An Application of Agent-based Modelling to Explore the Complexity of Public Recreational Places:
Case Study: Weras Ganga Public Park, Sri Lanka

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1. Introduction

In the contemporary planning practice, there available various methods to understand Safety in Mobility (SM) (Alemian et al., 2010). Yet the possibility to study different scenarios in order to select the best measures to enhance SM is minimum with regard to public spaces. For a space to become a place for everybody, the rhythm of time and the patterns of user behaviour which reflects the level of importance that place generates in the city life is very significant. Since this combination of people, space and time form complex relationships, particularly in public recreation spaces, there arises a crucial necessity to identify the true nature of complexity in order to facilitate safety of the users. In the modern scientific fields, the Agent-based Modelling (ABM) concept is vastly utilised to understand complex systems. The ABM enables the ability to create, analyse and experiment complex systems with models composed with agents that interact within an environment. (Tosto, 2012)

2. Research Background

A complex system comprised of numerous particles and their inter-relationships; hence every part and particle and each act of the elements within a system becomes highly important. At the same time, the 'entire structure' is much-more than the 'sum' of all those parts and inter–relationships. Most importantly, complex systems are continuously progressing and unfold over time (Batty, 2007).

The dynamic nature of public recreation spaces also have these characteristics, and hence can be considered as highly complex systems where safety is a higher level concern. Therefore, it is required to pay attention to the complex combination of individual behaviours in the physical setting of public recreation spaces to identify measures to ensure safety in mobility. However, this is an aspect which is being ignored in contemporary planning practice because the recreational spaces seem to

be considered as simply meant for recreation in most of the urban planning endeavours so far. This happens due to unavailability of a method to be utilised in a comprehensive manner to understand the complexity in public recreation spaces in present day practice.

In similar conditions where the ground situation is difficult to understand, computer simulation models play an important role enabling simulation capability (Ronchi E., 2014). Among most of those modelling concepts, application of Agent-based modelling (ABM) in spatial planning has been used to understand the urban spaces as complex systems for number of studies. Especially, in understanding the space–time dynamics related to behaviour of people in public streets and public buildings has drawn more attention since they are really difficult entities to understand by the usual methodologies. Still, the public recreation spaces are not considered as complex entities so far.

Hence this study explores the applicability of Agent-based Modelling (ABM) concept in observing complexity of public places. Focused on studying the significance of ABM to ensure safety in physical planning, the study reveals possibilities of using ABM as a tool to maintain safety in mobility. Accordingly, the paper demands attention for the importance of understanding simple rules of the interactions between place users and place landscape which act as the real generators of complexity in public recreational places.

3. Methodology

This research is designed with the main objective of framing out Agent-based Modelling as a suitable technique for Sri Lanka which can be utilised to understand the complexity of public recreational spaces and to reveal possibilities to develop the framework into a tool to ensure safety in mobility of public recreational spaces.

Weras Ganga Public Park was selected as the case study location and preliminary observations with place user composition audit, participatory observation, random in-depth focus group discussions, activity audit survey using a structured brief questionnaire, people centred maps and photographs were used for data collection.

The collected data were analysed to identify the characteristics of main components and parameters concerning Safety, relevant in developing an Agent Based Model framework representing the complex nature of the case study location using the 'Simplest ABM structure (Batty, 2007). The model interface selected was 'NET LOGO 5.2.1', which enables the possibility to study the connection between the "micro-level behaviour of individuals and the macro-level patterns that emerge from their interaction." (Wilensky U., 1999).
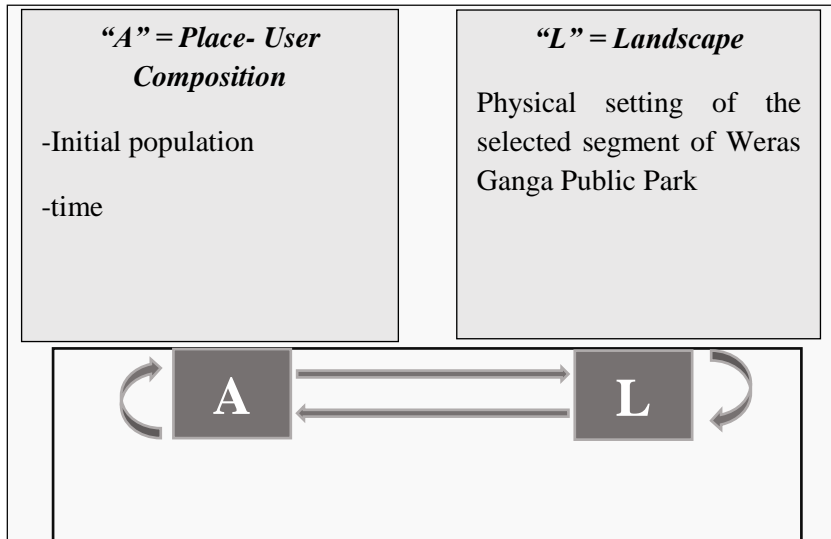
Figure 1: The ABM structure of 'public recreation space as a complex system'
Source: Compiled by author using the concepts identified in literature review

4. Summary of Findings

The stimulation results were used to understand whether there were collective patterns in complex individual behaviours towards the considered landscape. The identified conditions were elaborated using the concepts of complexity theory. Accordingly, this study framed out 'Behaviour pattern of place users' (**P**)*,* as determined by the function of four parameters which raise concerns for Safety in Mobility.

$$P = f(t, a, c, f) \text{ .... (1)}$$

1. The time which users prefer to visit the place (**t = time**),

2. Priority purpose of visiting the place and the preferred ways how users interact with each other (**a = active engagement),**

3. How people feel the elements of the place (**c = comfort and relaxation)**

4. The effects of imposed rules and controls (**f = freedom of action)**

The developed ABM framework enables the possibility to observe the case study location in the model interface and to simulate how the individual place – user agents' independent behaviour can be read into general patterns as explained in the Complexity Theory. The factors which disturb the ongoing interactions cause safety issues when the place become crowded with agents having different priority purposes who desire to actively engage with same landscape elements. Especially,

frequent accidents are happening when the imposed rules and controls are not followed by place users. Safety is in question where the active engagement of the agents' movements, path finding and speed becomes influenced by the changes of considered parameters.

5. Conclusion

Utilising an ABM framework as a tool to model the public recreation spaces as complex systems will open advantageous doorways in Physical Planning to understand the existing patterns of interactions between place users and place landscape. The study pinpoints the need to further develop the framework considering other important factors which increase the complexity of public recreation spaces. This is important since safety has become a higher level concern in the context. Hence this study reveals the possibility to capture the individual agents' behaviour patterns using ABM. With that, the Planner or Urban Designer will have the capability of identifying the most suitable changes in the landscape of a particular recreation space catering the needs of safety in mobility for the place users.

References

1. Alemian C., Greenwood J., Oliveri M., Shaddock C. (3/5/2010) Advisors: Professor Richard Vaz Professor Chrysanthe Demetry: Research Proposal to Study Pedestrian Mobility in Newton, MA Final Project Proposal Sponsors: League of Women Voters in Newton City of Newton Planning and Development Department

2. Batty, M. (2007.). Cities & Complexity, understanding cities with cellular automata - Agent based models & fractals. (1st paperback ed.) Cambridge, Massachusetts, London: The MIT press

3. Ronchi E., (2012) Department of Fire Safety Engineering, Lund University P.O. Box 118 Lund, 22100, Sweden e-mail: enrico.ronchi@brand.lth.se

4. Tosto, G.D. (2012.). Introduction to Social Simulation, INFOMSOCS Lesson 1, Universiteit Utrecht, BBL- 515, g.ditosto@uu.nl.: Retrieved fromwww.cs.uu.nl/docs/vakken/msocs/slides/intro.pdf

5. Wilensky, U. (1999). NetLogo 5.2.1 User Manual: NetLogo.http://ccl.northwestern.edu/netlogo/. Center for Connected Learning and Computer-Based Modeling, Northwestern University, Evanston, IL

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