Investigating Tools for Multi-Stakeholder Decision Making to Improve the Spatial Performance in Transport Interchanges

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Abstract. Public transport interchanges often involve several stakeholders for planning and decision-making. As a result complexity leads to inefficient processes, leading to indecision, disruption, or costly delays. Consequently, the paper focuses on the application of tools for navigation and prioritization of opportunities in the need finding, fuzzy-front end, or mystery phase as introduced by Martin (2009). The paper outlines in a case study how a multi-stakeholder platform can progress from complete ambiguity in project definition through to clearly defined and understood projects that have a shared intent across the multi-stakeholder platform. These tools have been applied in a public transport context, by demonstrating the process of integrating digital innovation into various stakeholders through a participatory research process. The paper introduces the research background; discusses the hypothesis; outlines the case study; emphasizes its significance for multi-stakeholder decision-making and discusses the opportunities for the built environment.

Keywords. Participatory design; soft-systems methodology; multi-stakeholder; urban planning; transport environment.

INTRODUCTION
What is good performance of space in a public transport environment? Let us illustrate with an obvious tension between system operations and individual customer experience. A system working efficiently from an operational perspective may not be the ideal through the eyes of a customer – For example, if a bus pulls away as someone is running to catch it, operationally the on-time running performance indicators and connecting services may work better, but the customer left stranded at the bus stop.

Defining spatial performance of space at transport interchanges good performance of a space in this paper is therefore not limited only to an aesthetic discussion. What is defined as good is shrouded in complexity, as the public space must try to accommodate a myriad of alternative goals and values of each stakeholder. This research adopts methods from other adjacent disciplines such as design thinking in business (Martin, 2007; Martin, 2009) participatory design (Muller and Kuhn, 1993; Buur and Matthews, 2008), and soft-systems methodology (Checkland and Scholes, 1999) to test their value in architectural design in order to improve design outcomes within transport interchanges. These methods, as defined in this paper, aim to elicit the tensions and goals in each stakeholder group so
as to come up with design interventions that best cumulatively balance the needs of each. No matter the level of technical expertise of designers within a multi-stakeholder environment – if due attention is not given into stakeholder engagement any design process working within such a context can lose momentum and rapidly stall.

The case demonstrated in this paper follows an academic team with a mandate to deliver new information systems for more responsive transport environments which has been assembled from diverse backgrounds of robotics, human computer interaction, media architecture, transport planning and design thinking. True to the nature of transport planning problems this project involved several stakeholders for planning and decision-making, the case study involves the engagement of multiple complex project stakeholders - one local council, the state transport provider, and two consultancies in architecture and engineering. Only the first six-month period of the project is being discussed in this paper; in which several participatory methods were applied by this academic team to navigate and progress through the fuzzy front-end or mystery phase of the design process to align the stakeholder intent for the creation of defined project and innovation opportunities.

BACKGROUND
Planning problems can be defined as wicked problems (Rittel and Webber, 1973). Wicked problems have six characteristics by Conklin (2006);

- The problem is not understood until after the formulation of a solution.
- Wicked problems have no stopping rule.
- Solutions to wicked problems are not right or wrong.
- Every wicked problem is essentially novel and unique.
- Every solution to a wicked problem is a ‘one shot operation.’
- Wicked problems have no given alternative solutions.

It is within this context the research team attempt to find our project and innovation opportunities amongst the agendas of the multiple stakeholders assigned to the project. Many planning decisions in the urban environment have a long half-life and are irreversible in terms of the changes that the intervention has on the system. In the case of digital interventions; a lighter, lower risk and more iterative approach is possible. However, this does not mean that any intervention decisions are taken lightly. As Rittel and Webber (1973) define within wicked problems; the planner has no right to not be improving the characteristics of the world where people live; “Planners are liable for the consequences of the actions they generate; the effects can matter a great deal to those people that are touched by those actions.” As Rittel and Webber further states “The formulation of a wicked problem is the problem”. Even in reference to measurement in an optimisation model, the very naming of the solution space, the decided system constraints, and the performance measure as function of the planning and contextual variables all contribute to the definition of problem (Rittel and Webber, 1973).

New participatory methods of multi-stakeholder decision-making serve to create a clearer platform on which problems can be defined as a multi-stakeholder group in which stakeholders can all take ownership of some part of the problem. Faysse (2006) discusses five factors that must be addressed when setting up a multi-stakeholder platform. These are:

- The Power relationships within the group.
- Choosing the composition of the group and its effect on invited stakeholders’ decision to participate.
- Stakeholder representation and capacity to participate meaningfully in debates.
- Decision-making powers and mechanisms of the group.
- Costs of setting up the process.

This research paper uses Roger Martin’s (2009) knowledge funnel as a visual structure to demonstrate the progression of the multi-stakeholder platform from mystery to heuristic (problem definition).
Martin’s (2009) model has three phases; namely mystery, heuristic and algorithm. Martin (2010) describes how phenomena enter our collective consciousness originally as mysteries, which excite our curiosity but may elude our understanding. With sufficient thought a first level of understanding emerges and develop rules of thumb to approach them from the patterns that are understood. These patterns guide us toward a solution by way of organized exploration of the possibilities. A heuristic in an organisational context is one that is seen to provide value for the organisation – a way of achieving an organisational objective. A good manager’s skill is in their ability to reduce ambiguity to progress an idea through the knowledge funnel without losing the validity of the idea (Martin, 2009) (Figure 1).

This mystery phase is also referred to as the fuzzy-front end of design (Wheelwright and Clark, 2002). Kim (2002) discusses the ambiguity prevalent in the early phases of idea development which prevents an opportunity from proceeding into development phase; this uncertainty can come from technology, markets, required resources, company-fit and capabilities, and company limits. Within the complexity of a transport case, uncertainly also arises from political pressures, based on location and current agendas. To intervene in design or modification of a transport interchange involves the accommodation of wants and needs of pedestrians, bicycles, cars, bus services, train services, commercial enterprises. Necessarily, stakeholder groups can contain but aren’t limited to transport service providers, governments – local and state, regulators, commerce, security, institutions, retail, tourism, and of course citizens. From an organizational theory perspective, Adler (2007) states that when organisations are large there are two key questions they must ask crucial questions from both societal and organisational perspectives; namely “What will they do?” and “Who will it benefit?” In the design of urban spaces for the public realm, the ‘ownership’ of the decisions of what will the space does and who will benefit is shared between stakeholders. “What will they do?” and “Who will it benefit?” also become increasingly difficult to answer when the organisation is accountable and dependant on political pressures, constant scrutinising media, customers, communities, and a city’s constraints and regulations.

**HYPOTHESIS**

For an academic team to be exploring the mystery phase of a problem is a natural fit, due to the high-
cost, high-risk nature of the exploration in this space (Martin 2009). Martin discusses a designer’s ability for abductive reasoning to take a wide approach to the analysis of the given field, in which a designer looks at everything so as not to omit what may be key to solving the problem. The following methods of design thinking in business (Martin, 2007; Martin, 2009) participatory design (Muller and Kuhn, 1993; Buur and Matthews, 2008), and soft-systems methodology (Checkland and Scholes, 1999) support the creation of a synthesized and shared ownership and intent for action from the initial broad view of the problem space. There were three established methods proposed to be used in the emergent process to move the multi-stakeholder platform from mystery to heuristic in the definition of the problem (Figure 2).

- **Rich Picture** – A Rich Picture is a Soft-systems methodology representation tool as defined by Checkland and Scholes (1999). A Rich picture is a sketched subjective map the problem space from the participants’ perspective using as few words as possible. The emphasis is on relationships and stakeholders involved in the participant’s view of the problem. The participant must name the picture with ‘this is a rich picture of…’ and also include him or herself in the picture to show their relationship to the problem. The Rich picture is designed to elicitate individual subjective views and opinions in a non-confrontational way.

- **Ethnographic Interviews** – An approach to learning about the social and cultural life of communities and institutions. These interviews as defined by Lecompte (1999) seek to understand a participant within their locally specific context – in this case their organization. Through Ethnographic interviews the research team aims to understand what is important to the individual in their organizational role, how the organization makes decisions in relation to the problem and how they could best be supported.

- **Participatory-design** - Participatory design methods can involve stakeholders in the collective definition of the wicked problem, and can be applied using different methods to achieve defined outcomes at each phase of the exploration (Muller and Kuhn, 1993). Created artefacts through participatory processes that demonstrate this can form boundary objects that unify the group around a shared understanding. Visual maps can create a synthesized view including the input of all participants in Figure 2.
Collaborative and Participatory Design

Buur and Matthews (2008), states that the use of participatory design can be an exercise in organisational change, bringing diverse stakeholders together to confront each other’s differing perspectives.

- **Participatory evaluation** – Wright (1991), discusses co-operative evaluation methods to enable rapid and low cost evaluation of design choices in qualitative ways. Kaner (2011) discusses similar methods for evaluation in facilitated workshops. This research proposes to use participatory voting as a means of turning qualitative conversation into quantitative data about the apparent value of each option. Where all the stakeholders agree that the ‘project’ would be value generating for their organisation.

The intent is that the outputs from the use of these methods are that they become boundary objects. Boundary objects are artefacts of practice that are agreed and shared between communities, yet the objects satisfy the informational requirements of each of the groups (Star and Griesemer, 1989) – in this case enough for each stakeholder to recognise their relationship to the project and the value they can gain from being a part of the process. The hypothesis is that a shared platform for decision making based on the holistic understanding of the roles, strategies, and interfaces of each relevant stakeholder and their relationship to each other – will enable the research team to clearly define projects that all stakeholders are motivated to support.

**CASE STUDY – THE BUS STOP OF THE FUTURE**

The case study is based on a work that is funded through an Australian Government ARC Grant where a group of trans-disciplinary academic researchers from architecture, human-computer interaction, robotics, transport planning and design are working on **Responsive transport environments** in order to investigate spatial and visual information technologies to allow improved passenger flow and better customer experience. One of the main stakeholders is the state government organisation that operates public transport and is responsible for policy decisions that lead to changes in public transport. Whilst the research aimed in its original grant proposal to investigate a complementary approach to transport infrastructure expansion – and its associated costs, disruption, energy use, and implementation periods – through the use of responsive digital information to facilitate improved passenger flow and to offer better customer experiences, it became very quickly obvious to the research team that the answer to the research problem can not be found in digital or smart technologies. As described in the hypothesis it became essential that one needs to align stakeholder intent around problems (in the **mystery** phase) prior to defining the intervention methods (in the **heuristic** phase) and implementing them to achieve efficiently achieve organisational objectives (in the **algorithm** phase).

The case outlines the activity beginning in the researchers' foundational study (in the **mystery** phase) where other then the topic ‘Public Transport’ no specific ‘needs to address’ or ‘projects’ had been previously defined. The research team created an explorative process with the multi-stakeholder platform creating **Rich Pictures**; conducting **Ethnographic Interviews**; organising **Participatory Design workshops**; and defining the projects at the end through **Participatory Evaluation** as defined earlier. This process has led to the resulting project ‘The Bus Stop of the Future’, which had not been defined as a project at the beginning of the process but is the result of the emergent process. In the following the paper wants to guide the reader step by step through each phase that was carried out.

**Rich Picture**

In a first Kick-Off Workshop all sixteen key members of the five main industry partner organisations of the ARC grant met in August 2012 and were asked to draw a rich picture of what everybody was thinking about public transport (Figure 3). The research team used this method to explore everyone’s perspective on the issue of customer information in
the environment of inner city stations. As part of Soft-systems methodology, rich pictures provide a way of learning about complex and difficult to define situations by drawing relationships between key elements. Rich pictures followed no commonly agreed syntax, consisting of symbols and sketches that contained as much information as individuals deemed necessary. The only rule was that everybody had to include him or herself in the drawing. The motivation for this approach and the value of this technique is the way it compels the drawer to think about the situation and describe it as a web of elements, features and relationships — a process known as action learning. This process enabled us to capture the unique viewpoint of everyone in the room, using their rich picture to spark conversations and trigger new ideas about the role of information in public transport environments with the rest of the group. The research team did the exercise first as individuals and then worked in teams of 4–5 to identify common themes. Based on this step first major themes could be identified. The exact nature of these major themes and the major questions that emerged out of this workshop are beyond the scope of this paper and are often confidential and are therefore not further discussed. Still what could be drawn and concluded from this step are four major topic areas for exploration, these are: (1) Reframing the relationship between customer and system; (2) Decision making support on an individual basis; (3) Understanding mode choice; (4) Understanding what more information enables. It was also agreed at the end of the Kick-Off Workshop that the ARC team should visit the individual partners for one to one interviews to better understand the individual organisations and their goals and issues.

**Ethnographic Interviews**

Through having contact via the sixteen key members into the individual partner organisations the ARC team could meet in the following months more then 40 individuals and interview them about insight information about the individual organisations and the four major topic areas above. Naturally in these discussions the ARC team gained a very holistic picture of the project and started to understand the KPI’s from different members and groups of the organisations as well as understanding their current challenges. In the case of transport there are several stakeholder groups immersed in the business of

![A participant's Rich Picture.](image-url)
providing public transport services and who have an interest in how these services are delivered. Sifting through these different perspectives to identify tensions between them and those of public transport customers is central to this research. As a result of the ethnographic interviews the ARC team could identify four key stakeholder groups who play different roles within the public transport space. In detail these are:

- **Policy** - People who direct administrative and governance structures and lead or engage in transport decision-making.
- **Precinct** - People engaged in activities located in public transport precincts that benefit from passing pedestrian traffic such as shops and other land-use activities.
- **Providers** - People who provide public transport services.
- **People** - Customers who use public transport services and also those who pass through the area.

The categorization into these four key stakeholders as a result of the ethnographic interviews helped then the research to provide a transparent and trustworthy map of a given situation or system and consequently led to hosting a second round of smaller more specific workshops.

**Participatory Design workshops**

The research team aimed to develop situation maps through participatory design workshops that visually captured the problem context for shared definition of the problem. The research team began through the four key stakeholder groups Policy, Precinct, Providers, People by identifying the system components, their attributes, relationships between component parts and flows between them. In this situation the ARC team focused on information flows.

Situation maps provide a picture of the wicked problem definition involving complex combinations of physical and human decision-making systems, the later involving multiple stakeholder perspectives. Significantly, the methodology attempts to remove the biases of different viewpoints and perspectives that arise between different stakeholder groups involved in the delivery and use of a system. It does this by working to create a customer focus interpretation of the system — one based on the needs and aspirations of the people. The strategy applied for creating change through Situation Mapping was to discuss and outline the **Current Situation** and compare it with an **Aspirational Situation**. Naturally there should be a tension between the current situation and the aspirational situation.

**Current Situation** - To begin further understand the four key stakeholders and the direction the research and project could take, a robust picture of the current state of the each of the four key stakeholders was established. Mapping the current situation in each stakeholder group includes identifying why the system is the way that it is. Consequently it includes any relevant trends, legacy and historical factors that have contributed to the current situation as well as descriptions of its current structure and practices. The Situation Map was developed though three research stream including:

- **People and Organizations History** - where or ganizations have come from and why they’ve changed
- **Key stakeholder perspective** - Passenger, Precinct, Provider and Policy-maker
- **The Physical System (generic and location specific)** – in detail description of network components leading to a ‘Taxonomy of Public Transport Spaces’; Transport information systems as part of operators services and systems; Passen ger travel behaviour features across networks and public transport spaces.

**Aspirational Situation** - The aspirational situation is where the organizations want to be. This should be a strong and evocative reframing of the situation map for the current situation. A methodology called Customer Value Chain Analysis (CVCA) will be used to assist in making decisions as to the best way to
shift the current situation to the aspirational by helping to identify what kinds of shifts will add the most value and benefit customers most. The KPIs to be developed could include:

- Clarity around making interchanges
- Real-time information on service arrivals
- Greater clarity on route geometry
- Linking public transport service levels to key destinations and events

In an iteration and testing cycle between

1. POSSIBLE PATHWAYS TO CHANGE Defined as, once the structure of the current and aspirational situations is clear, pathways that can potentially bridge the tension between the two needs to be identified. This might be encapsulated in discreet research projects; organisational change; changes to processes; shifts in KPIs or a combination of measures and

2. ACTIONS TO CREATE CHANGE Defined as, once a pathway has been identified aimed at shifting the current to the aspirational situation, the next step is to introduce actions and changes that will track the system along that pathway. Measuring progress towards change is critical for assessing the effectiveness of the actions and the pathway.

The research team created visual maps that articulate the relationships between stakeholder groups and systems components in a clear and concise way. These were living documents that were constantly updated, iterated and improved upon as the research team found out more about the situation. Based on two Precinct Situation Mapping Workshops in February and March 2013 the ARC team could define six potential interventions of which the case study ‘The Bus Stop of the Future’ was one of them (Figure 4).

**Participatory Evaluation**

All six potential interventions were introduced in a workshop at the end of March 2013 where for the first time after six months again all key members came together (Figure 5).

The workshop had three general purposes.

- Provide an overview of concepts being used in the core research. In order to give participants the a full background and therefore a clear picture about what has happened in the Ethnographic Interviews and Participatory Design workshops.
- Check-in with industry partners on timeframe and work undertaken to date.
- Discuss ideas for the development of on-site prototypes in the next phase of the project.

The topic 3 had for the paper the main significance as here members could discuss and vote for projects the ARC team will concentrate on in the next year. In detail topic 3 had three parts.

- **Part 1** of the topic 3 provided a brief overview

Figure 4
An output of the Participatory Design workshop – a map of bus-stop ownership.

Figure 5
The Participatory Evaluation workshop.
of the Situation Mapping methodology and the four stakeholder groups (or perspectives) being used to organise the research. These are described in more detail in a prior to the workshop provided document. This section also provided an overview of what has been done since the last workshop in August 2012 with a timeline of these activities attached.

- **Part 2** of the topic 3 discussed the six potential interventions as research topics and/or development of prototypes that would involve on-site testing that would be pursued in the next phase of the project. The overview and results from the group discussion where summarized in the document.

- **Part 3** of the topic 3 discussed the relative merits of each proposal and then ranked them. The results of this discussion, which combined some of the ideas into one project, then lead to the joint decision of which projects to follow up.

Consequently after this process the research team could identify and only now name ‘The Bus Stop of the Future’ as on project amongst two that will be will be developed in the next six months to a year. The ARC team provides regularly after any of main mile stones such as Rich Picture; Ethnographic Interviews; Situation Mapping workshops; or Participatory Evaluation reports and documents to not only to document the results but also inform key members that can to join events due to other commitments.

**DISCUSSION**

What observation does the research draw out of the case Study? Even in retrospective the process and it results (developing a Bus Stop of the Future in a public transport environment) is far from being innovative but this potential conclusion a reader could draw needs to be revisit. As mentioned earlier at the paper the main research aim was to investigate spatial and visual information technologies to allow improved passenger flow and better customer experience and to investigate a complementary approach to transport infrastructure expansion – and its associated costs, disruption, energy use, and implementation periods – through the use of responsive digital information to facilitate improved passenger flow and to offer better customer experiences. The use of digital technologies is un-arguable penetrating our daily life with a large population using these digital devises in a personal and private context. Creating the same openness towards digital technologies in large private or governmental organisations where risk management, revenue strategies and achievements of set KPIs are driving factors is another story. This is particular challenge when the academic team is compromised of a group of trans-disciplinary researchers from architecture, human-computer interaction, robotics, transport planning and design that all have state-of-the-art interests, which want to be applied in the grant. This is particular the case with bringing concepts from robotics engineering into to transport planning where ideas from autonomous systems (as machines) want to infiltrate buildings and typologies to become autonomous systems where spaces can monitor behaviour and autonomous making decisions that changes potentially the operation of these typologies.

**CONCLUSION**

In designing for the transport planning, and the integration of needs to be made as accessible and integrated as possible, supporting individuals to make the best decisions. There has been great uptake in interest as the stakeholders are working together to create these artefacts/tools. The value of applying the methodologies of design thinking in business (Martin, 2007; Martin, 2009) participatory design (Muller and Kuhn, 1993; Buur and Matthews, 2008), and soft-systems methodology (Checkland and Scholes, 1999) for decision making for has resulted in a wider, more inclusive and engaging process for stakeholders to define the future of the transport interchanges. Decisions are made within businesses, and it is important that all involved stakeholders felt a part of the journey. It is through the participatory methods that a multi-stakeholder platform can
begin to define the performance measures of space and interventions – or how they will be judged. On what measures the performance of space will be judged has begun to be defined through the methods used with the multi-stakeholder platform. It is in the collective naming the wicked problem that the performance needs have emerged. The method outlined within this paper could serve as a reference for designers within a similar situation of project and context complexity to emerge with heuristics for how to intervene in the system. Digital technologies in application in wicked problem spaces must be treated with the similar focus to any other intervention with respect to the stakeholder agendas that are involved in each. Next steps, for the project are to develop the projects that have been agreed upon by the multi-stakeholder platform. The continuation of this work through rich pictures, ethnographic interviews, participatory design workshops, and participatory evaluation will be repeated within each progressing stream of activity. This process worked within the current project conditions, with a good level of stakeholder engagement and commitment already developed through the research grant. There are on-going risks as we move from concepts to prototype and later implementation, which must be carefully managed.

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