituted within the surrounding environment (Vygotsky 1978). In other words, the interaction between the human agent (the subject) and the world (the object) is mediated by tools and signs (Karanasios et al. 2015). The subject is the active element of the activity process and can be either an individual or a group (Chen et al.

2013) (see Figure.1). The **first generation** of AT is defined by 'mediated action,' which was set out by Vygotsky (1978) (Yamagata-Lynch 2010).

The basic model of mediation proposed by Vygotsky had been illustrated with the use of bi-directional arrows (Engeström 2001) (see Figure.1).



As shown in Figure. 1 the first-generation of activity theory focused on individual action and studied the concepts of subject, mediating artifacts, and object (Vygotsky 1978). This basic model does not include a social context, which can be represented in rules and collaboration with others (Montoro and Hampel 2011). In order to address this problem, Engeström et al. (1999) developed the model further by adding more elements and complexity to the basic structure (Montoro and Hampel 2011, p.122). The **second generation** of AT is attributed to the work of Leontiev and Engeström (1987) in that it considered the collective nature of the human activity (Yamagata-Lynch 2010) by adding three more elements to the first generation of AT, which are the rules, the community and the division of labour (see Figure.2).

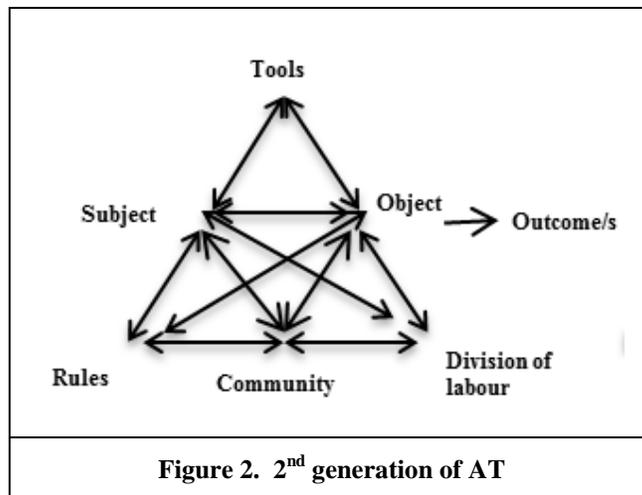
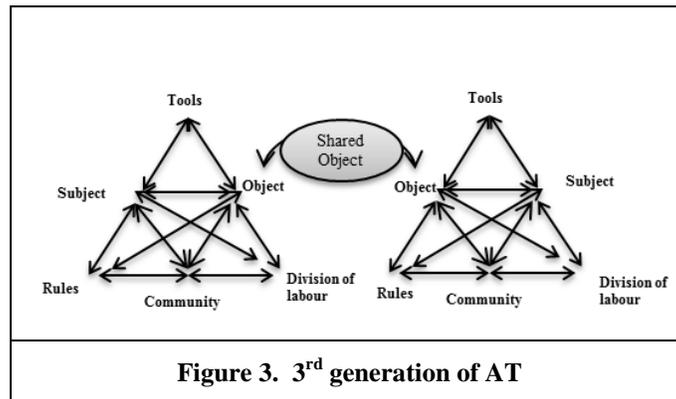


Figure.2 shows that in any activity, subjects (people) will use tools to achieve their objectives and the overall activity will have outcome(s). This process can also be mediated through an

organisation/community/environment. The community or organization may impose rules or regulations that may affect the activity. People can work as part of a community to achieve their objectives. Activity can feature a division of labour, which means the way in which the work is divided into tasks, which is responsible for carrying out each task and how the roles are organised. Not all activities require the division of labour depending on the size of the activity/ project.

The second generation of AT has some problems. For example, it does not consider more than one activity that shares the same objective, which has been addressed in the third generation. Despite these problems, Yamagata-Lynch (2010) claims that many studies in the USA using AT have predominantly focused on the descriptive nature of second-generation activity theory, and used AT as a supplementary tool in qualitative research. The **third generation** of AT was developed for applications of activity systems analysis where the researcher takes a participatory and interventionist role in the participants' activity (Yamagata-Lynch 2010) (See Figure.3).



In Figure.3 the researcher observes a potentially common object between two activities that are comparable. According to Yamagata-Lynch (2010), many researchers are encouraging the use of the third generation of AT in order to engage in new work within an interventionist framework. Yamagata-Lynch (2010) contends that researchers who used AT found that AT is helpful and can bring insights to their research.

AT in IS research

The use of AT in IS research varies. The first presentation of AT in information systems research was at the IFIP WG 8.2 conference in Copenhagen in 1991 (Mursu et al. 2007). Since 1991, AT has been applied to research in many IS related fields (e.g. Information Systems, Computer-Supported Cooperative Work, Social-Psychology, Management, and Education, Human-Computer Interaction, and Information Science) (Kuutti 1996; Mursu et al. 2007; Mwanza 2002). AT is used in the IS field for understanding and driving IS mediated change in organizations. AT's structure has proven to be useful in the IS field (Chen et al. 2013). For example, Mwanza (2002) uses AT in her Ph.D. thesis to conduct her research within the field of Human- Computer Interaction (HCI), and she created six research questions based on AT as follows:

1. What tools do the subjects use to achieve their objective and how?
2. What rules affect the way the subject achieve the objective and how?
3. How does the division of labour influence the way the subject satisfy their objective?
4. How do the tools in use affect the way they community achieves the objectives?
5. What rules affect the way the community satisfies their objective and how?
6. How does the division of labour affect the way the community achieves the objectives? (Mwanza 2002, p.155).

Working within the field of HCI, Mwanza (2002) found that AT was an appropriate theory for conceptualizing IS research (Mwanza 2002). At the same time, she claims that whilst AT has been identified as a suitable framework for conceptualizing user perspectives, the lack of a standard methodology for applying AT to HCI research and practice has meant that many systems developers have failed to benefit from the richness of AT framework. This shows that there is still room for developing AT.

AT and smart city research

As AT used in IS research, there are also research papers that more specifically focused on using AT with smart city field (Cook et al. 2015; White et al. 2016). In Cook et al's paper, they suggested using AT in smart city research to understand the combination of formal and informal social structures in terms of power and control in an activity system. In other words, to understand the role that people adopt or are positioned into in terms of structural relations of the control and power in institutional and cross-institutional settings. AT also can be used simply to addresses issues for actors in social networks in smart city research by investigating and finding answers to some questions like, what are the rules in such activity? And who are the stakeholders in this activity? In White et al.'s paper, AT was used for understanding behaviour in problem structuring methods interventions with activity theory (White et al. 2016). White et al.'s paper explored AT as an approach to examine a case study of the participatory planning of smart city interventions for energy efficient city district redevelopment. The paper found concerns and issues in their analysis such as the issue of power and contradiction. However, the paper did not suggest adding this aspect (barriers/ concerns) to the AT. White et al. (2016) said that the analysis with AT helped to theorise the micro level dynamics and to understand PSM (particularly problem structuring methods) interventions. This suggests that AT is useful to be used in smart city research taking into account that AT can be developed by adding more elements to its structure. This is important with smart city research since smart city technologies are varied.

Criticism of AT

Although AT has been used as a framework for qualitative analysis in multiple research papers in different disciplines, it has been subject to some criticisms (Blunden 2009). Criticism of AT in this paper is predominantly influenced by Bakhurst's 2009 paper entitled "Reflections on activity theory". Four main points are presented as some of the weaknesses of the AT

Firstly, the catalyst which motivates people to achieve their object is absent in the AT models.

According to (Brown)

The premise of activity theory is that a collective work activity, with the basic purpose shared by others (community), is undertaken by people (subjects) who are motivated by a purpose or towards the solution of a problem (object), which is mediated by tools and/or signs (artefacts or instruments) used in order to achieve the goal (outcome). The activity is constrained by cultural factors including conventions (rules) and social organisation (division of labour)(2011, p.1).

The motivation aspect is mentioned in the above quotation, but implicitly rather than explicitly stated.

Secondly, any acknowledgment of barriers and difficulties that people may face when conducting any activity is absent in the AT model. It is important to be realistic when investigating an activity. Any activity can be surrounded by obstacles and challenges. Bakhurst (2009) states that:

It is also interesting that there seems to be no obstacle what so ever, apart from ideological ones to employing any one of a number of other methods in conjunction with an activity-theoretical approach [...] But there appears to be no obstacle to doing this in any one of a number of ways. This might [...] be a symptom of its [activity theory] emptiness. (p. 207)

Based on Bakhurst's quote, the need for adding the barriers element is clear in order to make the model more plausible.

Thirdly, the vagueness of the term object in the AT models calls the needs to be clarified.

It is unclear whether the term 'object' means objective or literally an object. Bakhurst (2009) draws attention to the fact that Russian and German languages have two words for the word object. He said:

“ob”ekt” – the term typically counterposed to subject, with connotations of brute objectivity and otherness, and “predmet”, with connotations of a conceptualized object – an object of inquiry, situated in a space of intention and purpose. What kind of thing should we be talking about when we are modelling activity systems? (p.208)

Based on the Russian translation, ob”ekt means an object/ a physical item and “predmet” means a thing. This transition or translation from Russian philosophy makes the term “object of activity” in English ambiguous. One interpretation of an object is that it means the purpose or aim of the activity. The second interpretation of an object is hazy because the object of the activity can indicate what the subject is acting on (Bakhurst 2009). Hence, when investigating an activity, the two questions in both cases are what people are trying to achieve by conducting their activity and what it is that people are working on? Bakhurst (2009) states, “once we sort out the ambiguity manifest in the English, we are home” [Bakhurst hopes] (p. 208). Thus, it is proposed that the term object is changed (in the fourth generation of AT) to be 'objective' instead of 'object'.

Fourthly, there are unclear role of arrows (contradictions/ relationships) in AT model. This shows the need for reshaping the AT model with clearer 'terms' and clearer 'arrows'. The reshaping of the model was stimulated by Bakhurst (2009) when he stated that:

The model also says almost nothing about the relation that the various components bear to one another. The points of the triangles are joined by lines, but what do the lines represent?

This is an important question because the items at the nodes are not just given: the relations they bear to each other will to some degree constitute them (p.207).

Bakhurst (2009) described AT as a framework that is “still-emerging” (p.197). He encourages researchers to rethink AT and to have a self-critical dialogue between the different styles of thinking within the AT (Bakhurst 2009). Bakhurst (2009) adds that in terms of understanding the dynamics of the activity system, the idea of contradiction is vague (Bakhurst 2009). He asserts that:

Within Russian philosophy and psychology, the concept of activity was always seen as problematic and open to multiple interpretations. It is important that Vygotsky's interest in mediation quickly led him to become preoccupied with meaning, as he recognized that mediating artifacts do not influence us simply as artificial stimuli, but in virtue of their significance, which can- not be understood causally (p. 201-202).

Bakhurst (2009) admits that AT contains a significant 'degree of truth' (Bakhurst 2009, p.204). However, it needs more work to make it 'plausible' (p.204). Critical rethinking is needed in order to develop it in a ways, which would make it conceivable. In this research, three steps have been taken to achieve this. Firstly, four more elements have been added to the AT model (motivations, barriers, level of awareness, and effectiveness). Secondly, some terms have been changed; the subject has been changed to people, and the object has been changed to objective. The reason for changing the names is to remove the vagueness of both terms. The third step was reshaping the relationships in the triangle and changing positions and arrows that indicate their relationships (See Figure.5).

The rationale behind adding each element to the AT

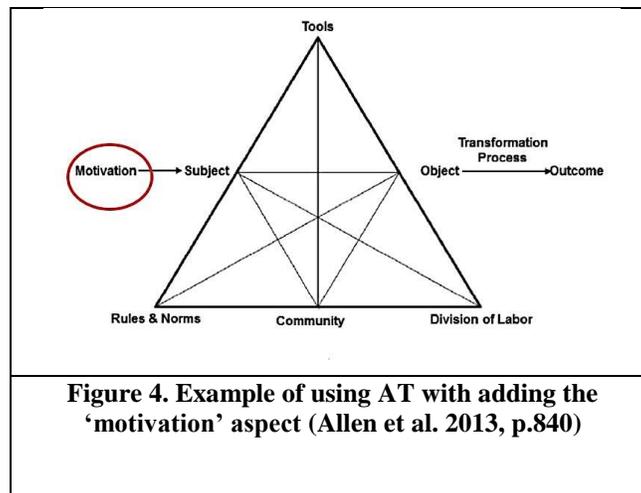
The four added elements in the fourth generation of AT are justified as follows:

Motivations

Allen et al. (2011) and Allen et al. (2013) added the motivation aspect to the AT model (Allen et al. 2011)(see Figure.4). This paper emphasises on adding the motivation element to be part of the AT constructs because it is the predominant factor in influencing an individual's goals or aims is their drive; (Singh 2011). Singh (2011) claims that motivation may come from an internal or external source and motivation can be a combination of factors that lead people to achieve their goals (Singh 2011). Motivation is derived from the Latin meaning is "to move" (Weiner, 1992) cited in (Eccles et al. 1998). According to Weiner (1992), motivational psychologists study what moves people to act and why people do what they do (Eccles et al. 1998). Motivation can be intrinsic or extrinsic (Singh 2011). Singh (2011) states that:

“According to various theories, motivation may be rooted in the basic need to minimize physical pain and maximize pleasure, or it may include specific needs such as eating and resting, or a desired object, hobby, goal, state of being, ideal, or it may also be attributed to less-apparent reasons such as altruism, selfishness, morality, or avoiding mortality. Conceptually, motivation should not be confused with either volition or optimism. Motivation is related to, but distinct from, emotion” (Singh 2011, p.162).

Moreover, according to Montoro and Hampel (2011), human activity is driven by needs that account for a general motivation (Montoro and Hampel 2011). Wertsch, Minick and Arns (1984) claim that motives are socioculturally determined as cited in (Montoro and Hampel 2011).



In keeping with this view of motivation, this element was an addition to the AT with the intention of understanding people's motivations to carry any activity in order to promote their motivations if possible. The importance of understanding their motivations will assist improvising ways to promote and increase the utilisation of any activity such as Smart Cities activities.

Barriers

One of the definitions of barrier is “A fence or material obstruction of any kind erected (or serving) to bar the advance of persons or things, or to prevent access to a place.”¹ The main reason for adding the barriers element to AT is to help in understanding any activity in a deeper manner in order to provide solutions and recommendations of how to overcome these barriers.

Awareness

One of the definitions of awareness is “The quality or state of being aware, consciousness; (also) the condition of being aware (of something or that something is).”² The main reason for adding the awareness aspect to the AT, is that knowledge plays a significant role in the smart city activities. Understanding the level of awareness within the smart city stakeholders can assist in justifying the findings of any research as it gives a clearer picture of the research context.

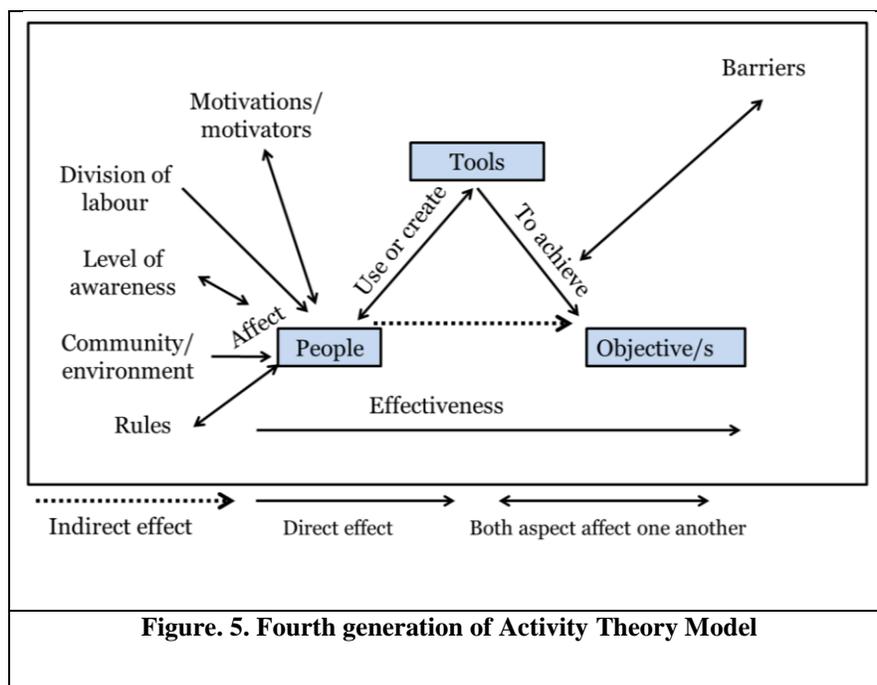


Figure.5 shows that in any activity, people need to use mediators or tools to achieve their objectives and outcomes as Vygotsky (1978) argued. Other aspects have been taken into consideration, which has an effect on human beings such as the:

- Motivations (drivers to achieve their objectives), taking into account that people may create the motivations such as creating competitions for the best application and others are being motivated, and thus the arrow has two heads;
- Environment and the surrounding community who can have a direct or indirect impact on the activity of the people;
- Rules or regulations that can limit any activity, taking into account that people may create the rules such as using specific sensor-based IoT networks and others are being governed by what is available;

¹ <http://www.oed.com/view/Entry/15765?rskey=OWWiik&result=1&isAdvanced=false#eid>

² <http://www.oed.com/view/Entry/13894?redirectedFrom=awareness+#eid>

- Division of labour that means who do what in the activity;
- The level of awareness about what they have and what they can do.
- Barriers and challenges, which may affect the outcomes of the activity.
- And lastly, the researcher can check the effectiveness of the activity by checking if people achieved their objectives, then the activity can be considered as effective.

Finally, the new proposed model of AT aimed at opening new venues for the researchers to more helpful elements that can be important in their research inquiry.

Conclusions

This paper represented the AT generations and proved that there is room for improvement. This paper analysed the gaps in the AT models and accordingly suggests the fourth generation for it with the hope that it can help researchers to analyse the smart city activates based on it. The new proposed model of AT can open the researchers' eyes to more helpful aspects that can be taken into consideration when using AT in their research. More elements can be added to the fourth generation of AT based on the research needs.

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References

- Allen, D., Karanasios, S., and Slavova, M. 2011. "Working with Activity Theory: Context, Technology, and Information Behavior," *Journal of the American Society for Information Science and Technology* (62:4), pp. 776-788.
- Allen, D. K., Brown, A., Karanasios, S., and Norman, A. 2013. "How Should Technology-Mediated Organizational Change Be Explained? A Comparison of the Contributions of Critical Realism and Activity Theory," *Mis Quarterly* (37:3), pp. 835-854.
- Bakhurst, D. 2009. "Reflections on Activity Theory," *Educational Review* (61:2), pp. 197-210.
- Blunden, A. 2009. "Criticisms of Vygotsky's Concept of Activity." 2015, from <http://home.mira.net/~andy/works/vygotsky-critique.htm>
- Brown, A. 2011. "Activity Theory." from <https://www2.warwick.ac.uk/fac/soc/ier/glacier/learning/theories/activitytheory/>
- Chen, R., Sharman, R., Rao, H. R., and Upadhyaya, S. J. 2013. "Data Model Development for Fire Related Extreme Events: An Activity Theory Approach," *MIS Quarterly* (37:1), pp. 125-147.
- Eccles, J. S., Wigfield, A., and Schiefele, U. 1998. *Motivation to Succeed*. John Wiley & Sons Inc.
- Engeström, Y. 2001. "Expansive Learning at Work: Toward an Activity Theoretical Reconceptualization," *Journal of education and work* (14:1), pp. 133-156.
- Engestrom, Y., Miettinen, R., and Punamaki, R.-L. 1999. *Perspectives on Activity Theory*. Cambridge University Press Cambridge.
- Karanasios, S., Allen, D., and Finnegan, P. 2015. "Information Systems Journal Special Issue On: Activity Theory in Information Systems Research," *Information Systems Journal* (25:3), pp. 309-313.
- Kuutti, K. 1996. "Activity Theory as a Potential Framework for Human-Computer Interaction Research," *Context and consciousness: Activity theory and human-computer interaction*, pp. 17-44.
- Montoro, C., and Hampel, R. 2011. "Investigating Language Learning Activity Using a Call Task in the Self-Access Centre," *Reading*).
- Mursu, Á., Luukkonen, I., Toivanen, M., and Korpela, M. 2007. "Activity Theory in Information Systems Research and Practice - Theoretical Underpinnings for an Information Systems Development Model " *Information Research*, 12(3) paper 311 Retrieved April 2007, Vol. 12 No. 3, from <http://informationr.net/ir/12-3/paper311.html>

- Mwanza, D. 2002. "Towards an Activity-Oriented Design Method for Hci Research and Practice." Open University.
- Singh, K. 2011. "Study of Achievement Motivation in Relation to Academic Achievement of Students," *International Journal of Educational Planning & Administration* (1:2), pp. 161-171.
- Vygotsky, L. S. 1978. "Mind in Society: The Development of Higher Mental Process." Cambridge, MA: Harvard University Press.
- White, L., Burger, K., and Yearworth, M. 2016. "Understanding Behaviour in Problem Structuring Methods Interventions with Activity Theory," *European journal of operational research* (249:3), pp. 983-1004.
- Yamagata-Lynch, L. C. 2010. "Understanding Cultural Historical Activity Theory," in *Activity Systems Analysis Methods*. Springer, pp. 13-26.