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FACULTY OF THE BUILT ENVIRONMENT

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"Appraisal of Mass Rapid Transit system options for Milton Keynes using a fully participatory Multi-Actor Multi-Criteria Analysis"

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Being a dissertation submitted to the faculty of The Built Environment as part of the requirements for the award of the MSc in Transport and City Planning at University College London: I declare that this dissertation is entirely my own work and that ideas, data and images, as well as direct quotations, drawn from elsewhere are identified and referenced.

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List of abbreviations

AHP	Analytic Hierarchy Process
AQPS	Advanced Quality Partnership Scheme
AV	Autonomous Vehicle
BRT	Bus Rapid Transit
BRT-L	Bus Rapid Transit Light
BUG	Bus User Group
CBA	Cost Benefit Analysis
CBD	Central Business District
CIL	Centre for Integrated Learning
DfT	Department for Transport
DLR	Docklands Light Railway
e-AV	Electric Autonomous Vehicle
EcIA	Economic Impact Assessment
EIA	Environmental Impact Assessment
EVEC	Electric Vehicle Experience Centre
GHG	Green House Gases
LRT	Light Rail Transit
MAMCA	Multi Actor Multi Criteria Analysis
MCA	Multi Criteria Analysis
MCAF	Multi Criteria Appraisal Framework
MCDA	Multi Criteria Decision Analysis
MCDM	Multi Criteria Decision Framework
MK	Milton Keynes
MKC	Milton Keynes Council
MKDC	Milton Keynes Development Corporation
MRT	Mass Rapid Transit
Non- LRT	Non Light Rail Transit
Non- MRT	Non Mass Rapid Transit
PROMETHEE	Preference Ranking Organisation MeTHod for Enrichment Evaluations
RTV	Rubber Tyre Vehicle
SEA	Strategic Environmental Assessment
SIA	Social Impact Assessment
SLOAP	Space Left Over After Planning

SWOT	Strengths Weaknesses Opportunities Threats (Analysis)
TIDP	Transport Infrastructure Delivery Plan
TOD	Transit Oriented Development
Tram-L	Tram Light

Abstract

Decision making in transport projects frequently leads to extensive discussions, controversy and disagreements. Major projects in particular are the subject of scrutiny by multiple stakeholders. Milton Keynes committed to be carbon neutral by 2050 and seeks to deliver a Mass Rapid Transit system to accommodate growth and achieve ambitious environmental targets. This work examines previous studies conducted by the authority including the effectiveness of the project appraisal techniques used. It seeks to understand if a participatory Multi-Criteria Analysis (MCA) is a better approach to appraise such transport projects. The study examines the importance of incorporating scenario planning as well as local policies and objectives in the appraisal process. It seeks to understand what the balance between the capital cost of the system in comparison to social and environmental objectives should be in the MCA. The study shows that a fully participatory MCA method, developed by combining Multi-Actor Multi-Criteria Analysis (Macharis, 2012) and Multi-Criteria Mapping (Stirling, 1998) and giving maximum power to the stakeholders, is not only a robust method for understanding attitudes towards different options, but also an efficient way to address local challenges.

1. Introduction

Rapid growth, urbanisation and climate change have urged many local authorities to review their functions, including how they plan future growth and transport. Milton Keynes Council (MKC) has responded to the climate change emergency by committing to be zero carbon by 2030 and carbon negative by 2050 (MKC, 2019). Additionally, as part of the new housing deal, MKC has determined that its population will double by 2050 to accommodate 500,000 residents and a Mass Rapid Transit (MRT) system is planned to support this growth in a sustainable way (MKC, 2019).

Mass Rapid Transit can be defined as…

*"…a **passenger transportation service**, usually local in scope, that is available to any person who pays a prescribed fare. It usually **operates on specific fixed tracks or with separated and exclusive use of potential common track**, according to established schedules **along designated routes** or lines with specific stops, although Bus Rapid Transit and trams sometimes operate in mixed traffic. It is **designed to move large numbers of people at one time**. Examples include Bus Rapid Transit, heavy rail transit, and light rail transit" (*Wright and Fjellstrom, 2003)

Figure 1 How the MRT network could look in the city Centre (MK Futures, 2050)

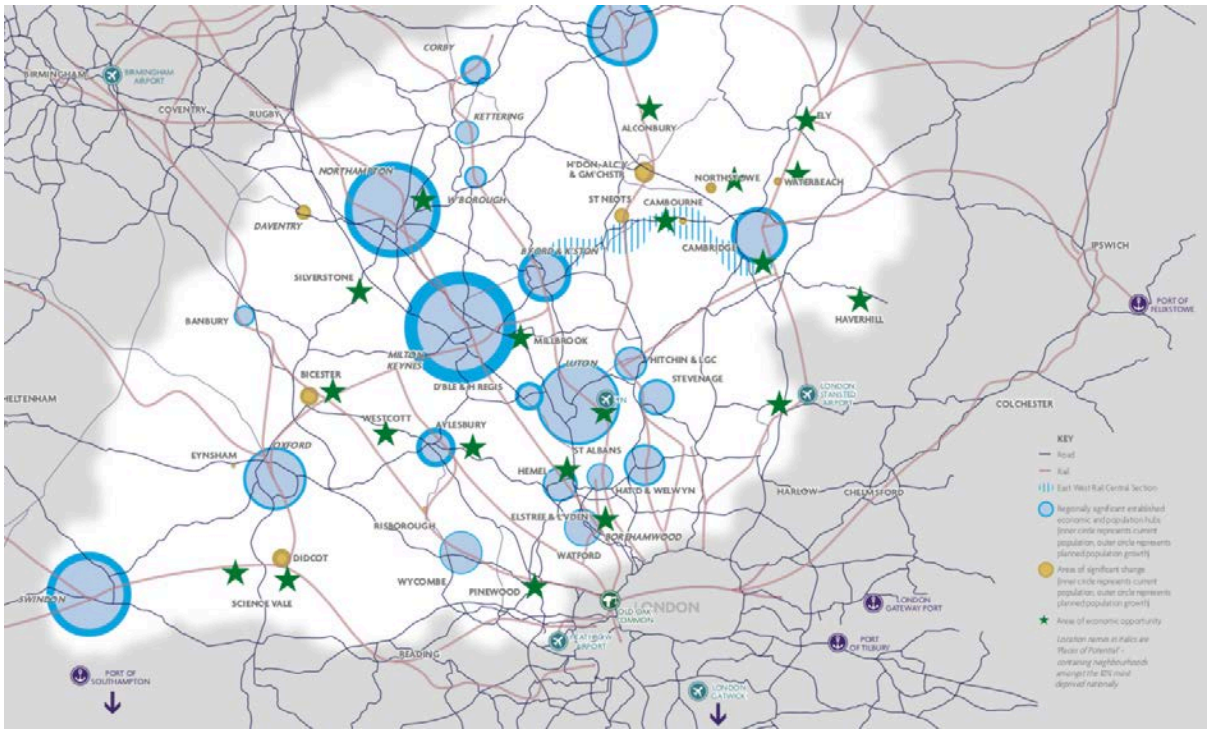
At present, a clear action plan has not been agreed and this study aims to bring some clarity as to the next steps in terms of bringing this project forward. Originally, this study was going to review in detail different MRT systems in line with latest transport planning guidance and

best practice examples and recommend the most suitable system. However, research shows that appraisal methods for transport studies, including those used in previous studies by MKC, have significant gaps and lack consistency. Hence the study changed its focus into investigating appraisal methodologies with a view to understand if participatory Multi-Criteria Analysis approach is more advanced than Cost Benefit Analysis and is more suitable for project appraisals like Milton Keynes' MRT.

1.1. Overview of Milton Keynes

Milton Keynes is a new town in Buckinghamshire located approximately mid-way between London and Birmingham, sitting mid-way on the 'Oxford Cambridge arc' an area of significant economic development (Figure 2).

Figure 2 Regional position of MK (England's Economic Heartland, 2019)



MKC political environment:

The outcome of the Local Government Elections in May 2019 resulted in no party having overall control in MK. A joint manifesto was signed between the Liberal Democrat Group and the Labour Group ensuring clear leadership for the town and delivering the best outcomes for the residents of Milton Keynes. It provides a set of clear priorities, aims and objectives setting the policy framework of MKC:

- Action on climate change and sustainability – making MK the greenest and most sustainable city in the world, implementing the Sustainability Strategy and introducing

an action plan to meet the intention to become carbon neutral by 2030 and a post-carbon city by 2050.

- Sustainable transport – supporting and encouraging innovative transport services with a focus on improving public transport.
- Growth and economic prosperity– supporting the aspiration that MK should grow to a population of 500,000 and beyond by 2050 with a thriving, robust and resilient economy that creates high-skilled jobs.

Sustainability Strategy (Figure 3) This strategy pledges MK to "strive to be carbon neutral by 2030 and carbon negative by 2050 while creating one of the world's most truly sustainable economies and models for growth".

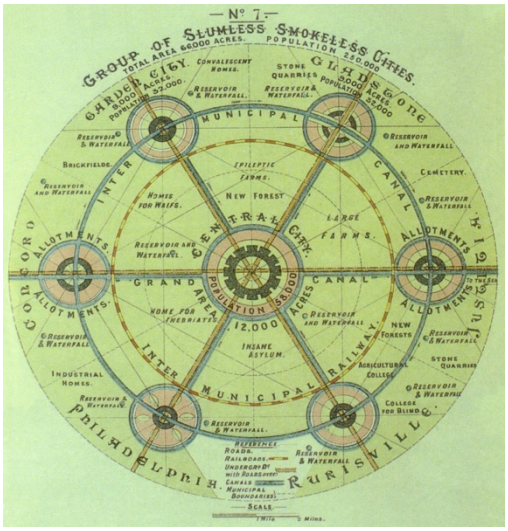
Figure 3 Sustainability Strategy: objectives (MKC, 2019)

Only a small percentage of this reduction comes from transport (MKC, 2019). As per latest DfT data, transport emissions were cut by only 3% nationally (DfT, 2020). This means that any future transport solution in MK has to be ambitious and robust to meet the strategic environmental objectives of MKC.

1.2. Specifics of Milton Keynes: planning history and transport system

Milton Keynes was conceived as a New Town in 1967, when the Development Corporation (MKDC), was created to develop the farmland, villages and rail towns into a modern city as part of the government's solution to a housing crisis (Heritage MK, 2017). MK was created under Ebenezer Howard's vision of "garden cities" (Rydin, 1993). Rich on green and blue infrastructure, MK was an experiment for modernistic and innovative urban settlement. Inspired by an American urbanist Melvin Webber, the town was designed as a poly-centric "post-industrial" car heaven with high-speed grid roads (Bendixson and Platt, 1992). MK's unusual and modern style of housing, inspired by Le Corbusier severely contradicts self-containment sought by the Garden Cities Movement (Alexander, 2009), yet it works as the town is loved by the residents and has attracted international interest for decades (Barkman, 2016).

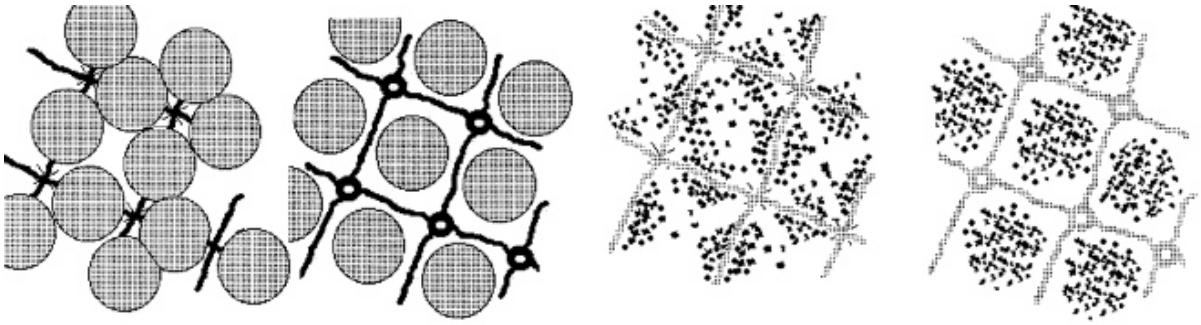
Figure 4 Garden city by E. Howard



The Master Plan spaced grid roads at 1000m to allow freedom and ease of movement by multiple travel modes – car, walking, cycling and public transport (Edwards, 2001). Furthermore, as per Figure 5 (below, left), the original activity centres were planned adjacent to the grid roads. In reality, most of the housing and activity is located in the centre of each grid road, leaving space by the road empty and unused.

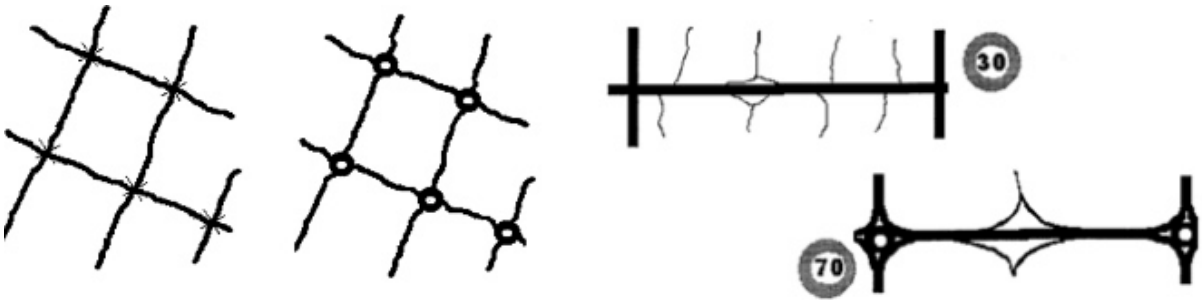
Housing densities are reasonably low, there are extensive public open spaces, and employment and retail uses are decentralised across the city (Jeffery, 2012). Local shopping and service centres were pushed away from the centre too, making them difficult to be seen from the main road. Originally planned mixed developments including high density flats were scrapped giving space to more luxurious lower density housing off-grid roads (Figure 5, right).

Figure 5 Planned vs Actual Layout of Milton Keynes (Edwards, 2011)



The original plan for Milton Keynes was to have a 30, not 70 mph speed on the road which was quickly scrapped by the Corporation. Traffic lights were replaced by roundabouts and only a few turnings would be permitted as seen below (Figure 6):

Figure 6 Planned vs Actual Road Designs (Edwards, 2011)



This made it unsafe for cars and buses to stop on the side of the main road. Land reservations by sides of the road were widened to fit the acceleration and deceleration lanes on roads that became much noisier, meaning that additional planting was required to reduce it. Local shopping and service centres were pushed away from the centre too, making them difficult to be seen from the main road. To date, the town's travel pattens prove that it is still a polycentric city (Figure 7), while the bus network is monocentric (Figure 8).

Figure 7 Top 15 travel destinations (MKC, 2019)

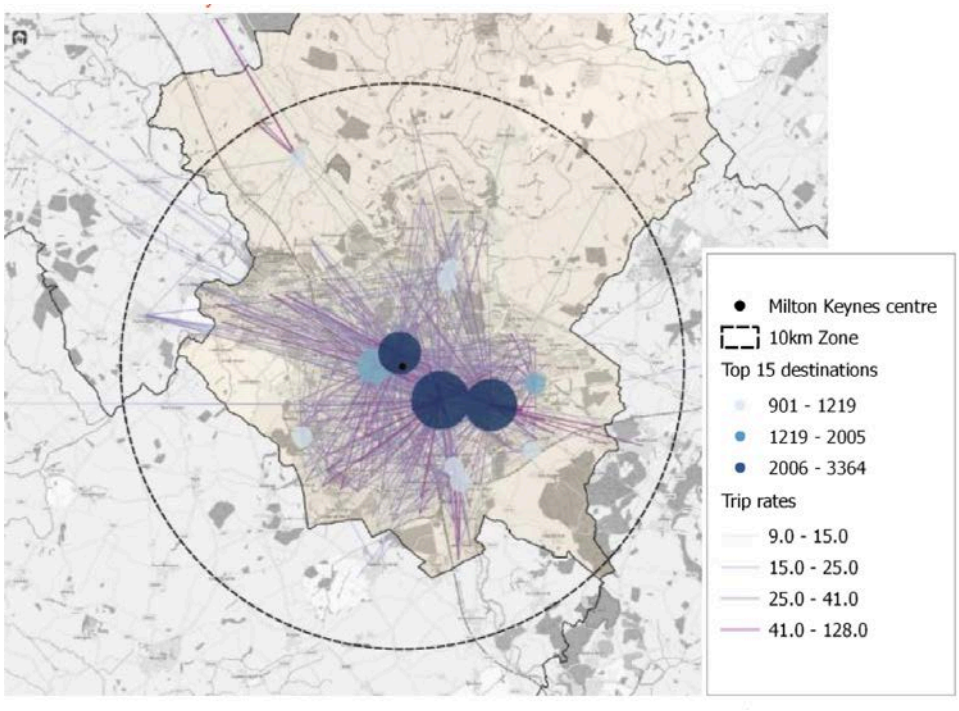
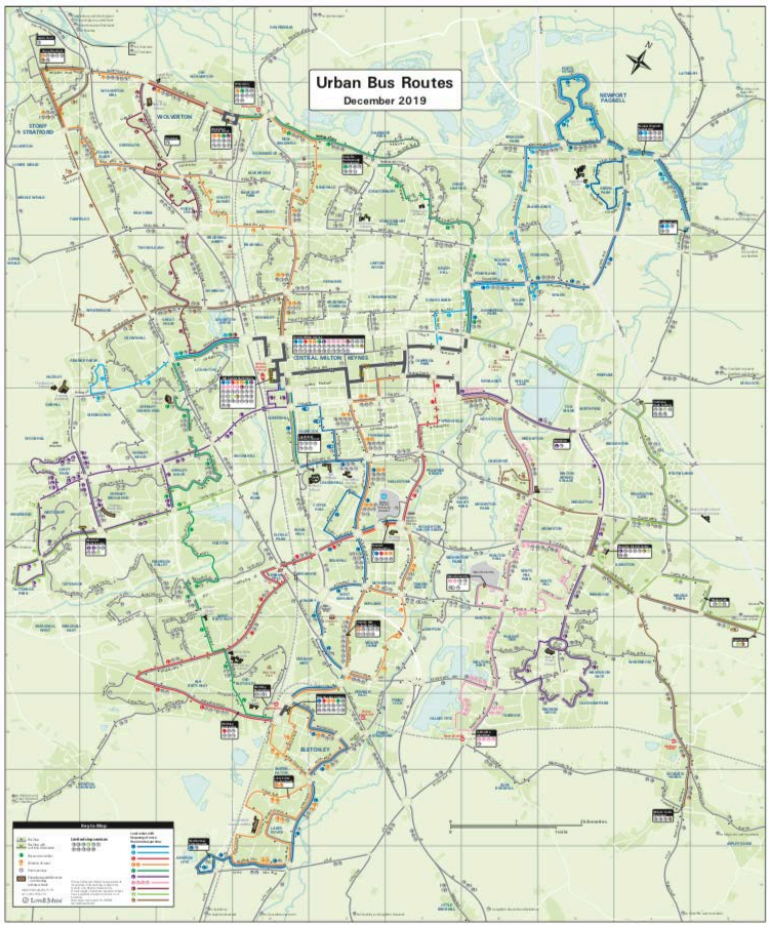


Figure 8 Bus route network (MKC, 2019)



There was a plan to prioritise public transport through a four-loop monorail connecting living areas as beads on strings with a central work and service zone it was withdrawn with a view to developing MRT system in the future (Edwards, 2001). Today, only 6% use public transport in MK to get to work and the car remains the made mode (Table 1).

Table 1 Modal split in Milton Keynes (MKC, 2019)

Journey	Car / Other Modes (%)		
	2011 (Actual)	2030 (Target)	2050 (Target)
Milton Keynes	65 / 35	60 / 40	50 / 50
Intra-borough	80 / 20	70 / 30	55 / 45
Inter-borough	85 /15	80 / 20	60 / 40

Source: Strategy for First Last Mile Travel

1.3. Socio-spatial segregation

MK has a noticeable difference in the distribution of resources across the town - older estates show significantly higher lever of multiple deprivation (Figure 9) which echo the location of the "crescent" – first stage of town planning. Most notably, the borders between deprived and non-deprived areas are sharp and align well with the road network. This suggests that grid-roads act as a spatial and therefore, social separator. Today the town still has the green areas along the main roads referred to as SLOAP (space left over after planning) by Pritchard (2000) which further adds to physical barrier between the estates. Notably, areas where multiple deprivation is the highest have the lowest car ownership and the highest usage of public transport (Census, 2011). Socio-spatial segregation is likely to worsen as future growth areas are on the outskirts of MK as per Figure 10 while public transport struggles to stay commercially viable and inner city continues to become more deprived. Future growth certainly represents funding opportunities for MRT, the new transport system should aim to reduce transport inequality across the borough and to minimise socio-spatial segregation, not add to it.

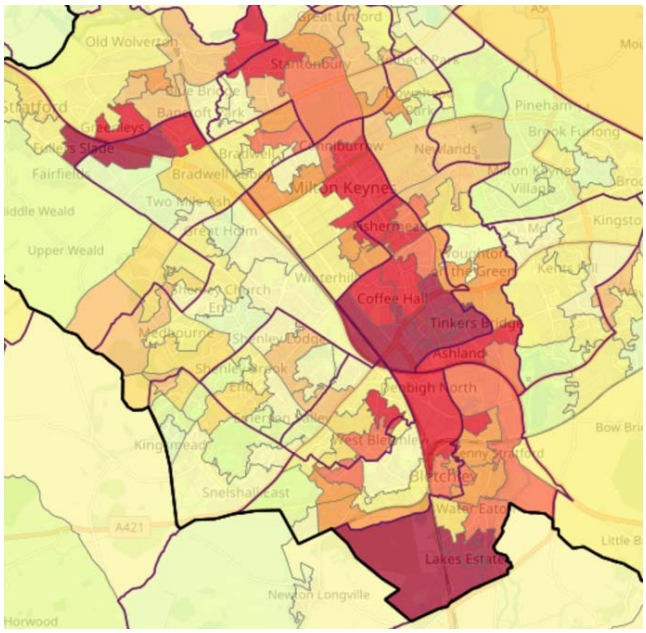
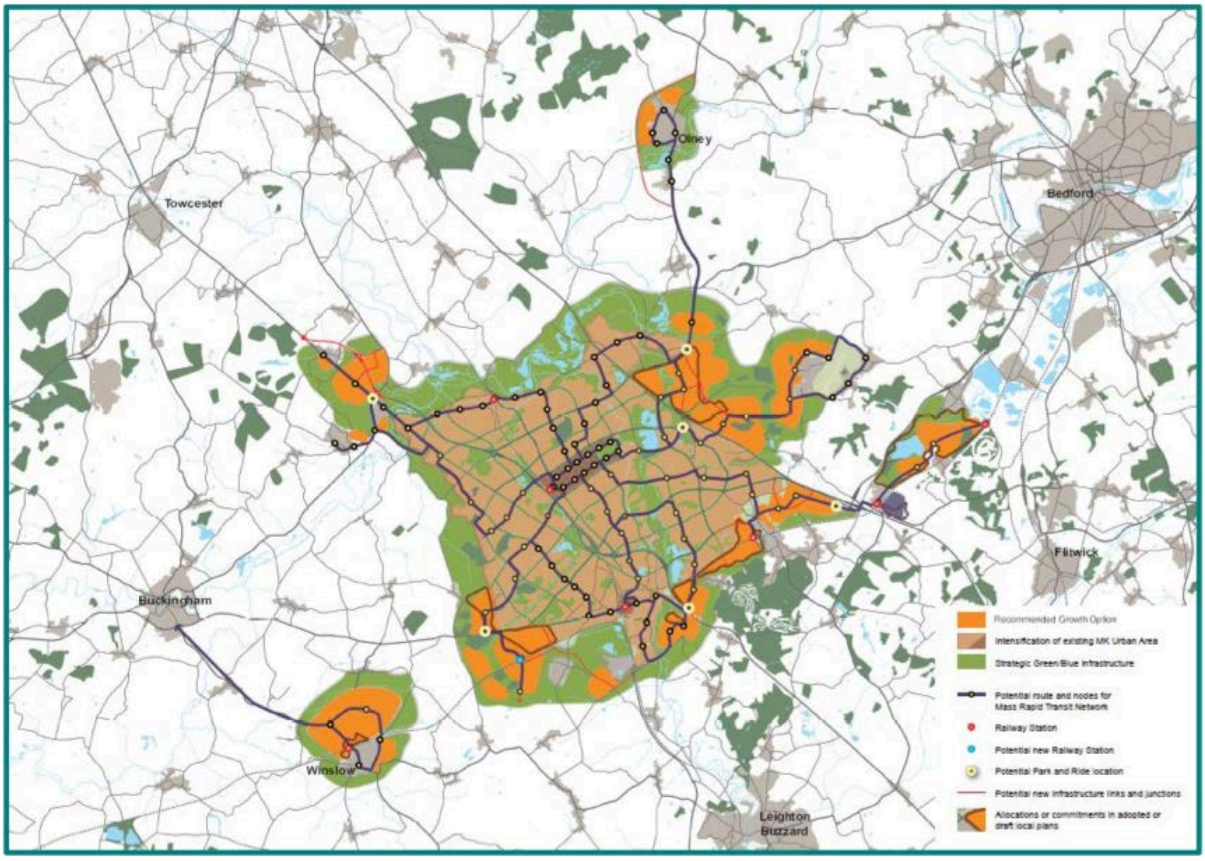


Figure 9 Areas of multiple deprivation in Milton Keynes, Census (2011)

Figure 10 Recommended Spatial Strategy (MKC, 2019)



1.4. SWOT analysis

A policy-Led approach is well-known in project appraisal practice (OMEGA Centre, 2010; Dimitriou et al., 2016; Ward et al., 2016). Some have used SWOT analysis to provide more depth to the issue examined and assist with the appraisal exercise (Wickramasinghe and Takano, 2009; Groselj, et al. 2016). Further to the policy review presented in the introduction, a SWOT analysis was conducted in order to review local, regional and national policies in more depth (Figure 11).

Figure 11 SWOT Analysis (Author's own)

Strengths	Weaknesses
• Strong political will to address climate change issues, including transport • Commitment to be carbon neutral by 2030 • MK Futures 2050 work and evidence on the need to deliver MRT and address transport inequality • Wide roads, lots of space for Public Transport (PT) priority • Good provision of infrastructure for PT – 6 stations, 2 Bus hubs • Good railway links to London and Birmingham • Good location, economic hub that attracts visitors • Space for flexible development of MK and continuous growth • Centre for technology and transport innovation	• Extremely high car usage, car dependency, ample parking (city for cars) • High car parking standards in new developments • Limited PT provision, short operating times, low frequencies • Low bus usage and declining user satisfaction • Unreliable bus service, long travel times, indirect routes • Lack or integration between transport modes, especially at the key transport hubs • Due to low densities, many routes are not commercially viable, high subsidies are required to run services • Outdated infrastructure – bus priority lanes and bus shelters • Limited availability of PT in some areas of the borough and transport inequality + social injustice
Opportunities	Threats
• Growth & Mass Rapid Transit &East West Rail • Regeneration of older estates present new opportunities to improve PT • Income from future and planned developments • Upgrade train stations and interchanges • Integration between PT modes - community transport, Demand Responsive Transport (DRT) and taxis • Manage PT schemes better, better use of finances from parking revenue to support • Better facilities for PT • Car parking restrictions, demand management and P&Rs	• Failure to manage car traffic can result in more congestion, further decline in PT, risk to lose more commercial routes • Economic climate post Covid-19 • Low quality service is discouraging PT use and pushing more people to buy cars • New developments will generate more traffic due to high car parking standards, location of the new housing and the layout of the town • Good Demand Responsive Transport and taxi service can further weaken infrequent and indirect bus routes • Unrealistic targets (MRT, Zero Carbon) vs limited resources and lack of proactivity to deliver major changes in public transport

Based on the SWOT analysis it is evident that MK has strong environmental targets but no clear action plan. Furthermore, dependency on the car and poor public transport service undermines these ambitions.

1.5. Previous MRT studies:

As a New Town, MK is known for being innovative and forward thinking. Several transport studies have explored possible MRT options:

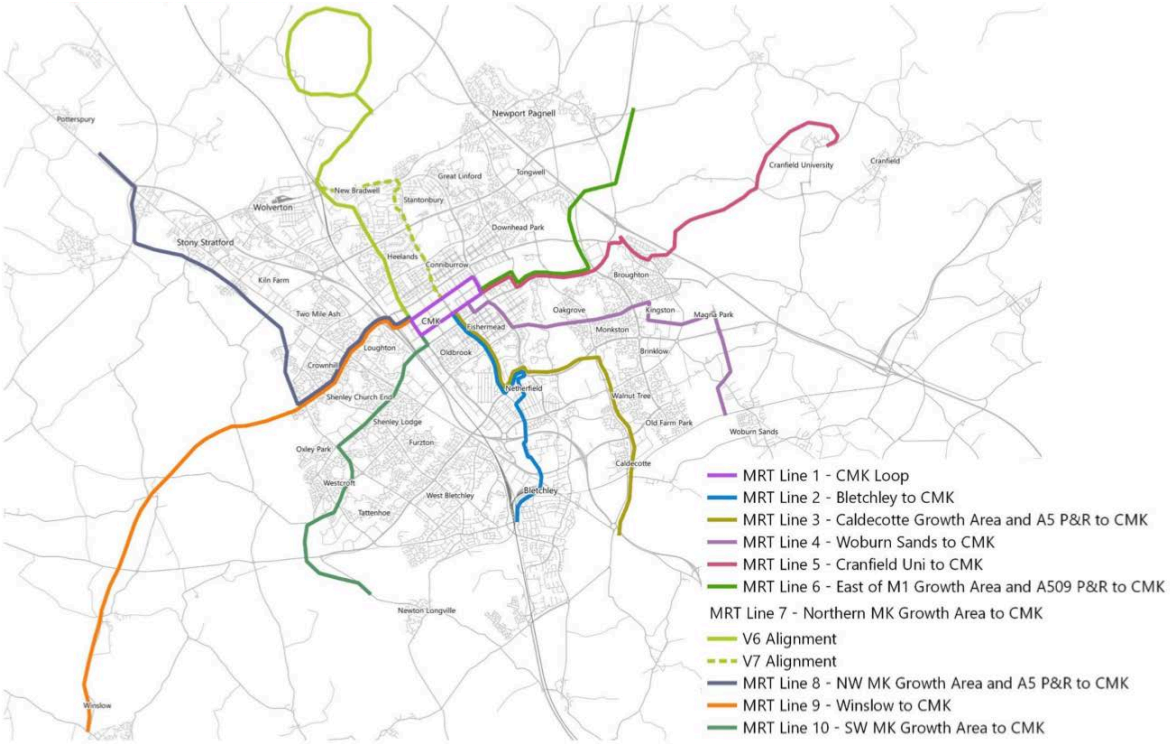
- Study 1: Mass Rapid Transit Study (2019), conducted as part of MK Futures 2050 strategy (2020) by ITP (consultancy)
- Study 2: MKC Transport Infrastructure Development Plan (2019) by WSP (consultancy) as part of/in addition to the Local Transport Plan 4/ Mobility Strategy (2018)
- Study 3 Public Transport Long-Term Vision (2003) Faber Maunsell (consultancy)

Summary of previous studies is presented below.

Study 1 – ITP (2019)

This study appraised two MRT options: Light Rail Transit and Bus Rapid Transit (BRT). The study assumes that routes for both systems would be the same (Figure 12)

Figure 12 Proposed 2050 Rapid Transit Network (ITP, 2019)



A Cost Benefit Analysis (CBA) was undertaken. The methodology used for determining Value for Money was the ***Department for Transport Web*** **Transport Analysis G**uidance (Web TAG). The marginal external benefits reviewed were reductions in congestion, infrastructure, accidents, noise and greenhouse gas emissions, and improved local air quality. It has been assumed that both systems have the same benefits, the same ability to encourage modal shift and the same user satisfaction.

However, the cost of constructing a tram network was estimated to be four times higher than BRT. A tram option for the whole network returns Benefit Cost Ratios of 'poor' to 'low' value for money while a BRT option presents 'high' to 'very high' value for money. The key determinant in both cases was the scale of construction and operational costs relative to the potential patronage, and therefore revenues, that could be generated (as per Table 2).

Table 2 Economic appraisal Benefit Cost Ratio (ITP, 2019)

Interventions	Scenario 1		Scenario 2		Scenario 3	
	RTV	Tram	RTV	Tram	RTV	Tram
Marginal External Benefits (cost benefits) (£m)	£3.4	£3.4	£2.7	£2.7	£3.4	£3.4
Health benefits (cost benefits) (£m)	£1.4	£1.4	£1.5	£1.5	£1.4	£1.4
Cost (including maintenance) (£m)	£1.1	£4.4	£1.1	£4.4	£1.6	£6.6
BCR	4.43	1.10	3.77	0.94	2.95	0.73

Study 2 (WSP, 2019)

The study reviewed a total of 103 transport schemes, including 16 public transport schemes which covered four MRT/Non-MRT options. The schemes were appraised using a bespoke Multi Criteria Appraisal Framework (MCAF). Additional criteria covered a number of objectives including environmental, economic, social, management and deliverability. Two workshops were held where engagement with stakeholders took place: the participants scored public transport options as Low-, Medium-, and High-Priority. As a result, measures like Park and Ride sites, bus priority corridors and improvements to bus infrastructure scored higher than MRT systems. Out of the MRT options offered, BRT and Light-Rail scored the highest, followed by a MK Micro-Metro and Autonomous people movers (Figure 13).

Figure 13 Future Transport schemes (TIDP, 2019)

CONCEPT TYPE

High-Quality Public Transport

CONCEPT NAME

35. Milton Keynes Micro-Metro

INITIAL OPTION SKETCH

Image source: https://www.cambridge-news.co.uk/news/cambridge-news/cambridge-metro-really-ever-going-14229407

DESCRIPTION

Implementation of a micro-metro transit system that delivers a fast and attractive, rubber-wheeled tram service (either driven or autonomous), along dedicated routes across Milton Keynes, potentially linked to Park & Ride Sites *(Option 32)* and Travel Hubs *(Options 25-27)*. The system will provide: dedicated bus lanes; bus priority at junctions; distinctive stops with real-time passenger information; cashless payment systems and network branding.

BENEFITS	DISBENEFITS
▪ Encourages modal shift by providing access to a fast and attractive alternative mode of transport ▪ Potential to expand and support other transport infrastructure and growth areas	▪ Reallocation of carriageway space could constrain capacity for other modes of transport ▪ Significant investment required to facilitate the creation of the routes and development of fleet ▪ May require alterations to the cost and availability of parking in Milton Keynes to be financially viable
PROGRAMME	**FUNDING OPTIONS**
▪ Long-term (10+ years)	▪ Milton Keynes Council ▪ South East Midlands Local Enterprise Partnership ▪ England's Economic Heartland ▪ Central Government Funding Bids

Milton Keynes Transport Infrastructure Plan – Option Proformas

CONCEPT TYPE

High-Quality Public Transport

CONCEPT NAME

36. Milton Keynes Bus Rapid Transit

INITIAL OPTION SKETCH

Image source: https://www.belfasttelegraph.co.uk/news/northern-ireland/belfast-rapid-transit-system-faster-buses-in-belfast-and-a-train-to-the-airport-30286938.html

DESCRIPTION

Implementation of a high-quality Bus Rapid Transit (BRT) delivering a fast and attractive service on dedicated routes across Milton Keynes, potentially linked to Park & Ride Sites *(Option 32)* and Travel Hubs *(Options 25-27)*. The system would provide: dedicated bus lanes; bus priority at junctions; distinctive stops with real-time passenger information; cashless payment systems and network branding. Potential routes include: Central Milton Keynes to Eaton Leys, Central Milton Keynes to Woburn Sands and east of the M1 (pre-2025) and city-wide post 2025.

BENEFITS	DISBENEFITS
▪ Encourages modal shift by providing access to a fast and attractive alternative mode of transport ▪ Potential to expand and support other transport infrastructure and growth areas	▪ Reallocation of carriageway space could constrain capacity for other modes of transport ▪ Significant investment required to facilitate the creation of the routes and infrastructure ▪ May require alterations to the cost and availability of parking in Milton Keynes to be financially viable
PROGRAMME	**FUNDING OPTIONS**
▪ Medium-term (5-10 years)	▪ Milton Keynes Council ▪ South East Midlands Local Enterprise Partnership ▪ England's Economic Heartland ▪ Central Government Funding Bids

CONCEPT TYPE

High-Quality Public Transport

CONCEPT NAME

37. Milton Keynes Light Rail Transit

INITIAL OPTION SKETCH

Image source: https://www.toronto.ca/news/opinion-story/8713240-dreschel-lrt-full-steam-ahead-/

DESCRIPTION

Implementation of a high-quality Light Rail Transit (LRT) system delivering a fast and attractive tram service (either driven or autonomous), along dedicated routes across Milton Keynes, potentially linked to Park & Ride Sites *(Option 32)* and Travel Hubs *(Options 25-27)*. The system would provide: dedicated tram lines (segregated and mixed traffic); tram priority at junctions; distinctive stops with real-time passenger information; cashless payment systems and network branding.

BENEFITS	DISBENEFITS
▪ Encourages modal shift by providing access to a fast and attractive alternative mode of transport ▪ Potential to expand and support other transport infrastructure and growth areas	▪ Reallocation of carriageway space could constrain capacity for other modes of transport ▪ Significant investment required to facilitate the creation of the routes and infrastructure ▪ May require alterations to the cost and availability of parking in Milton Keynes to be financially viable
PROGRAMME	**FUNDING OPTIONS**
▪ Long term (10+ years)	▪ Milton Keynes Council ▪ South East Midlands Local Enterprise Partnership ▪ England's Economic Heartland ▪ Central Government Funding Bids

CONCEPT TYPE

High-Quality Public Transport

CONCEPT NAME

38. Autonomous People Movers

INITIAL OPTION SKETCH

Image source: https://insideevs.com/autonomous-navya-arma-shuttle-lease/

DESCRIPTION

Trial and introduce micro-autonomous people movers for short local trips. The transit vehicles can be personal, or shared. Example journeys that could be undertaken using autonomous people movers include: movements between shopping centres in Central Milton Keynes; movements between key employment centres and travel hubs (Milton Keynes Central Railway Station); movements between Central Milton Keynes and key trip attractors such as the Milton Keynes University Hospital, Stadium MK and Bletchley.

BENEFITS	DISBENEFITS
▪ Encourages modal shift by providing access to a fast and attractive alternative mode of transport ▪ Potential to expand and support other transport infrastructure and growth areas	▪ Potential safety risks associated with autonomous vehicles in urban areas ▪ Requires technological infrastructure to ensure vehicles are connected
PROGRAMME	**FUNDING OPTIONS**
▪ Medium-term (5-10 years)	▪ Milton Keynes Council ▪ South East Midlands Local Enterprise Partnership ▪ Central Government Funding Bids ▪ Scheme Operators

The study did not look at the MRT options in depth and stakeholders were involved only for a single stage of appraisal: for scoring, where a single-dimension criteria was used (priority).

Study 3 (Faber Maunsell, 2003)

Although the report is quite outdated, it acknowledges MK's unique structure, such as grid road squares discouraging the passage of through traffic, meaning that bus routes would have to be either remote from users if they run along grid roads or be "torturous and inefficient" if they loop through estates to get closer to users (Pharoah, 2003). The report reviews densities and concludes that higher housing density is required to support public transport. The study also acknowledges that Milton Keynes has a polycentric nature where employment nodes are scattered around the town. Three transit options are reviewed: light rail transit, guided light transit (rubber wheels, partly on tracks) and busways.

Different transport scenarios are explored on two growth options using an Economic Assessment and the report concludes that based on Cost Benefit Ratio (CBR) guided Light transit and Light Rail Transit (LRT) have "very poor" performance. While the study acknowledges that these modes have the ability to attract more users (higher modal shift), it is not incorporated in the assessment process. Stakeholder engagement was limited to the client group and no stakeholders were involved in the appraisal exercise.

1.6. Summary of findings

While being extremely expensive, large infrastructure projects can generate significant economic, financial, environmental, social, political and technological effects on the area and communities (Hirshman 1995, Omega Centre 2011, Dean 2018). Appraisal methods have changed and evolved significantly, but there are concerns about the excessive importance given to monetary/economic aspects, such as CBA (Parkin and Sharma 1999, Brown et al., 2001, Alexander 2006a, Naess 2006, Metz, 2008, Omega Centre 2010, Hickman 2016, Dean 2018). Indeed, Study 1 and Study 3 heavily weighted cost of the system without expediting other benefits much. O'Neil (2009) argues that public transport is a social infrastructure and does not have to be profitable. In the Study 2, where stakeholders were involved, it was evident that preference was given to rail based systems, though costs have been excluded from the exercise and details on each intervention have not been presented.

Furthermore, limited stakeholder engagement and the exclusion of many project stakeholders from the appraisal process (as seen in Study 1 and Study 3) has been further criticised by

colleagues (Haezendonck 2007, Macharis et al., 2009, Colomb 2010, Omega Centre 2012, Dean 2018).

Table 2 below summarises methods employed in three MRT studies, level of stakeholder engagement and participation in the appraisal process. It also summarises how effectively environmental and social benefits have been incorporated in the methodology:

Table 3 Appraisal Methods employed by previous MRT Studies (Author's own interpretation)

	Study 1	Study 2	Study 3
Appraisal Method employed	CBA	MCA	CBA
Stakeholder engagement level in the study	None	Some	Some
Stakeholder involvement in scheme appraisal	None	Low	None
Environmental and social benefits included in the appraisal method	No	Yes	No

Furthermore, the recent and the most advanced study (ITP, 2019):

- Excludes local policies and objectives from assessment (i.e. environmental targets)
- Acknowledges that bus services are more likely to be used by people without access to a car, rather than positively selected based on the merits of the service. It excludes social equality and social benefits from equation.
- Assumes that modal shift will raise from 6% users to 15% (same for BRT and LRT) yet it does not incorporate the likelihood of each of the modes to achieve a modal shift
- Presents limited evidence and supports arguments to strengthen the BRT option (bias)
- Despite recognising that Milton Keynes was conceived as and still is a poly-centric town, the study suggests monocentric routes and fails to acknowledge the unique structure of the town

To conclude, all three MRT studies show limitations and therefore do not offer MKC enough information to make a fully informed decision as to which option to proceed with. The research project further proceeds with the research question in the following section.

2. Research aim

Following a review of previous MRT studies, it can be concluded that there is a significant gap between the system that is required to achieve strategic environmental targets and the system that is being proposed (BRT).

On analysis of the ITP study of 2019 it seems naïve to assume that implementing bus priority measures along existing bus routes will achieve a significant modal shift in Milton Keynes. Arguably, more than "delivering more of the same" is required to reach the sustainability targets. Modal shift in a car centric city, where residents are spoilt by excessive parking and fast roads, will be difficult to achieve.

The structure of Milton Keynes is unique: population and activities are dispersed across a polycentric town topped by reasonably low housing density. The transport system including its high-speed grid roads and its impact on public transport has to be recognised.

Lastly and most importantly, the incomplete and subjective assessment of a transport project can not only fail to improve the town but potentially further contribute to the current environmental issues and social injustice, as well as strategic environmental issues for the generations to come (Dean 2018). Furthermore, absence of a clear future transport scenario generates a lot of uncertainty and does not make the existing approach to MRT system planning robust. To recap, two major problems with MRT project planning to date are:

1) The appraisal methods used in previous studies do not incorporate the following:
   I. Stakeholder views
   II. Benefits and impacts of different MRT systems (social, economic, environmental etc.)

2) MRT planning/vision does not incorporate the following:
   I. Local strategic priorities and policies
   II. Structural differences (polycentric city with grid roads)
   III. Long-term vision/ scenario (where do we want to be)
   IV. Strengths/Weaknesses/Opportunities/Threats for public transport in Milton Keynes

2.1. Research questions

To understand which MRT system would be the most suitable for Milton Keynes, the following questions arise:

- What appraisal techniques are available and which method is the most effective?

In particular, is there a transport project assessment methodology that is capable of adequately capturing the benefits of each transport system, local challenges, policies and strategies that give a wholesome and holistic answer?

- What should be included in the assessment criteria?

How important are the following: cost, various benefits, aesthetics and how should different objectives be prioritised? Hypothetically, different systems have different benefits and putting the cost of the system aside, these benefits should be acknowledged by stakeholders.

- How important is it to have a clear vision/scenario when planning a major transport project?

Lack of vision generates uncertainty. Would setting a clear scenario make a difference in the level of ambition that the future MRT system planning will incorporate?

- What is the role of stakeholders in the appraisal of a transport project?

Stakeholder engagement is certainly important, but how much power should be given to stakeholders? Why is only limited power usually given to stakeholders? How risky is it to give full power to stakeholders? Can stakeholders change the results of previous studies?

2.2. Research objectives

To answer the main question the following research objectives have been identified:

1. A review of appraisal methods suitable for major transport projects. The selection of the most suitable MCA method for practical application to this case study.
2. To understand Milton Keynes' background; summarise local challenges and objectives, future growth opportunities and threats through a SWOT analysis. To set a clear transport scenario for MK2050
3. To undertake the best practice review: understanding the main attributes of a good transit system and how these attributes can be captured through the objectives of the appraisal method
4. Practical application of a participatory MCA method on a wide range of stakeholders
5. Critically assess results to understand to what extent the use of participatory MCA methodologies enhances current appraisal practice (and if it does).

2.3. Research methods

In an effort to develop a new insight into a relatively unknown topic, in this case the practical application of a participatory MCA, the exploratory studies research method has been chosen. According to Selltiz and colleagues (1965), this method's research technique entails:

- a literature review
- an in-depth survey of people with expertise and
- an analysis of one or more case studies.

Below is a summary of the proposed research methods for the different stages of this work.

Table 4 Research methods employed, and types of data used

	Research Objectives	Research methods employed	Type of data used
1	Review of transport project appraisal methods	Literature review	Secondary
2	Understanding specifics of the case study. Setting a transport scenario for Milton Keynes 2050	Literature review Case study analysis	Secondary
3	Best practice review: attributes of good transport systems and how to incorporate this in the appraisal process	Literature review Informal survey	Secondary Primary
4	Testing participatory MCA on the case study of Milton Keynes	Literature review Workshops with different stakeholder groups	Secondary Primary
5	Analysis of the data and results, understanding strengths and weaknesses of the method.	Findings from previous sections Practical use of the method Feedback from participants (survey)	Secondary Primary

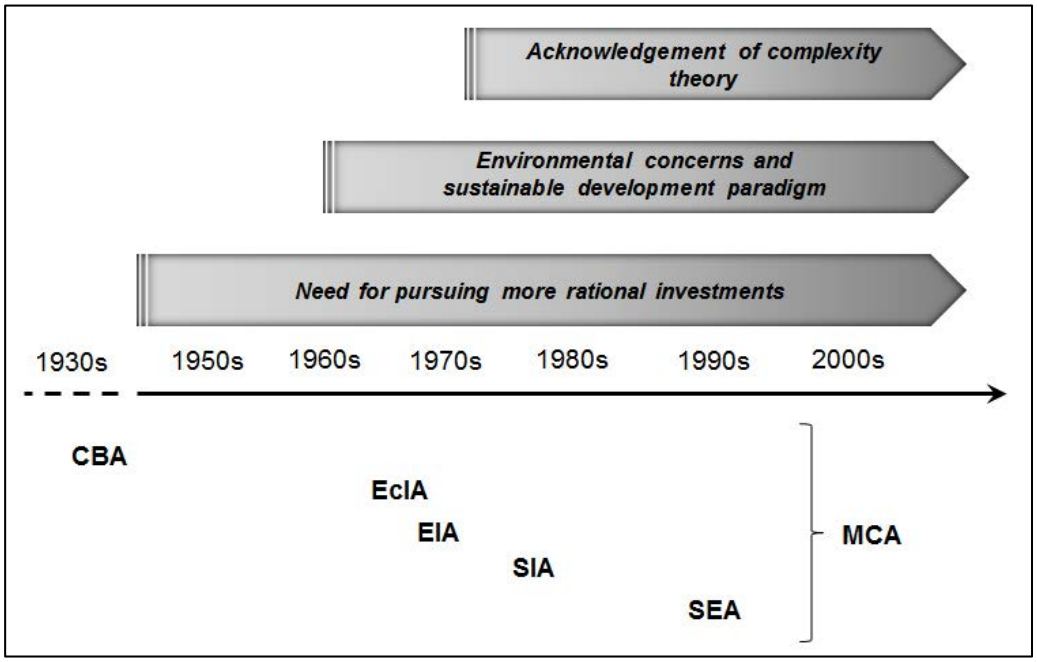
3. Literature review

This main literature review is conducted around the different research methods available to date with a focus on participatory MCAs, their strengths and limitations. Additional literature seeks to understand the importance of incorporated in MCA and reviews the attributes of a good public transport system to incorporate the findings in the author's own participatory MCA.

3.1. Appraisal methods: from CBA to MCA

Several colleagues researched a more advanced appraisal technique where stakeholders play an important role – a participatory Multi-Criteria Analysis. The International Society on Multi-Criteria Decision-Making stresses that there are several different methods, techniques and tools available, where multiple objectives and decision criteria or attributes can be incorporated in the analysis of and solution to the problem (Gamper et al., 2006). To understand this method better, a brief review of different appraisal techniques is conducted. Dean (2018) accurately summarised the evolution of appraisal methods in Figure 14.

Figure 14 Historical development of transport and infrastructure appraisal practice (Dean, 2018)



Cost-Benefit Analysis (CBA) is one of the first appraisal methodologies that seeks to establish the social desirability to implement a project mostly from the economic point of view (Sinden and Thampappilai, 1995). According to many economists including Snell (1997) and Egras (2009), this method is straightforward and relatively rigorous in determining if a project

is a good allocation of resources, easily understandable by decision-makers, well-researched and inclusive.

Later **Environmental and Social Impact Assessments (EIA and SIA)** have been introduced to evaluate any possible negative and damaging impacts of a project (environmental and social consequences) (Sadler and Varheem, 1996; Parkin and Sharma 1999). These approaches are well supported by several academics (Senécal, et. al ,1999; Petts, 1999; Glasson et al 2005) as they are seen to constitute a valid appraisal framework for assessment of environmental and social consequences of a project where these factors are weighted at the same level as economic and technical aspects. The stakeholder engagement during these methods is optional and views of the public do not have to be taken into account (Behre et al. 2015).

Multi-Criteria Analysis (**MCA)** methods typically encompass a wide array of techniques and tools through which multiple objectives and criteria can be incorporated into the analysis. There are several MCA methods, but typically according to Triantphyllou and Mann (1989), all of them have the following key elements:

- Options – a proposed solution to a perceived problem
- Objectives - a specific achievable result
- Criterion – a measurable indicator of performance that relates to an objective
- Dimensions- aggregation of objectives and appraisal criteria in overarching areas, typically clustered around the economic, environmental and social dimensions, the main three pillars of sustainable development.
- Score – an interval measure that identifies the performance of an option against a specific objective. Interval scales can be numeric or semantic and score high-performing options higher on the sale and low-performing options – lower.
- Weight – the level of importance of objective and appraisal criteria are measured by a coefficient where a high-importance objective/criteria are identified with higher weighting.

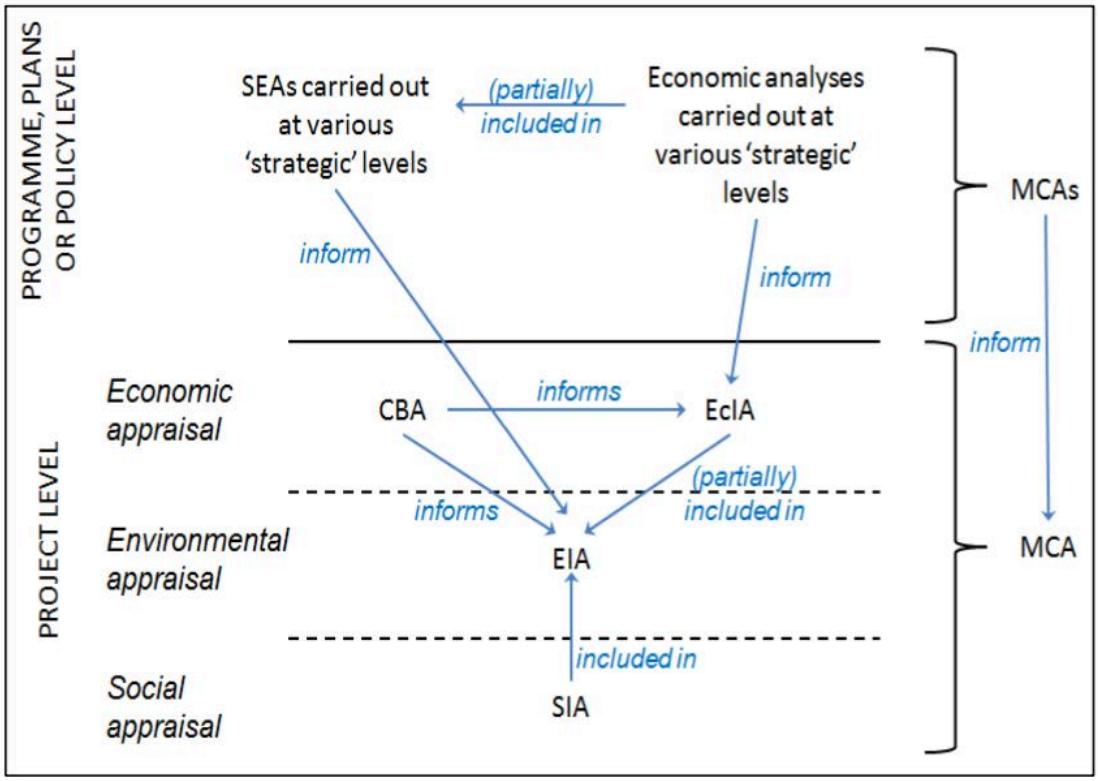
In overall the multi-criteria method can be defined as a set of rules establishing the nature of options, objectives, criteria, scores and weights in a way where these elements are ultimately aggregated together (Munda, 1995 ; 2008). Different scenarios (economic, environmental, social, political and technological) can be used to change the weights of objectives and criteria to examine the robustness of the project under a different future conditions (Goodwin and Wright, 2001; Belton and Stewart, 2002, Lambert et al., 2012). Dean (2018) illustrated the concept of MCA below:

Figure 15 Example of performance table for one option (Dean, 2018)

Option *a*					
Appraisal dimensions	**objectives**	**criteria**	**Weights *w***	**Scores s**	**Total *w x s***
Economic	Objective 1	Criterion 1,1	W 1,1	S 1,1	(W 1,1) x (S 1,1)
		Criterion 1,2	W 1,2	S 1,2	
		Criterion 1,3	....	....	
	Obejctive 2	Criterion 2,1	....	....	
		Criterion 2,2			
	Objective 3	Criterion 3,1			
Environmental	Objective 4	....			
		....			
	Objective 5	....			
	Obective 6	...			
Social	....				
	....				
.....					
.....					
				OVERALL PERFORMANCE	**∑ *w x s***

There is a significant amount of literature supporting and criticising both CBA and MCA methods (Hill, 1966 and 1973), though lately the complementariness between the two approaches have been identified and a combination of CBA and MCA has been used (Salling et.cal, 2005, Sijisma, 2006, Schuttle, 2010). Furthermore, CBA and MCA can be used in two stages, where one is used as a primary screening tool to identify and reflect poor projects and the other for a detailed assessment of the most suitable project proposal (Parkin and Sharma 1999, Goodman and Hastak 2006. Dean (2018) explains that all appraisal methodologies are closely linked not only at a project but also at programme, plans and policy levels as per figure below, hence non-MCA methods have been included in the review:

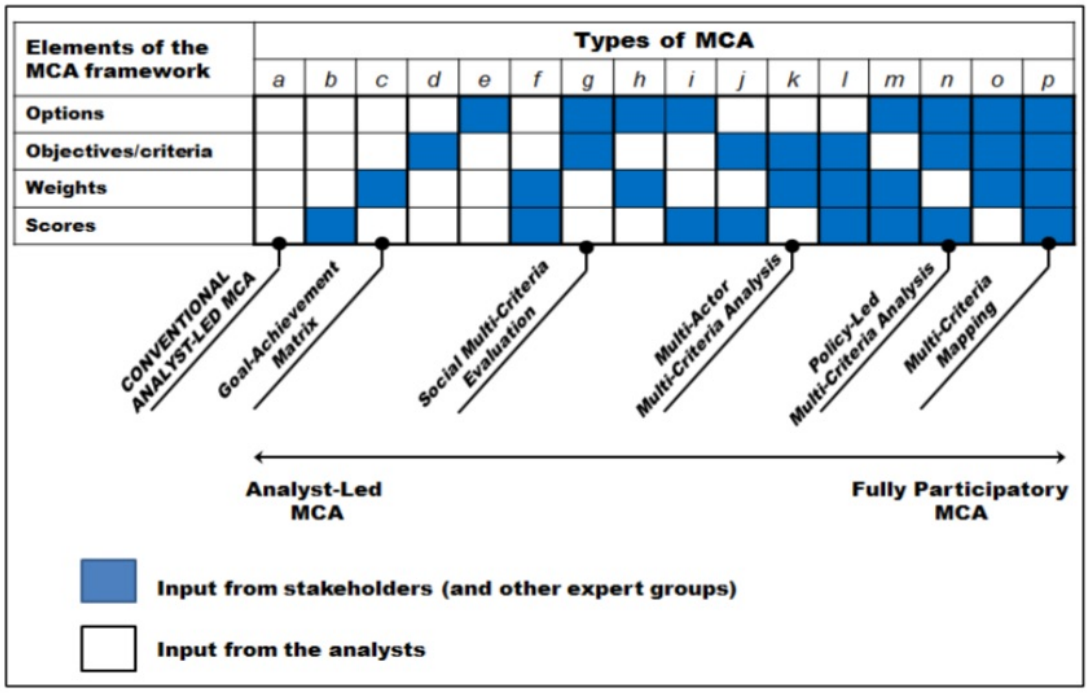
Figure 16 Relationships between appraisals (Dean, 2018)



3.2. Participatory MCA

MCA methodologies can be distinguished as analyst-led (non-participatory) and participatory depending on the number of actors involved in the process. Analyst-led appraisals can be carried out by a single analyst or a small team of experts who are well suited to make complex technical decisions (McAllister 1982, Stirling, 1998, Funtowicz and Ravetz 1991). Participatory techniques involve different parties to get a better understanding of a problem through a collaborative and democratic approach, Stirling, 1998, Funtowicz and Ravetz 1991. Engagement can be done through a co-operative decision-making process where only a few people with similar interests are involved, for example where participants are members of the same organisation; or through negotiation decision-making where many people are involved often with conflicting interests (Lu et al., 2007, Kilgour et al., 2010). The latter describes a typical decision-making process for a complex major project involving a number of actors and agencies. Dean (2018) reviewed types of participatory MCAs and mapped it based on level of stakeholder participation as seen in Figure 17.

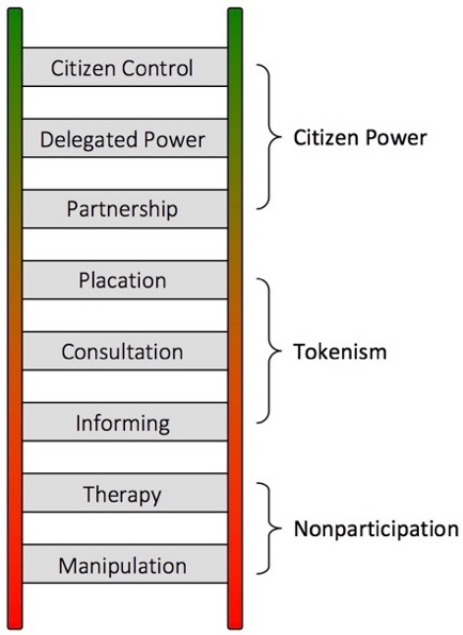
Figure 17 Level of participation within MCA (Dean, 2018)



For example, in the Goal-Achievement Matrix method (Hill, 1966, 1968, 1973) stakeholders are involved only during the determination of the weighting scheme while Multi-Criteria Mapping(MCM) (Stirling 1998) provides participants with the opportunity to drive all stages of the process.

As stressed in the Skeffington Report, published in 1969, (Cullingworth,1999) a systematic approach to community involvement in planning is important. Public participation is seen as a good thing, but for projects like MRT appraisal is not seen as essential element. Arnstein's ladder of participation (Arnstein, 1969; in Cullingworth, 1999) suggests that there could be different levels of participation (Figure 18) where higher rungs (citizen power) of the ladder are seen as desirable, while lower rungs (nonparticipation and tokenism) are seen as bad practice that should be avoided. Applying the ladder to the participatory MCA, it appears that the different methods are giving citizens different powers – citizen control, delegated power or partnership. The following two methods are reviewed in detail:

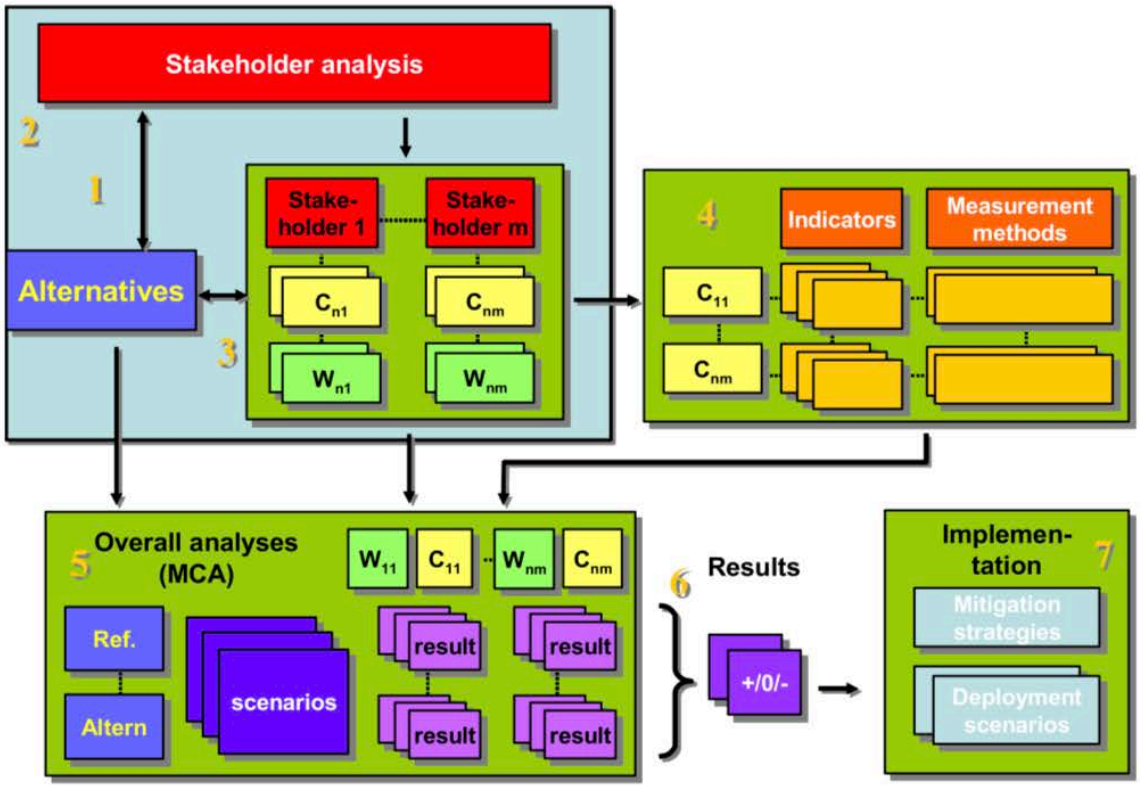
Figure 18 Arnstein's ladder of citizen participation (Cullingworth ,1999)



3.2.1. **Multi-Actor Multi-Criteria Analysis (MAMCA)**

MAMCA (Macharis, 2004, 2011, 2015) methodology is an interactive decision-making process where several stakeholders are involved, and their opinions are explicitly taken into account throughout the structured analytical process. It typically combines Analytic Hierarchy Process (AHP) and Preference Ranking Organisation MeTHod for Enrichment Evaluations (PROMETHEE) techniques to manage objectives and scores. The typical process consists of a stakeholder analysis, selection of alternatives, setting the criteria and weights by stakeholders followed by an analyst led scoring as per Figure 19:

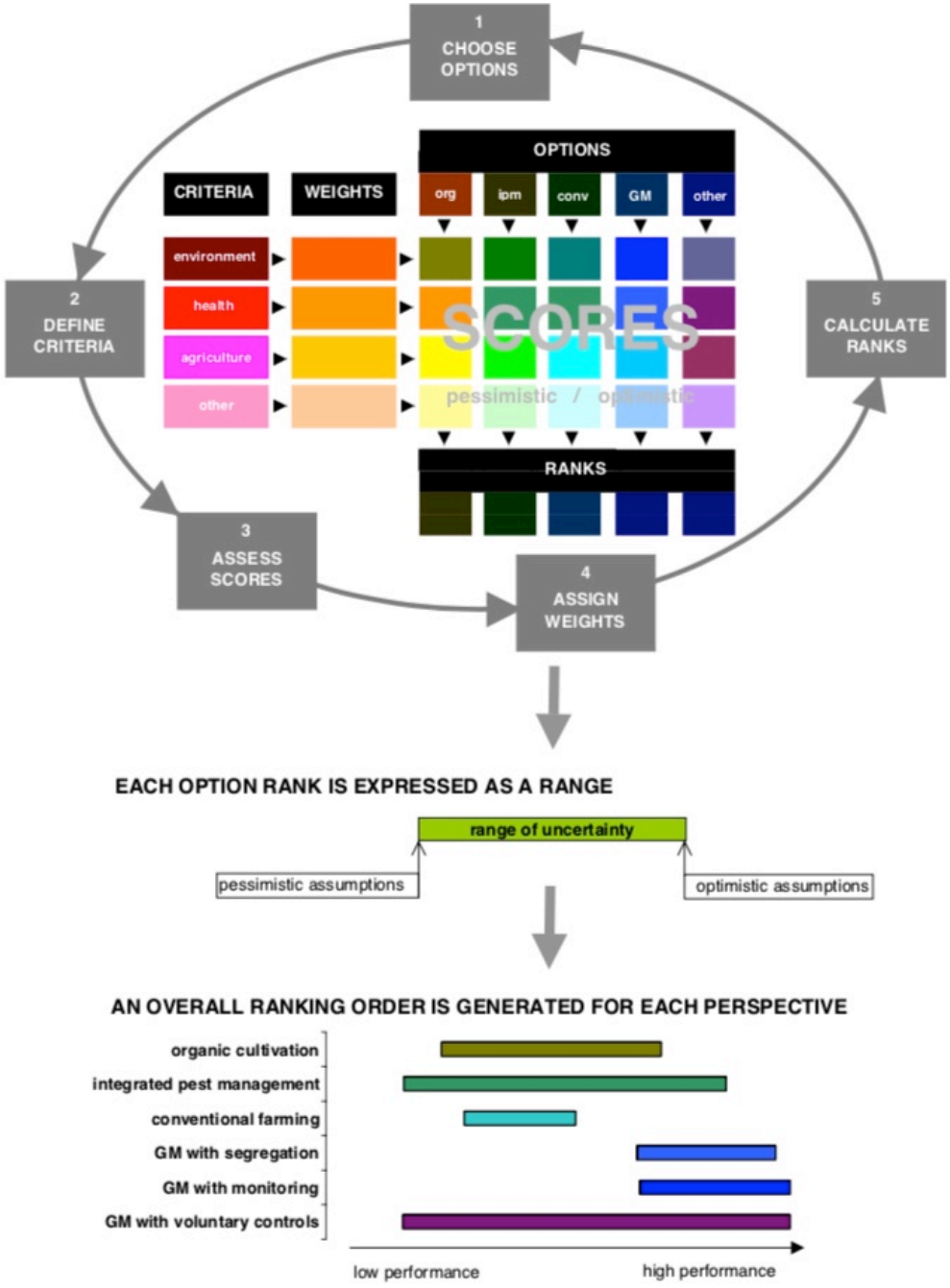
Figure 19 Methodology for MAMCA (Macharis, 2004)



3.2.2. **Multi-Criteria Mapping (MCM)**

MCM by Stirling & Mayer (1999) is an appraisal method where participants can choose their own options (including identification of new options) to appraise during individual interviews. The method includes defining the appraisal criteria, scoring of the performance of the chosen options and allocating weighting to each criterion in terms of its relative importance (Stirling, 2000). The method also acknowledges the uncertainty and ambiguity associated with possible outcomes.

Figure 20 Multi Criteria Mapping (Stirling, 1998)



MCM (Sirling 1998) approach gives more power to the stakeholders (citizen control) while MAMCA (Macharis, 2012) falls between partnership and delegated power. As this is an academic exercise and the planning guidance suggests “the greater the public participation the better”, a mix of appraisal methods will be adopted for the practical part of this study.

3.3. Defining Criteria for MCA: What makes public transport good?

Density and urban design

Naess and colleagues (2017) stressed that characteristics like the density of an area are important when planning transport. For instance, urban sprawl and low-density developments have been criticised for decades (Buchanan 1965, Hall, 1966, Lynch, 1961, Neman and Kenworthy, 1989) mainly because they are seen as inefficient land use (Camagni et. al, 2002) and encourage car dependency (Newman and Kenworthy, 1999). The relationship between public transport usage and density is a highly debated topic, but Guerra and Cervero (2010; 2011) clarify that low density does not necessarily mean low ridership. Mees (2010) highlights that European countries like Germany focus on timings and frequency of services to generate high ridership numbers. Walker (2012) assessed American cities and concluded that indeed, density is not an issue, the efficiency and convenience of transit is the priority of a good transit.

Some say that there is a strong relationship between the uptake of sustainable modes of travel, urban space and public health (Townshend and Lake, 2009, Tzoulas, 2007, Dulal et al. 2011). This relationship is well incorporated in TfL's Healthy Streets scheme appraisal in London (TfL, 2018). Good urban design and attractiveness of neighbourhoods can make a significant difference in levels of active travel and uptake of sustainable transport modes (Giles-Corti et al.,2013, Townshend and Lake, 2016, Townshend, 2017).

Boarnet and Crane (2001) argue that the built environment comes first, and travel behaviour follows. MK was built for cars where pedestrian space is allocated in the form of a fully segregated pathway network (Redways), pedestrians use underpasses and bridges to cross the major roads and not much thought was given to the quality of urban environment since MK was built. Could this be the reason for low public transport usage? Urban environment is clearly an important factor to consider when planning a new MRT and therefore should be included in the appraisal process.

Long term vision/ commitment

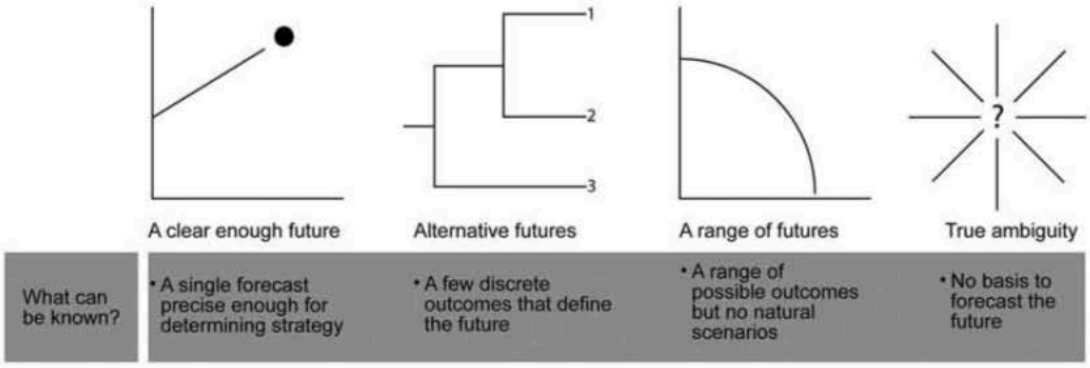
The polycentric and disperse nature of MK along with its distinctive but questionable urban design appears to be an obstacle to delivering a well-functioning public transport system. Are these obstacles fixed or can these issues be rectified? Some argue that housing and business nodes are very quick to change, and transport infrastructure responds to these changes slowly (reactive) (Lynch, 10972, Wegener and Furst, 1999). Transit-oriented developments (TODs) are seen as a more proactive town planning approach in terms of addressing environmental and social issues (Cervero et al. 2002, Cervero and Kockleman, 1997). TOD means densification around transit stations and building new nodes (housing and economic activities)

in those areas well-connected by public transport to reduce car dependency and determine future travel patterns (proactive). The approach works well in Europe, for instance Freiburg, Germany has a great public transport network and low car ownership levels. However, there has been a consistent TOD supporting transport planning approach for the last 60 years. One of the tools that can aid more strategic thinking is development of a longer-term scenario and working backwards from it (backcast).

Backcasting/Scenario planning:

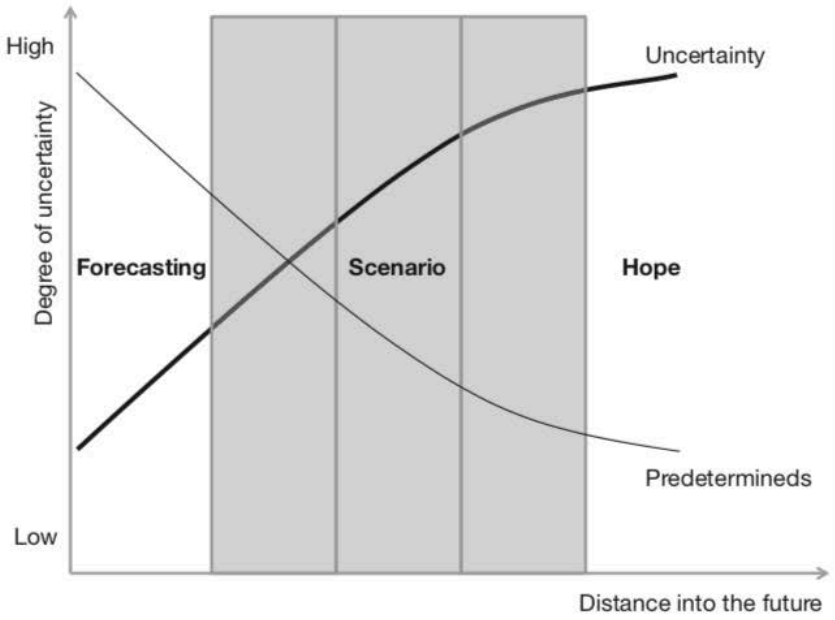
Uncertainty often accompanies large projects. According to Courtney 1997 and Frommelt 2008, there are different levels of "residual uncertainty" as presented in Figure 21 below.

Figure 21 Levels of residual uncertainty (Hickman, 2014)



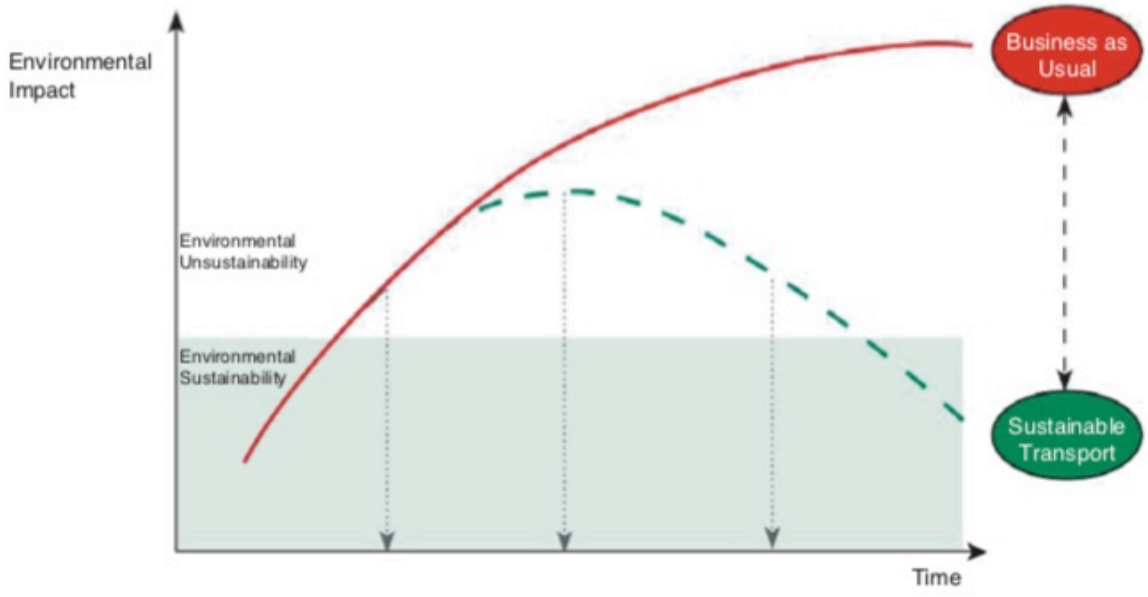
These range from low levels of uncertainty where the future is clear enough to a high level of uncertainty where there is no basis to forecast the future. Van der Heijen (1996) explains how the level of uncertainty changes over time, he stressed that in the long term everything is uncertain and strategies at that point is based on "hope" (Figure 22).

Figure 22 Predictability and uncertainty (Van der Heijden, 1996)



Hickman and colleagues (2014) use a Backcasting tool (Figure 25) to address uncertainty and reach sustainability targets (such as reduction of emissions).

Figure 23 Backcasting study approach (Hickman, 2014)



While MKC has already undertaken some future transport scenario work, the future transport path has not been chosen, hence planning MRT systems to date has been done with a lot of uncertainty and a distinct lack of strategic vision. TIDP study (MKC, 2019) presents the following possible transport scenarios:

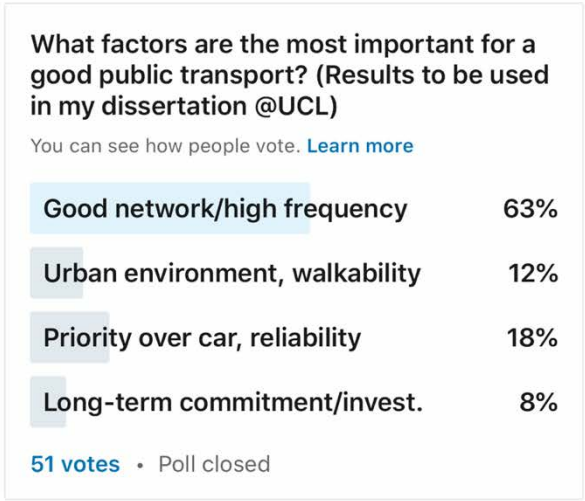
- Scenario 1: Sustainable Milton Keynes (Sustainable Max)
- Scenario 2: Autonomous, Seamless and Shared Milton Keynes (E-Av Max)
- Scenario 3: Mobility Choices Milton Keynes (Choices Max)

In all three scenarios MRT plays an important role, but there is no clear MK 2050 transport scenario. The hypothetical is scenario therefore presented later in this document to encourage strategic thinking among the participants.

3.4. Additional data gathering

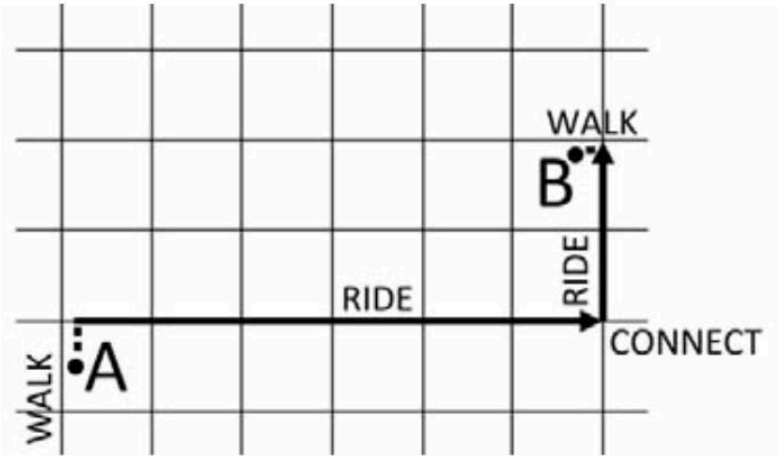
Despite the additional literature review that is not the priority of this work, it is still unclear what the formula for a successful MRT is. I therefore invited colleagues on LinkedIn to think about the best transport system in the world that they have used and answer one question “What factors are the most important for a good public transport?”. An astonishing 63% (32 out of 51 respondents) answered that “good network and high frequency”, as suggested by Mees (2010) , is the most important feature of a good transport system followed by other factors as per Figure 24.

Figure 24 LinkedIn Survey (Author's own)



Walker (2012) argues that grid roads are the perfect opportunity to optimise network and deliver an efficient and cost-effective transfer-based (Figure 25) transit. This is a crucial finding to this study as it stresses that our existing bus network is inefficient and is not fit for purpose, while the grid road system has potential to run a first-class transit. These findings should be validated by the stakeholders.

Figure 25 High-frequency transfer-base system (Walker, 2012)



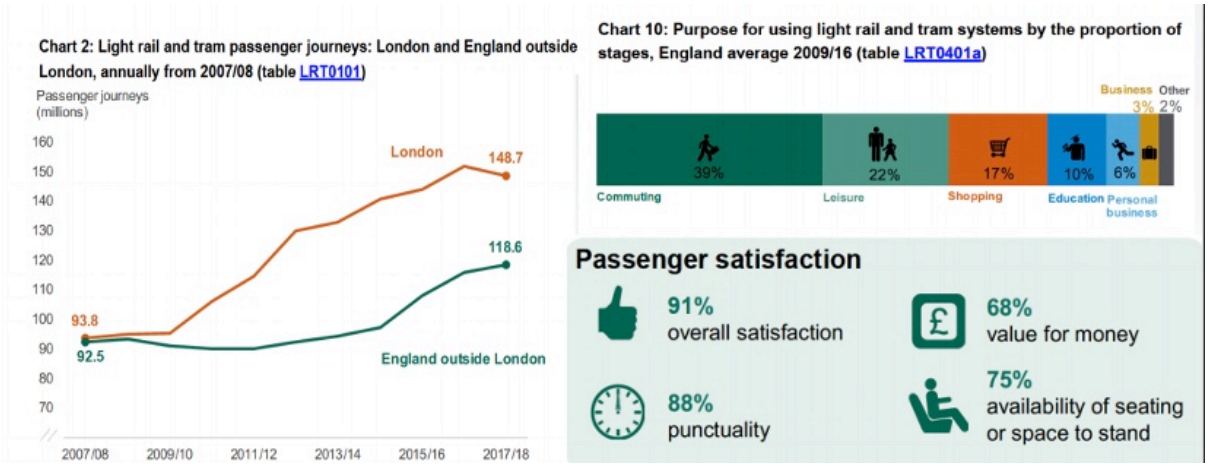
Understanding regulatory framework

Privatisation and the deregulation of public transport in 60s had a significant impact on the level of control that National Agencies and Local Authorities have over public transport operators today. While these policy decisions lifted the financial burden from the government's shoulders (Banister, 1994), the long-term benefits are questionable. Today, bus operators have full control over services and are able to change routes, frequencies and request additional funding from government to operate unprofitable services (Glaister et al.,1998). As per Bus Service Act (2017), bus operators in Milton Keynes operate under a Voluntary Quality Bus Partnership. The bus usage along with user satisfaction are rapidly declining and there is little the authority can do to help apart from allocating further subsidies. While the possibility of signing an Advanced Quality Partnership Scheme (AQPS)[1] is there, the decision to run a particular service lies with the operating company, which means that the local authority's ambitions in delivering a BRT system could be limited by what the operators are willing to provide.

Any major project, including Light Rail, requires a full appraisal by the Department for Transport as well as securing statutory powers under the Transport and Works Act 1992. This means that only a selected few local authorities in the UK have succeeded in delivering schemes like tram (Pharoah, 2003). Despite urban light rail showing a high passenger satisfaction and high patronage (Figure 26), only a few light-rail schemes have been delivered in the UK. This could be because DfT's project appraisal method prioritises CBA above other factors.

[1] Advanced Quality Partnership Scheme (AQPS) requires bus operators to meet specific local standards in order to use infrastructure provided by the local authority

Figure 26 Light rail and Tram statistics (DfT, 2018)



3.5. Key findings

As per literature review, CBA and MCA proved to have certain gaps. CBA is one of the most commonly used appraisal techniques (Vickerman, 2000, Goodman and Hastak, 2006) but has been criticised for assigning significant importance/weight to travel time saving when assessing transport system investments (Metz, 2008), along with excluding stakeholders during the analysis (Macharis and Bernardini, 2015) and a “disregard of intra-generation equity” (Van Wee, 2012).

The most suitable participatory MCA for this project is MAMCA (Macharis, 2012) because it is well researched, there is an online tool available to assist with complex calculations and it has previously been applied to transport projects. With the exception of option selection, stakeholders are extensively involved throughout the process. However, because MK has not properly assessed the MRT options, the participation will be extended to allow stakeholders to select their preferred MRT options, as per the Multi-Criteria Mapping Method (Stirling and Mayer, 1999).

While Dean’s (2018) and Macharis (2015) criteria used for transport projects comes from a policy review (similar to Policy-Led Multi-Criteria Analysis, Omega 2011) and can be broadly adopted, it needs to be specific to MK.

However, it doesn’t appear that other participatory MCAs looked at attributes of a good transit, hence more research was required to understand what defines a public transport system to make an appraisal method even more robust. As such, efficient and high frequency network is a key to a good public transport system, followed by priority over car, urban design and a long-term strategic planning. It was important to understand the limitations of a local authority

in delivering an MRT, for example, cost will be the most important factor if a project requires DfT's approval and hence BRT would be much easier to deliver. However, due to limited powers, the success of BRT system will depend on public transport operator's cooperation. Furthermore, low densities and grid roads are not necessarily obstacles for a good transit, quite the opposite: the new MRT system must use these unique features to it's advantage. Finally, strategic vision and long-term commitment to delivering a high quality MRT is crucial. While majority of these findings can be incorporated in the appraisal exercise, others would have to be left in the background.

4. Methodology explained: MAMCA with a twist

Dean (2018) explains that the MCA method and its outputs will vary depending on the level of stakeholder engagement. While Macharis' (2012) MAMCA appears to be a good solution to the underlying issues of the MRT in Milton Keynes research undertaken to date, it doesn't give stakeholders the freedom to explore MRT options of their own choosing. Going that one step further in terms of the level of stakeholder participation and selecting a fully participatory MCA where stakeholders instead of appraising pre-selected scenarios choose their own MRT must give a more holistic solution, similar to the method adopted by Stirling (1998) - Multi-Criteria Mapping.

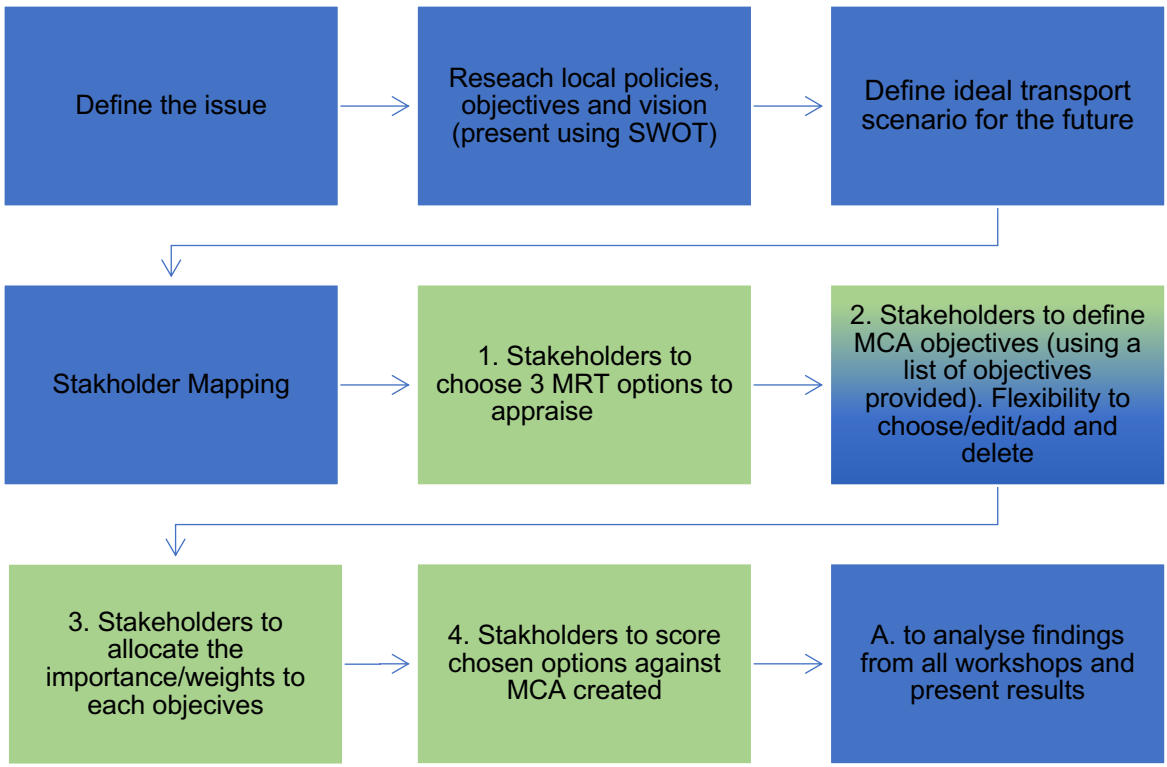
Therefore, the appraisal method chosen for this study is a mix of MAMCA (Macharis, 2012) and Multi-Criteria Mapping (Stirling, 1998), referred to as

"Fully Participatory (Multi-Actor) Multi-Criteria Analysis".

4.1. ***Fully Participatory (MA)MCA explained***

Figure 28 explains the approach that was taken to assess the options:

Figure 27 Fully Participatory MCA process (Author's own)



Analyst undertook the following steps

- Define the issue, analyse it and develop a framework for a solution
- Research case study, policies, strategies, ambitions, issues with public transport and present findings (includes current issues and future opportunities, SWOT)
- Define the ideal transport scenario for the area to allow options to be appraised with a more strategic approach
- Identify the stakeholders (conduct workshops)
- Prepare objectives and sub-objectives for stakeholders to choose from
- Analyse the results

As per picture above, **participants** are involved in:

1. Selecting MRT options
2. Defining objectives (sub-objectives only)
3. Allocating weights against objectives and chosen sub-objectives
4. Scoring the initially selected options against their own criteria

4.2. Process explained

Selecting MRT options

Dean (2018) and Macharis (2015) and the majority of other authors use pre-defined options in their methodologies, but for this case study the desire is to not limit possible MRT scenarios. Therefore, my methodology has an additional step where participants are asked to choose three MRT options to appraise. It was intended to give participants full freedom for creativity when offered to choose any known MRT options and therefore detailed scenarios were not prepared. It has been anticipated that other options than those on the list would be put forward and for consistency purposes detailed MRT scenarios weren't offered.

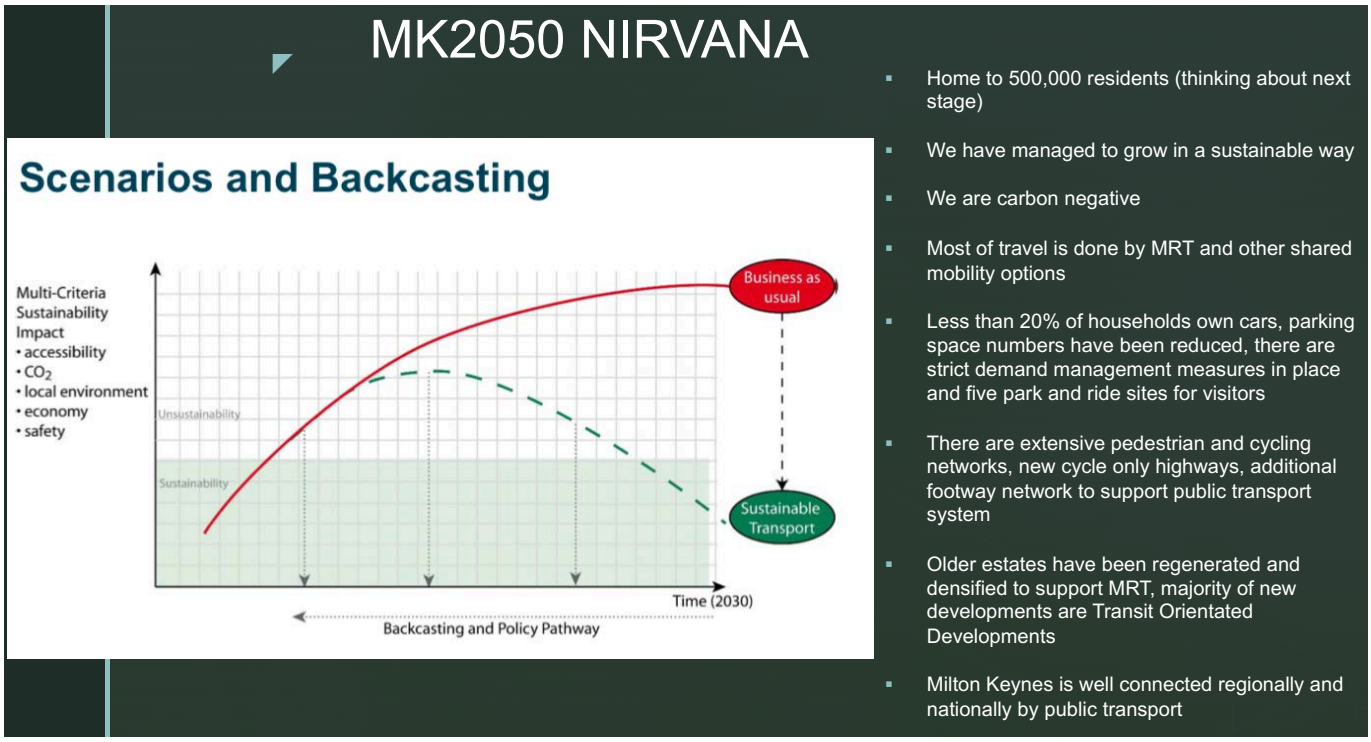
Approach to workshops

As the appraisal process was complex, participants were sent a short workshop briefing note (Appendix A) which presented participants with information on possible MRT options to choose from and how each mode is likely to score on the most controversial aspects like cost, also included was a SWOT analysis for public transport in Milton Keynes.

On the day participants were given a short presentation about Milton Keynes, briefed about different appraisal methods, previous MRT studies and explained the purpose of the

workshop. Participants were invited to appraise transport system in line with the MK2050 ideal transport scenario as follows (Figure 29):

Figure 28 MK2050 Future Transport Scenario/Vision



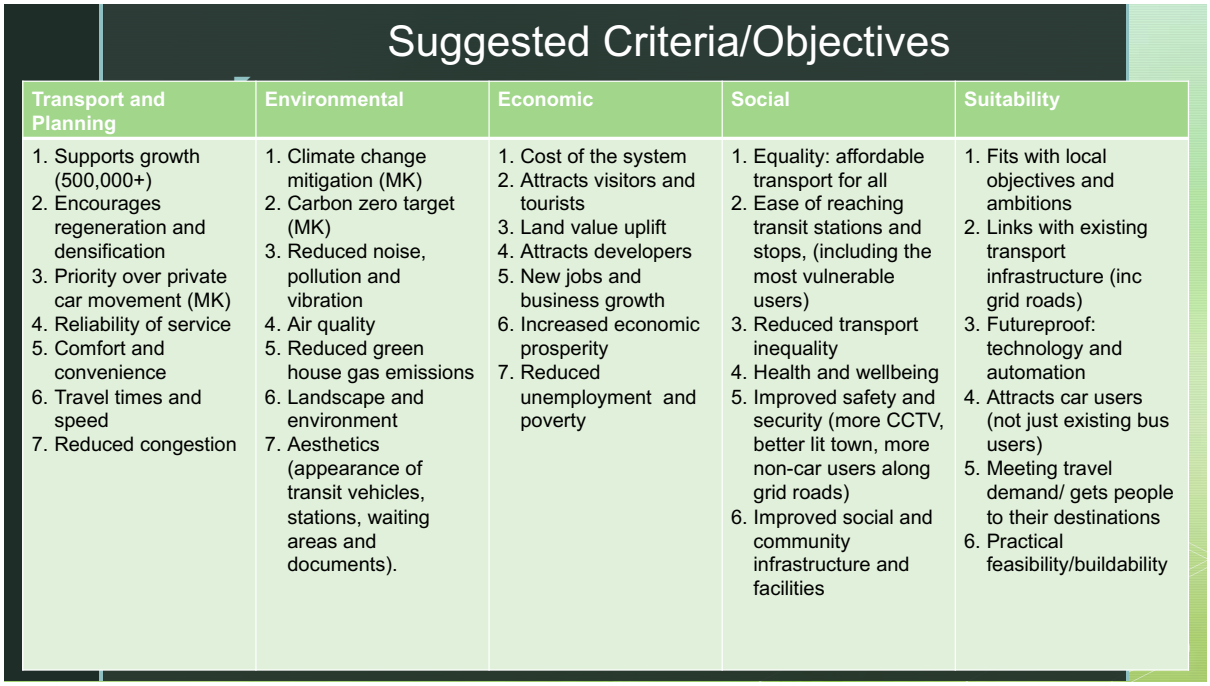
Participants were then presented with seven MRT and Non-MRT options and were encouraged to choose their own options if they wanted to:

1. BRT
2. BRT light
3. Tram
4. Tram light
5. Metro
6. Monorail
7. NON -Transit Demand Responsive Transit

Criteria selection:

Participants were invited to consider the proposed criteria for assessing the options and to select sub-objectives in five categories/objectives Transport and Planning, Environmental, Economic, Social and Suitability (TEESS).

Figure 30 Suggested criteria (Author's own)



Suggested Criteria/Objectives

Transport and Planning	Environmental	Economic	Social	Suitability
1. Supports growth (500,000+) 2. Encourages regeneration and densification 3. Priority over private car movement (MK) 4. Reliability of service 5. Comfort and convenience 6. Travel times and speed 7. Reduced congestion	1. Climate change mitigation (MK) 2. Carbon zero target (MK) 3. Reduced noise, pollution and vibration 4. Air quality 5. Reduced green house gas emissions 6. Landscape and environment 7. Aesthetics (appearance of transit vehicles, stations, waiting areas and documents).	1. Cost of the system 2. Attracts visitors and tourists 3. Land value uplift 4. Attracts developers 5. New jobs and business growth 6. Increased economic prosperity 7. Reduced unemployment and poverty	1. Equality: affordable transport for all 2. Ease of reaching transit stations and stops, (including the most vulnerable users) 3. Reduced transport inequality 4. Health and wellbeing 5. Improved safety and security (more CCTV, better lit town, more non-car users along grid roads) 6. Improved social and community infrastructure and facilities	1. Fits with local objectives and ambitions 2. Links with existing transport infrastructure (inc grid roads) 3. Futureproof: technology and automation 4. Attracts car users (not just existing bus users) 5. Meeting travel demand/ gets people to their destinations 6. Practical feasibility/buildability

They were then invited to choose/keep/add 3-4 sub-objectives in each of the categories.

Stakeholders/participants

The following stakeholders have been identified and grouped in 8 workshops:

- Group 1 Transport Planners (Milton Keynes Council)
- Group 2: External Transport Experts
- Group 3: Environmental focus
- Group 4: Youth
- Group 5: Centre for Integrated Living (CIL) (people with mobility issues)
- Group 6: Bus User Groups
- Group 7: Business groups, Architects, Property Developers, Urban Designers
- Group 8: Academia

Car drivers and residents of MK?

Originally, a car user group was proposed. Instead participants were asked if they are local to MK and if they are car drivers. The majority of them were drivers.

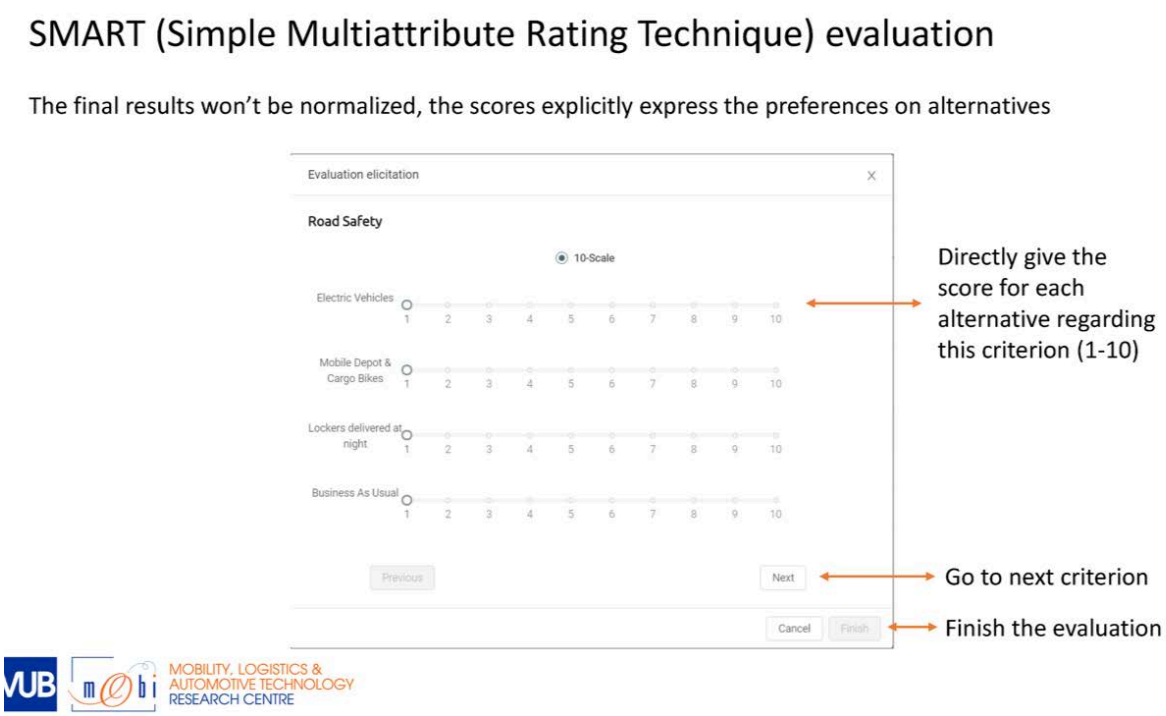
Weights

Each group has 100 points to allocate across five objectives. Next, participants had to allocate further 100 points across sub-objectives in each of the categories.

Scores

Participants then score on a 10-point scale using Simple Multiattribute Rating Technique:

Figure 31 Calculation methods explained (Macharis, 2015)



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5. Research ethics

As this research required stakeholder engagement, data gathering has been undertaken in accordance with UCL research ethics guidance. All of the participants have consented to take part in this study. Participants' personal data has been stored and processed in compliance with General Data Protection Regulation (GDPR 2018)

6. Analysis of data

6.1. Stakeholder analysis

Eight groups, with 25 people in total were surveyed. The aim was for stakeholder groups to cover as many issues as possible from those identified in the literature review. People from different backgrounds, at different stages in life and with various perspectives on the subject took part. The stakeholders were found through the author's professional network on LinkedIn and others were contacted directly via email.

The first two groups were professionals with extensive expertise in transport – internal and external colleagues. These were kept separate, mainly to see how their views compared in the end. Internal transport professionals (Group 1) represented corporate well-established thinking, while external professionals (Group 2) presented an opportunity to look at the issue from a different angle. Group 3 had an environmental focus and consisted of a sustainable transport mode users and supporters – UK Tram, Milton Keynes Cycling Forum and Electric Vehicle Experience Centre. These were individuals with a strong understanding of links between transport, harmful GHG emissions, climate change and the environment. Group 4 was comprised of young people, mostly young employees of Milton Keynes Council. It was important to me to survey younger generations to understand what transport system they would like to see in the next decades as they are going to be the future users. Group 5 consisted of one person: the chair of the CIL (Centre for Integrated Living) an organisation that supports, empowers and enables people with disabilities. Group 6, the Bus User Group, represented views and ambitions of existing public transport users. Group 7 was the most diverse in terms of the background of the participants: one urban designer (London), one shopping centre representative (National Transport Planner, Intu, MK), one architect (MK) and one major developer (MK). Finally, Group 8 represented academia with two participants from UCL. A full list of participants along with their job titles, car ownership status and residency (local to Milton Keynes) is presented in Appendix B (Table 1).

Covid-19. Organising workshops in the middle of the pandemic was certainly challenging. Engaging with the local Environmentalist Group was not possible. The majority of the group members were older and due to the Covid-19 situation it was unsafe to meet them face to face and online conference was not always possible. Furthermore, due to technical issues one participant (student, representing young people) could not take part.

5.2. Options chosen per group

Table 7 presents MRT options selected by each of the groups. The most popular options were Tram Light (selected 6 times), Non-MRT (selected 5 times) followed by BRT and BRT Light (selected 4 times) and a tram (3 times). Monorail was selected once and Metro was not selected by any of the groups. An additional MRT mode has been suggested – Docklands Light Rail alike which was selected once. Unlike MAMCA which offers pre-defined options to appraise, this method offered participants opportunity to select options that they were interested in. Arguably, freedom to select their own options allowed this study to examine more options than anticipated and resulted in a broader research that wasn't limited to two options (BRT and Tram) as per Study 1.

Table 5 MRT options chosen by group (Author's own)

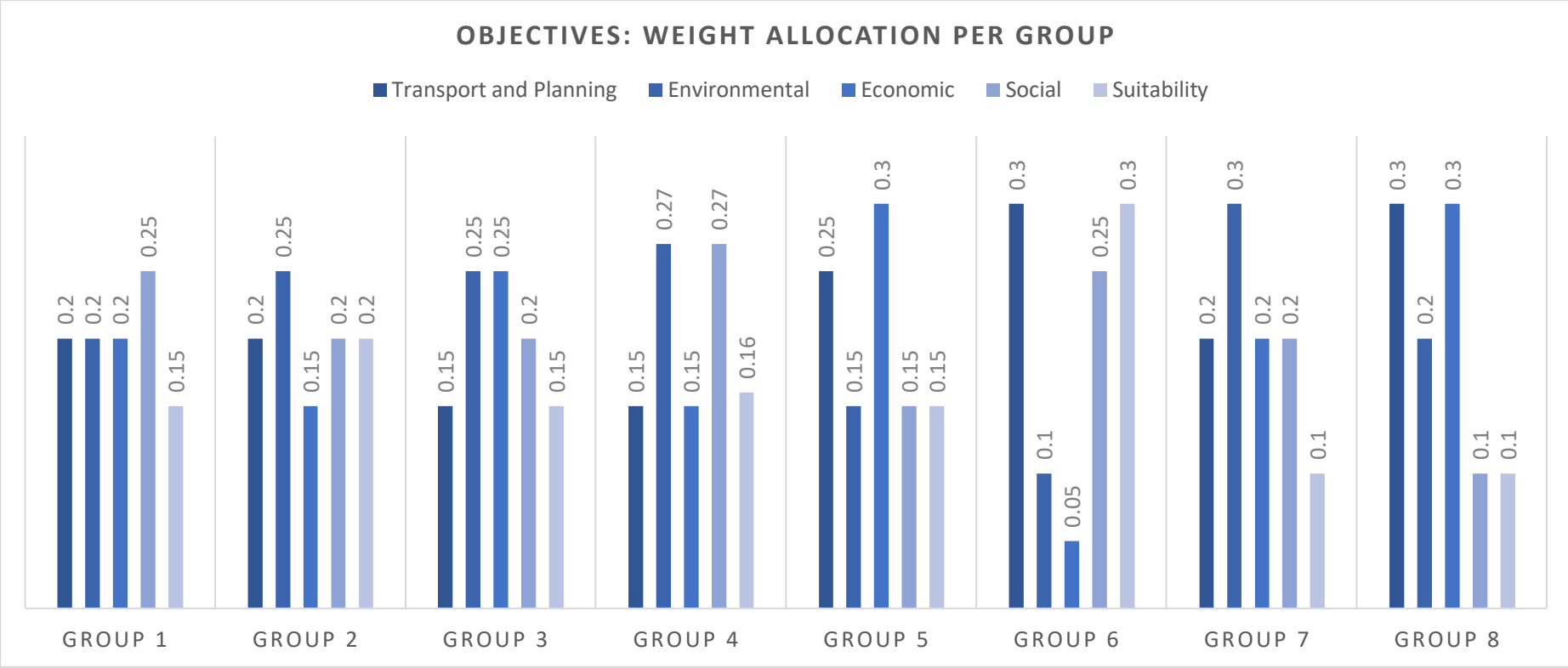
Type of MRT	Group 1 Transport Planners	Group 2 External Transport Experts	Group 3 Environmental Focus group	Group 4 Youth	Group 5 CIL	Group 6 Bus User Group	Group 7 Businesses/Architects/Developers/Urban Designers	Group 8 Academia	Number of times selected
BRT	●	●				●		●	4
BRT Light			●			●	●	●	4
Tram	●				●		●		3
Tram Light		●	●	●		●	●	●	6
Non-MRT Autonomous	●	●	●	●	●				5
Monorail				●					1
Metro									0
DLR alike					●				1

5.3. Objectives: weights allocation per group

Figure 34 below shows how different stakeholder groups chose to allocate 100 points across Transport and Planning, Environmental, Economic, Social and Suitability (TEESS) objectives. Two groups (6 and 8) scored Transport and Planning objectives the highest. Three groups, 2, 4 and 7 prioritised environmental objectives. Groups 5 and 8 gave environmental objectives the highest scores. Groups 1 and 4 prioritised social factors and only one group (6) gave significant weight to suitability objectives.

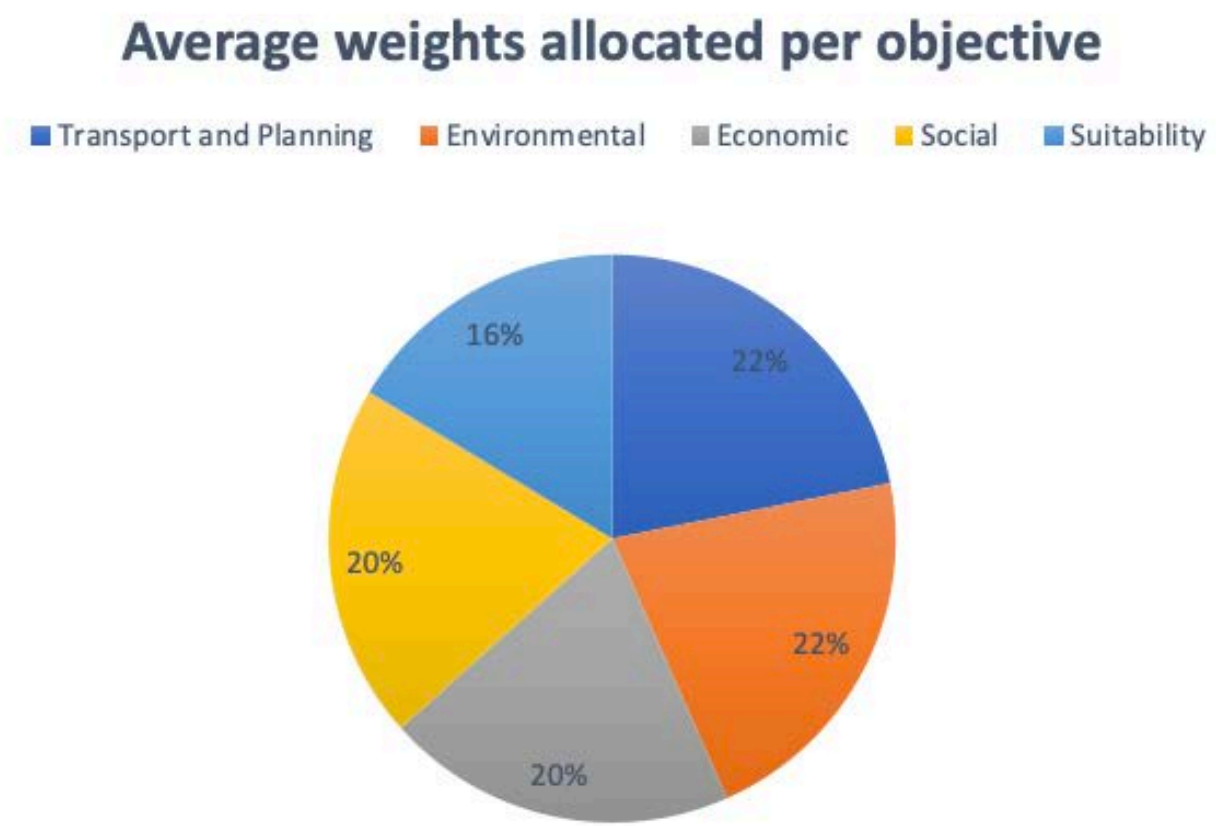
Environmental objectives have been scored consistently high across all groups apart from group 6 that gave it less than 10 out of 100 points. The same group allocated very low 5 points to economic objectives.

Figure 32 Objectives: weight allocation per group



However, looking at the average weights allocated, the split appears to be more or less even across the five objectives (Figure 33) which might suggest that the proposed criteria was useful and readily adopted by the participants. As earlier sections suggest there is lack of consistency across the criteria in MCA, therefore this or similar could be used as template for future transport project appraisals.

Figure 33 Average weight allocated per objective



5.4. Sub-objectives: weights allocation per group

Across all groups (8) several selected and prioritised the following sub-objectives for the new MRT system:

- Support growth (5 out of 8 groups selected)
- Priority over car (7/8)
- Travel times and speed (7/8)
- Carbon zero target (7/8)
- Reduced noise, pollution, vibration and emissions (7/8)
- Landscape and environment (6/8)

- Cost of the system (7/8)
- New jobs and business growth (6/8)
- Reduced unemployment and poverty (5/8)
- Ease of reaching the system (especially for vulnerable people) (5/8)
- Reduced transport inequality (7/8)
- Improved safety and security (6/8)
- Attractive to car users 6/8)
- Meets travel demands/get people to their destination (7/8)
- Practical feasibility/buildability (6/8)

This shows what aspects/attributes of an MRT systems the participants believed were particularly important. Figure 35 below shows all sub-objectives chosen and prioritised by each of the group:

Figure 35 Sub-objectives selected by group (Author's own)

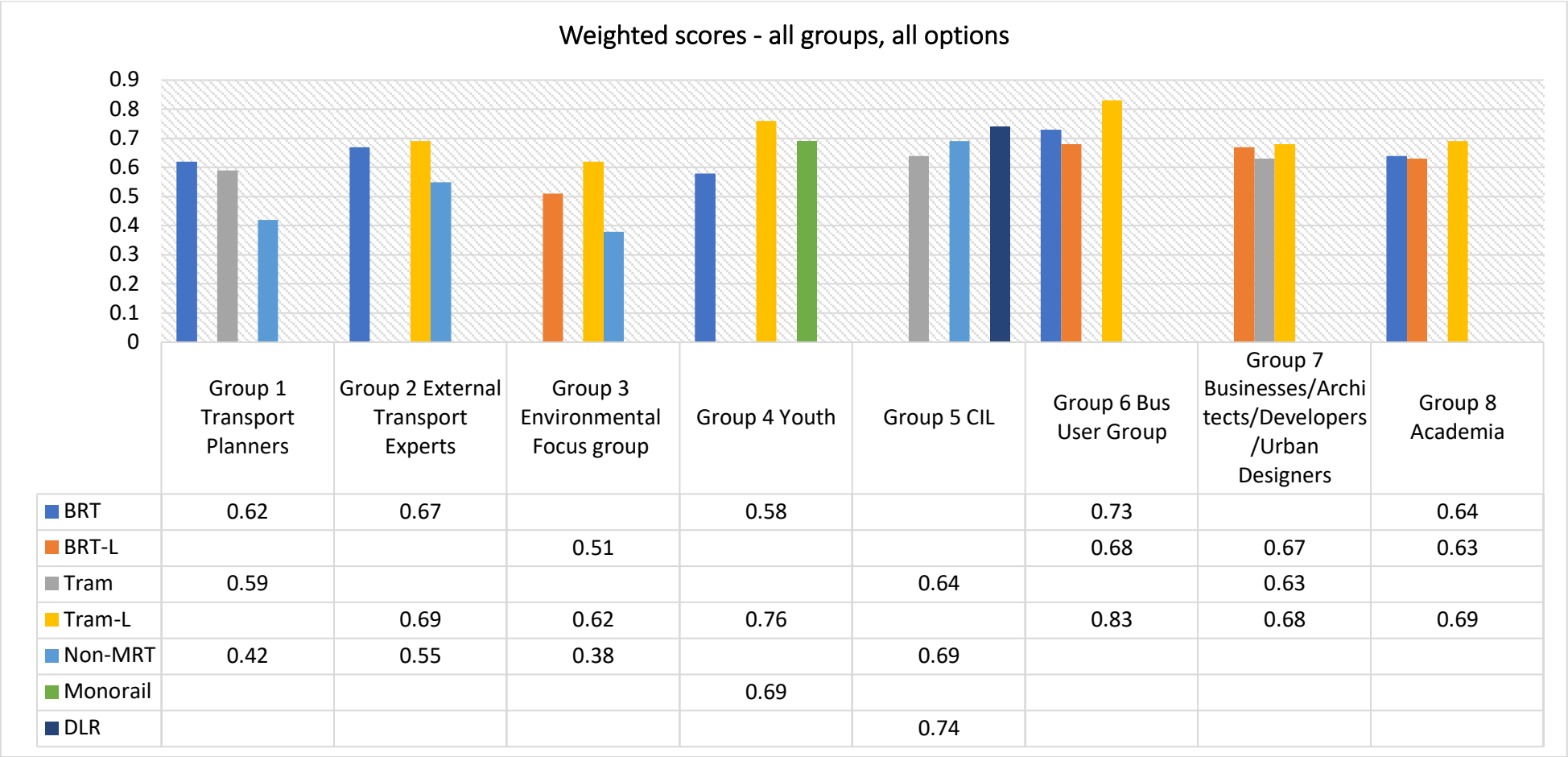
	Group 1 Transport Planners	Group 2 External Transport Experts	Group 3 Environmental Focus group	Group 4 Youth	Group 5 CIL	Group 6 Bus User Group	Group 7 Businesses/Architects /Developers	Group 8 Academia	Times selected	Significant importance
1.Supports growth (500,000+)	•	•		•			•	•	5	2
2.Priority over private car movement (MK)	•	•	•	•		•	•	•	7	0
3.Comfort and reliability			•		•				1	0
4.Travel times and speed	•	•	•		•	•	•	•	7	2
5.Reduced congestion				•	•	•			3	1
6. Connectivity (new)							•		1	0
7. Severance (new)							•		1	0
1. Carbon zero target (MK)	•	•	•	•		•	•	•	7	6
2. Reduced noise, pollution , vibration and emissions		•	•	•	•	•	•	•	7	0
3.Landscape and environment	•	•	•		•	•	•		6	0
4. Aesthetics (appearance of transit vehicles, stations etc)	•			•	•			•	3	0
1.Cost of the system	•	•	•	•		•	•	•	7	2
2. Operational costs (new)							•		1	0
3.Increase of land value and attractiveness (developments)		•					•	•	3	0
4.New jobs and business growth	•	•	•	•	•				5	0
5.Increased economic prosperity					•	•	•	•	4	0
6.Reduced unemployment and poverty	•		•	•	•	•			5	0
1.Ease of reaching transit stations and stops (inc. vulnerable users)			•	•	•	•		•	5	1
2.Reduced transport inequality	•	•	•	•		•	•	•	7	2
3.Health and wellbeing		•					•	•	3	0
4.Improved safety and security (more CCTV, better lit town etc.)	•	•	•	•		•	•		6	0
5. Safety of the system (NEW)					•				1	1
6.Improved social and community infrastructure and facilities	•				•	•			3	0
7. Social inclusion							•		1	0
1.Fits with local objectives and ambitions	•	•							2	0
2.Futureproof: technology and automation		•		•	•				3	0
3.Attracts car users (not just existing bus users)	•		•	•		•	•	•	6	1
4.Meeting travel demand/ gets people to their destinations	•	•	•		•	•	•	•	7	1
5.Practical feasibility/buildability			•	•	•	•	•	•	6	1
6. Aestetics (New)							•		1	0

•	50 points or more

5.5. Final results

Below are results of all groups on all options, using weighted method from MAMCA website.

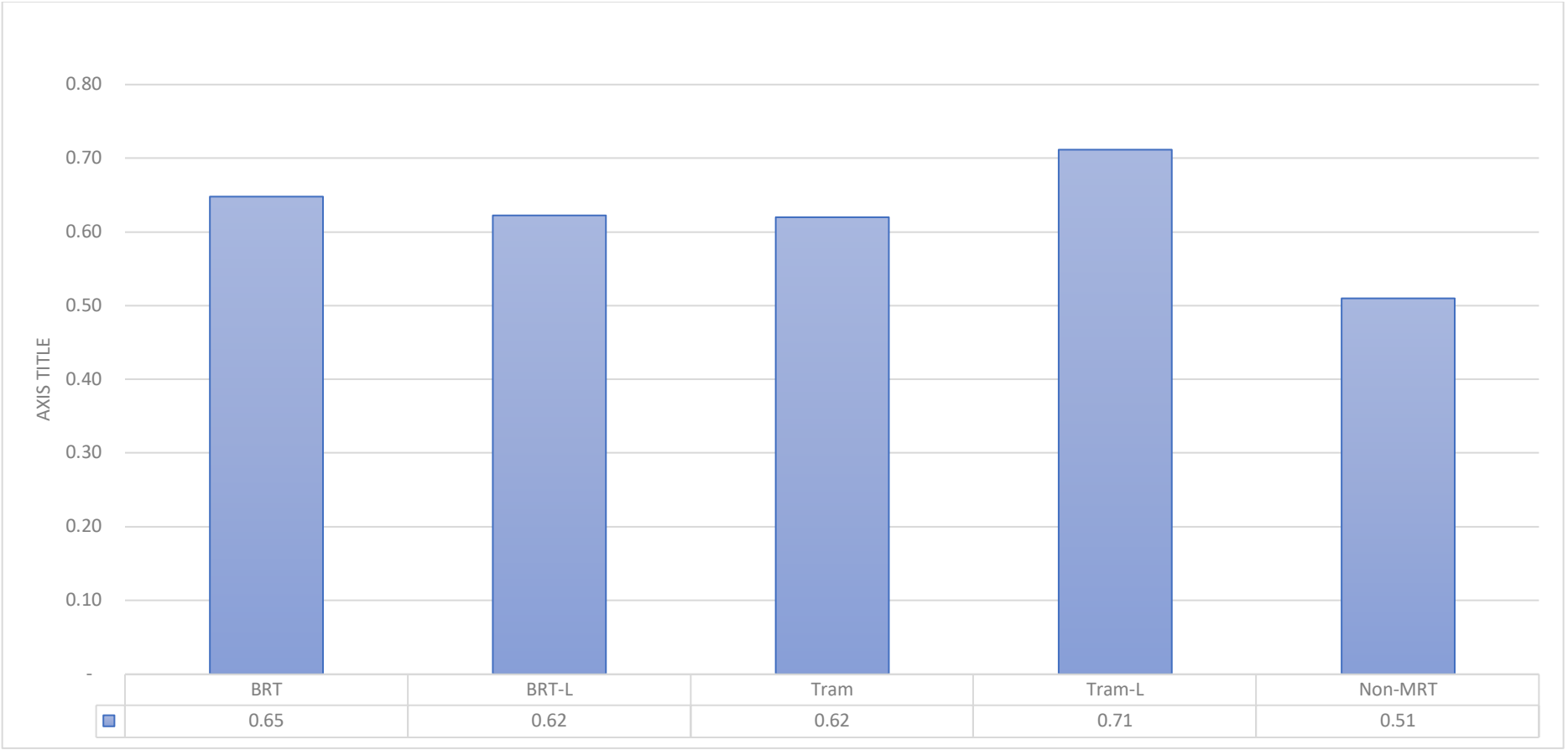
Figure 36 Scores, all groups



	Group 1 Transport Planners	Group 2 External Transport Experts	Group 3 Environmental Focus group	Group 4 Youth	Group 5 CIL	Group 6 Bus User Group	Group 7 Businesses/Architects/Developers/Urban Designers	Group 8 Academia
BRT	0.62	0.67		0.58		0.73		0.64
BRT-L			0.51			0.68	0.67	0.63
Tram	0.59				0.64		0.63	
Tram-L		0.69	0.62	0.76		0.83	0.68	0.69
Non-MRT	0.42	0.55	0.38		0.69			
Monorail				0.69				
DLR					0.74			

The DLR and Monorail have been excluded from the final (average) results as they have been selected only once.

Figure 37 Average scores – all modes



Across the groups Tram Light option scored the highest followed by BRT Light and Tram. Non-MRT scored significantly lower than the rest of the four modes. It is important to highlight that MAMCA's web tool was not suitable for presenting the final results as it doesn't extend to options selection, hence the results have been presented using MS Excel. It must be emphasised that these results would further benefit from a sensitivity analysis or further scrutiny as the options presented in Figure 36 have been selected different number of times, i.e. Tram-L six, while Tram only three times.

6.6. Key findings:

The detailed analysis of the workshops is located in Appendix B where each group, their chosen options, objectives, sub-objectives and allocated weights is reviewed in detail. Key findings are presented below:

Stakeholder engagement and setting the multi-dimensional criteria showed how different the results can be compared to the results of a standard CBA. In particular, in CBA while one mode (tram) was rated as “poor” while other scored extremely high (BRT). A participatory MCA showed that taking into consideration multiple objectives and the views of multiple stakeholders resulted in a more balanced results without such extreme differences. Although Tram-L scored slightly higher, BRT, BRT-L and Tram weren’t far behind. Looking at the results it is evident that participants have seen it as a more desirable option for a number of factors:

- Priority over private cars
- Ability to deliver environmental targets and attract car users
- Ability to deliver sustainable growth

However, BRT in general scored significantly higher on the following:

- Cost of the system
- Coverage/Connectivity

Group 1 Internal Transport Planners acknowledged their bias towards BRT based on previous research and understanding of political will. While it was acknowledged that buses are the least attractive mode, it has not been reflected in their scoring.

Several groups discussed the importance of the cost. Most notably, in Group 2, External Transport Experts, the majority of the group understood that in an ideal scenario cost should not be the main factor that dictates future of the project, but one participant strongly disagreed. As the session continued, it was clear that the participant understood the importance of MCA in capturing other benefits. Some Groups (6, Bus User Group) and (5, CIL), putting the user hat on, gave little or no importance to the cost of the system and stressed that functionality and efficiency of the system is the key objective. It was clear from the exercise that across all groups there was an agreement that cost (while being important) is definitely not the only important objective of this project. Group 7 (Mix) and Group 8 (Academia) prioritised environmental objective above others, but across all groups environmental issues have been well acknowledged.

Group 3 (Youth) paid extra attention to the aesthetics of the system, they understood that innovative and forward-thinking place like MK requires something iconic, but functional. An Architect (in Group 7) who had similar views did not have an opportunity to express their thoughts due to different dynamics in the group.

In general, setting a clear scenario and SWOT analysis was helpful and it encouraged participants to think strategically and with a certain level of ambition.

Feedback: majority of the groups found the method interesting, thorough and mentally stimulating and suitable for a high-level project appraisal, while some found it arbitrary (no detailed scenarios) and time-consuming (due to too many objectives offered).

7. Discussion

In answer to the research questions:

- What appraisal techniques are available and which method is the most effective?
- How important is it to have a clear vision/scenario?
- What is the role of stakeholders?
- Is the method robust?

…I draw the conclusions below.

Unlike a CBA where it is difficult to include non-monetary benefits, MCA has much better potential to capture those non-economic benefits (Dean 2018). In this case, giving power to stakeholders to choose what to prioritise showed that cost is not the only important factor.

As Dean (2018) stated, an appraisal based purely on a strong BCR can smother wider policy goals such as social and environmental objectives. This has been identified as one of the biggest weaknesses of the previous MK assessments where the method of calculation of benefits (NPV) potentially misjudged and disproportioned social and environmental losses forcing future generations to bear the cost of that failure. Incorporating MKC's policies and strategies completely changed how different MRT systems have been evaluated, the participants adopted a strong position on sustainability which aligned well with local policies and ultimately affected the results.

CBA allows the substitution of environmental quality for economic growth and theoretically, as long as a project generates sufficient economic capital, the possible depletion of natural, non-renewable resources is not considered a problem (Munda, 1995, 2008). The practical application of a participatory MCA showed that stakeholders do not accept such trade-offs. The involvement of groups like young people and environmentalists showed that features like the sustainability of the system and its impact on the environment are crucial to them and are not to be traded for monetary savings.

Macharis and Bernardini, 2015, and Stirling, 2006 claim that a participatory MCA represents the most appropriate approach to understand the various concerns of different stakeholders, mainly through participation, the ability to choose their own objectives and to allocate their own weighting. However, MCA can be considered even more arbitrary than CBA (Dobes and Bennet, 2009 and 2010) as CBA's principles are well-established and researched. Indeed, MCA and especially a participatory MCA, does not have accepted or specific guidelines with

regards to the selection of objectives and criteria, procedures for scoring and weighting and results aggregation (Cook et al, 1988, Ozernoy, 1997, Jeffreys, 2004). While the flexibility of the method allowed MKC's values and environmental targets to be fully incorporated, defining criteria and agreeing it with stakeholders came with a significant amount of ambiguity. (Dobes 2009) urges government to increase the degree of consistency and transparency in appraisal methods i.e. standardise variables and clarify assumptions. The method would significantly benefit from national and international standardisation.

What is the role of stakeholders in the appraisal of a transport project?

I want to emphasise that stakeholder selection was a task that I approached with great care and I believe that it is the exceptionally diverse mix of knowledgeable stakeholders that I owe the success of this work to. The sense of responsibility amongst the participants was extremely high, the commitment and dedication, conscientiousness and willingness to do a good job was present in all groups. It was also fascinating to watch how opinions, theories and debates evolved on various topics. The example with cost prioritisation was probably the most valuable and pleasing moment as frankly, this was the reason why I chose to study this topic. The crucial role of public participation is undeniable. In this case, it has turned the results around. Doelle and Sinclair (2005) argue that public participation should be legislated in project assessments to encourage constructive participation. I am fully supportive of this suggestion.

Participatory MCA and bias

While MCA can be misused by analysts and special interest groups (Dobes, 2009), public involvement in participatory MCA minimises the possibility of this occurring. It has been noted that participants not only challenged the analyst's views, but also questioned and challenged each other's during this study. Even with public participation there is still scope for this methodology to be misused and push certain agenda forward, for example through the choice of a particular participants, careful choice of the information that is presented to participants and by withholding certain data/information.

People will always have an inherent bias; some groups will be dominated by other individuals. *Macharis and Nijkamp (2011) suggest that* biases can occur due to following reasons:

- Cognitive: restrictions of the short-term memory to correctly process information (Reyna et al., 2003)

- Perceptual: failure to analyse individual's motivations in multi-person and multi-objective decision making (Mercer, 2005) and
- motivational reasons (or positive confirmation bias): where a participant selects a preferred option early and accepts information that supports this option and denies facts that don't (Jones and Sugden, 2001; Fisher et al., 2008)

An example of a potential 'motivational reason' occurred in Group 5, where one participant strongly favoured a particular rail system. As there were no other participants to scrutinise his views, the system scored highly, and the results had to be excluded from the final result.

Flyvbjerg (2004) talked about optimist bias that occurs during project evaluation, for instance construction companies and consultants having interest in a project and therefore might overestimate the economic benefits that a project can bring. In this case, as it was an academic exercise no parties had political, institutional or financial interests in this project, therefore it is highly unlikely that their views had been corrupted. Compared to the single analyst led CBA performed in Study 1 that showed definite bias towards BRT, this study is less likely to be subject to criticism for bias due to the extensive scrutiny by multiple stakeholders and a far deeper and thorough examination.

Rail base or rubber tyre

Rail-based urban transport is often perceived to be superior to bus systems, but research around this topic is limited. Scherer and Dziekan (2001) call this phenomenon psychological rail factor and their study on user perceptions on the attributes of different public transport modes explains that tram's fixed infrastructure (attribution of guideway) is one of the factors that makes this mode seem more attractive than buses. They conclude that social and emotional factors lead people to making irrational decisions when it comes to choosing a public transport mode. While this has no explanation, it is important to acknowledge that this phenomenon exists. DfT's (2018) research shows that patronage on trams (unlike on buses) is growing steadily. Furthermore, tram passenger satisfaction is significantly higher than bus user satisfaction. Yet, DfT's appraisal guidance prioritises cost benefit analysis above all, making it difficult for costly schemes like trams to be developed, further adding to the importance of this work.

Practical issues of a participatory MCA

Organising eight online workshops and several follow up sessions during the global pandemic was challenging as I encountered technical issues and some groups (environmental group) could not take part. Several sessions overran (3 – 3.5h instead of planned 2h), there were extensive discussions and contrary opinions that took time to address. While it is a valuable part of this exercise it is worth noting that this method is time consuming and resource intensive.

Would it be better to have smaller or bigger groups? Ohtsubo and Masuchi (2004) and Baumann and Bonner (2004) say that size of the group plays an important role, in particular, individual opinions in larger groups lose its strength. This study showed that it depends upon the individuals in the group. Out of two groups, both had four participants. The first group had a fruitful debate and organic evolvement of views which led to a helpful symbiosis of opinions and conclusions. The second group was dominated by one individual and the rest of participants had to adopt his views. In conclusion, 3-4 people in an optimal group size for this exercise, but the dynamics of the group work depends on individuals.

Analysing data proved to be challenging. The MAMCA tool was used to process each group's scores, however, the tool did not have the facility for options selection and therefore Ms Excel had to be used for part of the analysis.

8. Reflective conclusions

Originally, I planned to broadly review different types of MRT to understand which system would be the most suitable for MK. However, I acknowledge that my bias towards rail-based systems could not be ignored. The analyst-led research would be subjective and unhelpful. Instead, I decided to focus on a review of transport scheme appraisal methods and chose a participatory Multi-Criteria Analysis to scrutinise my views and hypnosis on a broad range of stakeholders in order to get the most objective answer. Did the participatory MCA helped to answer the main question: ***What system is the most suitable for MK according to the research?***

Yes. *To conclude, the highest average score is for a Tram Light system. Despite the higher cost which has been acknowledged during the scoring exercise, participants recognised the greater benefits of this mode*. The method proved that social, environmental and economic benefits are as important as (or even more important than) the cost of the system to all stakeholders. It is believed that incorporating MKC's policies, objectives and vision, an ambitious environmental goal, understanding the unique structure of MK and setting a clear

future transport scenario in the appraisal exercise encouraged participants to think more ambitiously and to prioritise environmental goals, and therefore prioritise Tram Light over BRT.

Should the cost be ignored?

Banister (2001) argues that first of all, transport is social infrastructure that should aim to benefit the society while improving the quality of living. Profitability is secondary, as long as transport delivers against main objectives and serves the purpose. Finally, O'Neil (2009) concludes that "failure to fund adequately non-economic and social infrastructure is a failure of understanding what infrastructure is". This study certainly pushed the importance of cost back giving more space to examine other factors. Undoubtably, cost has to be of great importance: if the system is not affordable it simply won't be built. There are benefits to CBA, for instance, it can be combined with MCA (Sijitsma, 2006; Shuttle, 2010; Van Wee ,2012) and CBA can be a helpful tool given its precision and accuracy if done properly Egras (2009). But there is still a lot of ambiguity around such approach. Cost should be incorporated in the appraisal, but it shouldn't be the most important criteria. As it stands, DfTs Web Tag is mostly prioritising cost which could explain why there are so few rail-based urban systems despite their superiority over buses. As it stands, the buyer dictates the rules. The future growth of MK means that developers will be bearing a significant part of the cost of any future MRT and it was made clear in this study that tram is seen as a preferred option. Yet the DfT remains the main decision maker, they have not only the funding but all the power.

How this study assists with decision making for Milton Keynes.

Although the methodology has been criticised for ambiguity and possible bias, it takes more factors into consideration and is far more superior to the methods used in past studies for a number of reasons:

- It Included extensive scrutiny through stakeholder engagement
- It gave significant consideration to the importance of local background (policies and strategies)

The MK MRT study would further benefit from understanding the psychological rail factor Scherer and Dziekan (2001). Given how low bus patronage is and the fact that it continues to fall, transport behaviour and attitudes towards types of any new MRT must be considered. MKC choosing BRT because it is cheaper is like buying pickled eggs instead of fresh: while they are significantly cheaper, it doesn't mean they will get eaten because not so many people like them. There is enough evidence in this work to stress that rail-based modes are more desirable. As environmental objectives are important, a research on the ability of different modes to achieve the carbon zero scenario through modal shift would be highly desirable

There are plenty of examples of failed BRTs mostly due to poor design and planning, including prioritising peripheral, low-demand locations (such as new developments with high parking standards on the outskirts of MK). When searching for “failed tram projects” a list of projects that never took off for a number of reasons, such as complexity, high risks and costs and fear of failure, is presented, but there aren’t actually many projects that failed once they have been constructed. It would therefore be useful to include a risk assessment for all types of systems in the appraisal.

In defence of participatory MCA’s flexible criteria that is often criticised for being arbitrary, could it be time to standardise the process to reflect those social and environmental targets set up nationally and globally?

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10. Appendix

10.1. Appendix A: Workshop: Briefing

UNIVERSITY COLLEGE LONDON

FACULTY OF THE BUILT ENVIRONMENT

BARTLETT SCHOOL OF PLANNING

Disclaimer: *This workshop is conducted as part of data gathering exercise for my dissertation in MSc Transport and City planning at UCL. All responses provided during this workshop are anonymous and will only be used for research purposes. Data will be processed in compliance with GDPR. Results of this work will be shared with Milton Keynes Council, by whom I am employed and who is sponsoring my final year tuition fees, however this is not council led research.*

Dissertation topic: Appraisal of Mass Rapid Transit (MRT) systems options for Milton Keynes using a participatory (Multi Actor) Multi Criteria Analysis (MAMCA).

The purpose of these workshops is to gather different stakeholder views on objectives for MRT and to incorporate them in a Multi-Criteria Analysis (MCA) to conduct a holistic appraisal of possible options. The overall aim of this research is to test if a fully participatory MCA is suitable for appraising a major transport scheme like MRT.

Background information and reason for choosing this topic.

Climate change has urged a number of cities, including Milton Keynes, to commit to zero carbon targets, but not many have a clear action plan to implement it. By 2050 Milton Keynes is expected to double in size to accommodate 500,000 residents and the Mass Rapid Transit (MRT) system is planned to accommodate this growth in a sustainable way. But what kind of transport system can meet all of these targets and the other objectives of Milton Keynes?

The latest MRT studies (ITP 2019 and Transport Infrastructure Delivery Plan (TIDP), 2019) did not fully cover local social, environmental and economic factors and appraisal techniques used had a number of weaknesses including limited or absent stakeholder engagement. All these factors can make it difficult to make a fully informed decision on the future of the town's transport.

Multi-Actor Multi-Criteria Assessment (MAMCA) (also known as participatory MCA) entails consulting with several stakeholder groups with different views throughout all stages of appraisal making this technique the most far reaching appraisal technique available to date. It can assist in providing the most widely acceptable transport solution.

Workshop

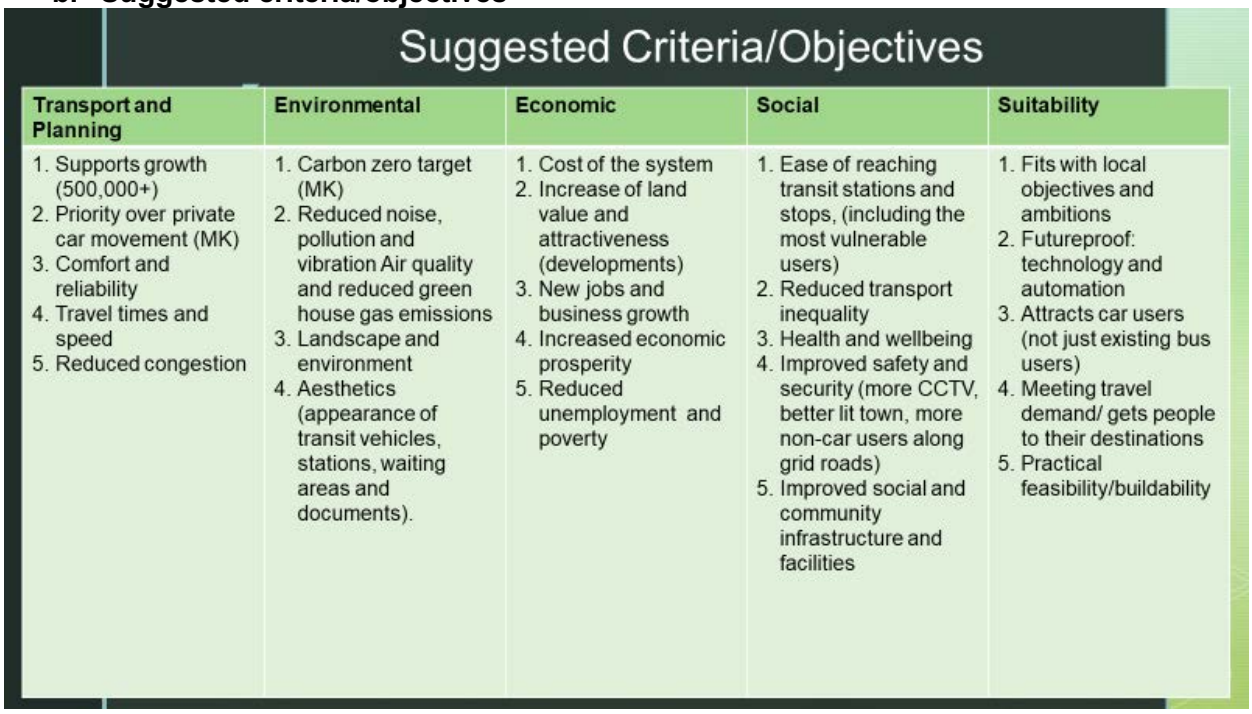
Each session will take 1-1.5h and will be delivered via Microsoft Teams where I will share my screen to deliver a presentation on issues affecting Milton Keynes, previous MRT studies and MRT options followed by the main activity, a **multi-stage** appraisal exercise done using a online MAMCA tool: https://mamca.vub.be/. Stages are:

Stage 1	Choose 3 MRT options to appraise (from section a.)
Stage 2	Choose objectives/criteria (from section b.)
Stage 3	Weight each objective (100 points to distribute in total)
Stage 4	Score the MRT options against the bespoke MCA using a 10-point system

a. Mass Rapid Transit Options

Bus Rapid Transit (BRT) involves busway corridors on segregated lanes – either at-grade or grade separated – and modernised buses			**Tram (Light Rail)** electric railway system , often *rights-of-way* at ground level, boards/discharges passengers at track or car floor level
Bus Rapid Transit light Some bus priority infrastructure, cheaper than BRT, less frequent service			**Tram Light (Very Light Rail)** – rail system, battery operated smaller vehicles
Monorail – elevated rail system, independent from other traffic, road or pedestrians.			**Metro** electric transport system with high capacity and high frequency of service, independent from other traffic, road or pedestrians.
NON –MRT: Demand Responsive Autonomous pods		?	**Other options** Tram Train Metro Light Flying cars …

b. Suggested criteria/objectives



Suggested Criteria/Objectives

Transport and Planning	Environmental	Economic	Social	Suitability
1. Supports growth (500,000+) 2. Priority over private car movement (MK) 3. Comfort and reliability 4. Travel times and speed 5. Reduced congestion	1. Carbon zero target (MK) 2. Reduced noise, pollution and vibration Air quality and reduced green house gas emissions 3. Landscape and environment 4. Aesthetics (appearance of transit vehicles, stations, waiting areas and documents).	1. Cost of the system 2. Increase of land value and attractiveness (developments) 3. New jobs and business growth 4. Increased economic prosperity 5. Reduced unemployment and poverty	1. Ease of reaching transit stations and stops, (including the most vulnerable users) 2. Reduced transport inequality 3. Health and wellbeing 4. Improved safety and security (more CCTV, better lit town, more non-car users along grid roads) 5. Improved social and community infrastructure and facilities	1. Fits with local objectives and ambitions 2. Futureproof: technology and automation 3. Attracts car users (not just existing bus users) 4. Meeting travel demand/ gets people to their destinations 5. Practical feasibility/buildability

Additional information:

1. **Indicative costs and benefits of these options (subjective)**

Costs, benefits, compatibility – Analyst's view

	Cost per km	Priority over other modes	Capacity (passenger numbers)	Coverage (number of km of infrastructure)	Can be autonomous?	Accessibility (disabilities/elderly)	Comfort (seating arrangements, ride quality, acceleration/deceleration)	Catalyst for growth/densification/economic prosperity/regeneration	Suitability for MK (size, structure)	Environmental improvement (how clean is the system/potential to reduce car use)
BRT	II	II	III	III	yes	II	II	II	III	II
BRT light	I	I	II	IIII	no	II	I	I	IIII	I
Tram	III	IIII	III	II	yes	IIII	IIII	III	II	II
Metro	IIIII	IIIII	IIIII	I	yes	I	II	IIII	I	II
Monorail	IIII	IIIII	IIII	I	yes	I	IIII	IIII	I	II
Light Tram	II	III	II	III	yes	III	II	II	III	II
Autonomous pods	III	-	I	IIIII	yes	III	III	I	IIIII	I
Other										

I	II	III	IIII	IIIII
Low	Moderate	High	Very High	Extremely High

2. Public Transport – SWOT analysis (based on evidence and local policy review)

Strengths	Weaknesses
• Strong political will to address climate change issues, including transport • Commitment to be carbon neutral by 2030 • MK Futures 2050 work and evidence on the need to deliver MRT and address transport inequality • Wide roads, lots of space for Public Transport (PT) priority • Good provision of infrastructure for PT – 6 stations, 2 Bus hubs • Good railway links to London and Birmingham • Good location, economic hub that attracts visitors • Space for flexible development of MK and continuous growth • Centre for technology and transport innovation	• Extremely high car usage, car dependency, ample parking (city for cars) • High car parking standards in new developments • Limited PT provision, short operating times, low frequencies • Low bus usage and declining user satisfaction • Unreliable bus service, long travel times, indirect routes • Lack or integration between transport modes, especially at the key transport hubs • Due to low densities, many routes are not commercially viable, high subsidies are required to run services • Outdated infrastructure – bus priority lanes and bus shelters • Limited availability of PT in some areas of the borough and transport inequality + social injustice
Opportunities	Threats

• Growth & Mass Rapid Transit &East West Rail • Regeneration of older estates present new opportunities to improve PT • Income from future and planned developments • Upgrade train stations and interchanges • Integration between PT modes - community transport, Demand Responsive Transport (DRT) and taxis • Manage PT schemes better, better use of finances from parking revenue to support • Better facilities for PT • Car parking restrictions, demand management and P&Rs	• Failure to manage car traffic can result in more congestion, further decline in PT, risk to lose more commercial routes • Economic climate post Covid-19 • Low quality service is discouraging PT use and pushing more people to buy cars • New developments will generate more traffic due to high car parking standards, location of the new housing and the layout of the town • Good Demand Responsive Transport and taxi service can further weaken infrequent and indirect bus routes • Unrealistic targets (MRT, Zero Carbon) vs limited resources and lack of proactivity to deliver major changes in public transport

10.2. **Appendix B: Stakeholder analysis**

Table1 Stakeholder analysis (Author's own)

	Group	Participants job title	Car owner?	Local to MK
1	Transport planners (internal)	Team manager Transport Policy	Yes	Yes
		Public Transport Manager	Yes	Yes
		Smarter Travel Transport Planner	Yes	No
		Trainee Transport Planner	Yes	Yes
2	Transport experts (external)	Associate Director Future Mobility, WSP	Yes	No
		Highways England,	Yes	No
		Nextbike	Yes	No
		Energy Saving Trust, Mooveit	Yes	No
3	Environmental/Sustainable	Cycling Forum MK, Chair	Yes	Yes
	Transport Focus	Cycling Forum, member and Environmentalist/Economist	Yes	Yes
		UK Tram	Yes	No
		Electric Vehicle Experience Centre	Yes	Yes
		Electric Vehicle Experience Centre	Yes	Yes
4	Young People	Young People Network, MK Development Partnership	Yes	Yes
		Youth Cabinet Member , MKC	No	No
		Transport Policy Administrator	Yes	Yes
			Yes	Yes
5	Centre for Integrated Living (CIL) focus on	CIL Chair and former Jubilee Line extension Design and Delivery Manager	Yes	Yes

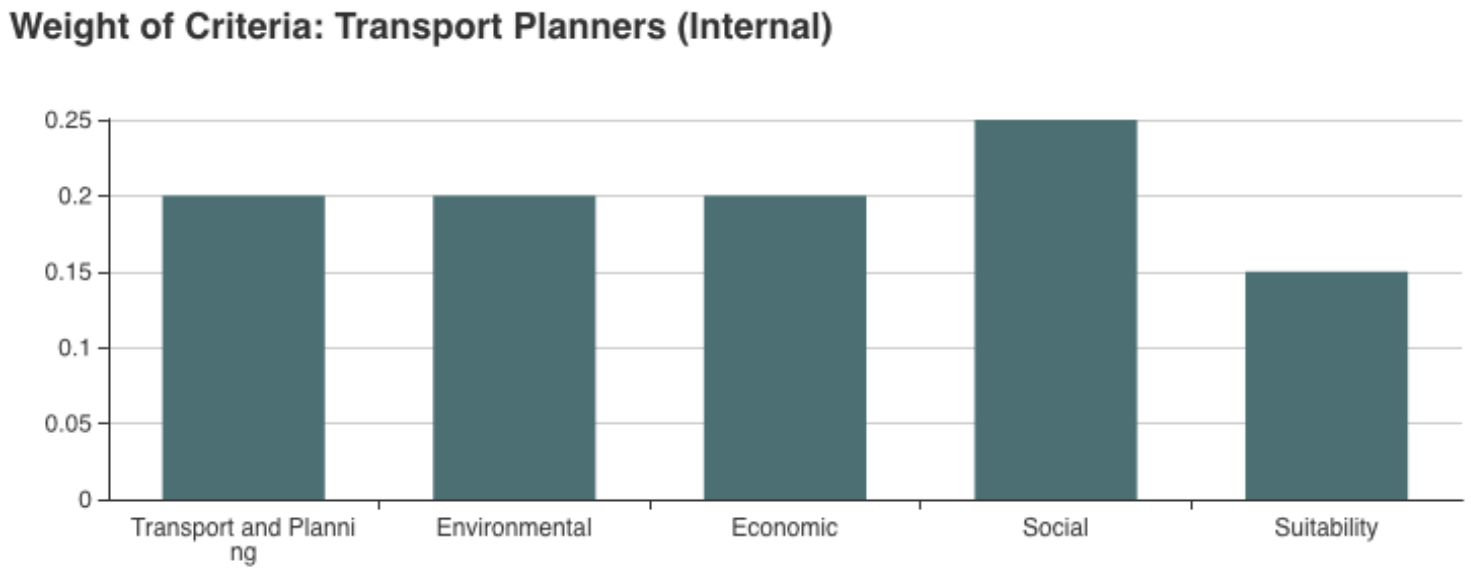
	disabilities and social equality			
6	Bus User Group – existing bus users	Chair of Bus User Group, Phd, MBA Deputy Chair of Buse User Group Former Chair of Bus User Group	Yes Yes Yes	Yes Yes Yes
7	Business representative/Architects/Urban Designers/Developers	National Transport Manager (INTU) Architect, Gants Urban Movement, Principal Design Architect Technical Director, Bovis Homes	Yes Yes Yes Yes	No Yes No No
8	Academia	Professor of Transport (UCL) Lecturer in Transport and Housing (UCL)	Yes Yes	No No

10.3. Appendix B – Detailed analysis of each of the workshops

Group1: Transport Planners

Firstly, this participatory MCA approach was tested on my colleagues, MKC Transport Planners. This group selected BRT, Tram Light and Non-BRT modes to appraise. This group was well informed about previous studies. Weights have been allocated evenly across the five objectives, prioritising social factors over suitability slightly (25 and 15 points respectively.)

Figure 1 Transport Planners



This group prioritised the ability of MRT system to achieve the following sub-objectives:

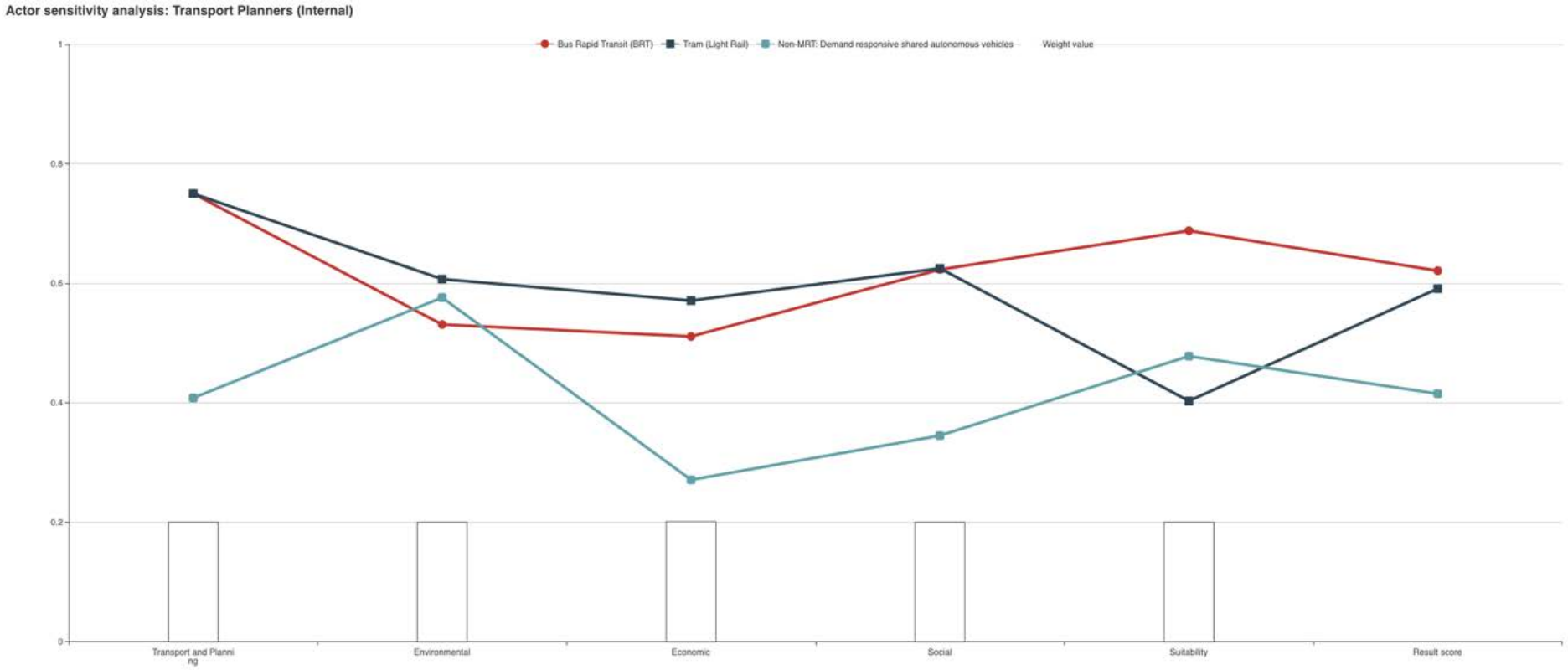
- Support growth (50points)
- Carbon zero target (60points)

- Reduce transport inequality (60points)

Overall BRT scored higher than Tram-L, as group felt that BRT would be significantly more suitable for MK (Suitability objective).

Although discussion took place about the importance of the aesthetics of the system and it was acknowledged that buses are the least attractive option on the list, the weight allocated to this objective was quite low and scores across three options very similar, meaning that the group's scores did not reflect their views on aesthetics. Participants admitted that familiarity with previous studies which favour BRT and the political will which also favours BRT, it was hard to be rational when scoring the schemes against objectives. Autonomous vehicles (non-MRT) system was scored low across Transport and Planning, Economic and Social objectives and following a full assessment came out as the least suitable option.

Figure 2 Transport Planners



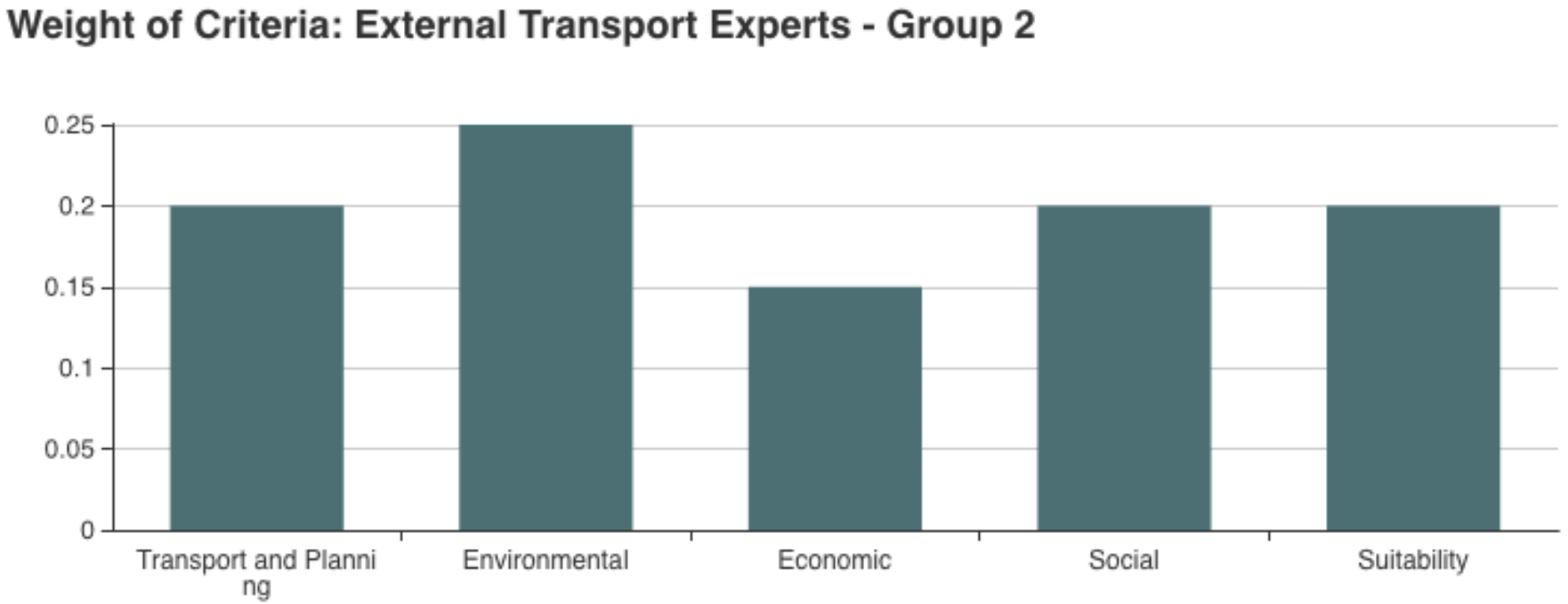
Group's feedback on the method: it gives a good insight into a group's thinking, preferences and opinions. The Group suggested that engagement with larger amount of people would be required to be able to make a rational decision.

Group 2 – External Transport experts

Group 2 was the most open-minded and interactive of all. Given that the participants had never met before, their views and rationales were harmonised from the start, once they had settled on one highly debated matter – costs. At the beginning of the workshop one participant

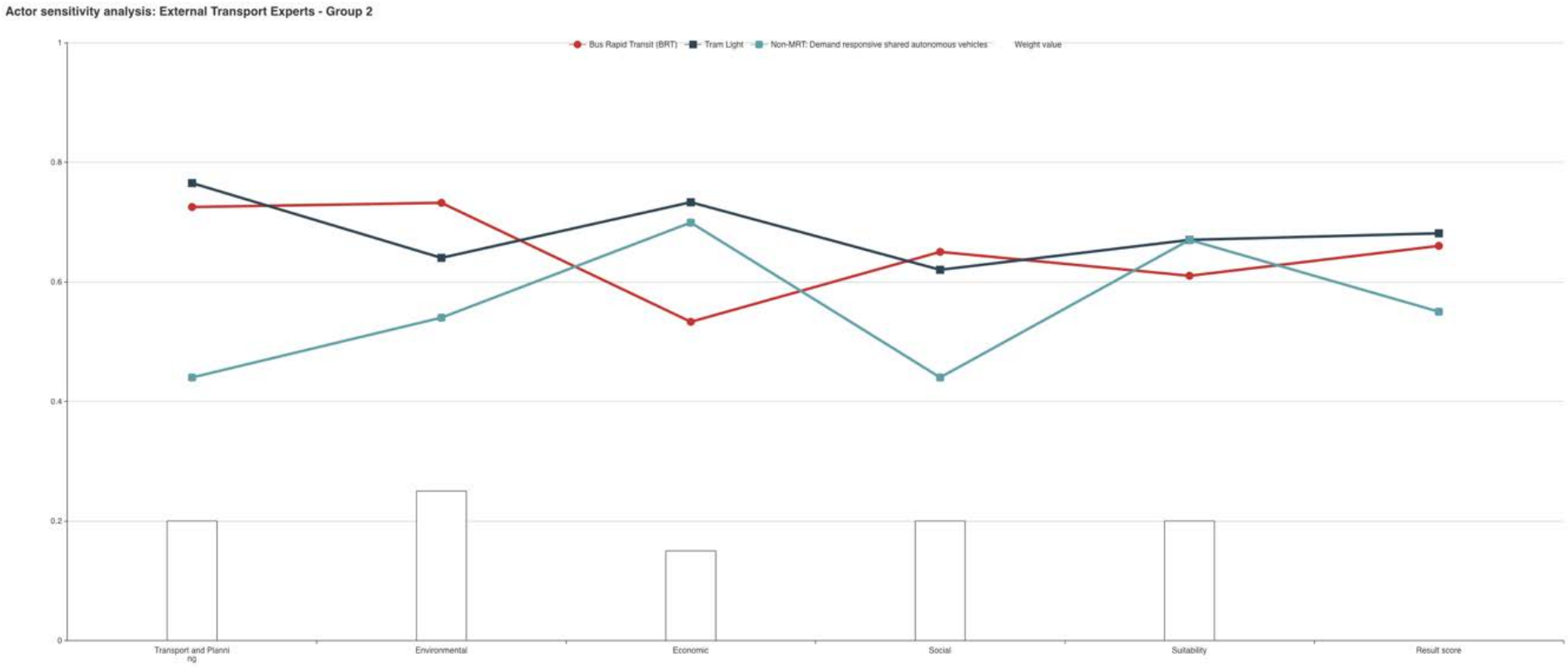
strongly believed that cost could be the critical objective in the project appraisal, while the other participants disagreed and presented strong arguments to emphasise that there are other, as important objectives that should be included. As we continued with the objective prioritisation exercise, the disagreement evaporated. Participants chose BRT, Tram-L and Non-MRT, and allocated weights across objectives evenly while slightly prioritising environmental objectives over economic as per Figure 3.

Figure 3 External Transport experts



This group allocated the most weight to the carbon zero target and reduced transport inequality sub-objectives. Tram-L scored the highest as the group acknowledged its potential to support growth, regeneration and bring prosperity to the borough. While the group acknowledged non-MRT mode's potential to bring prosperity to the area, it scored low across the board.

Figure 4 External Transport experts



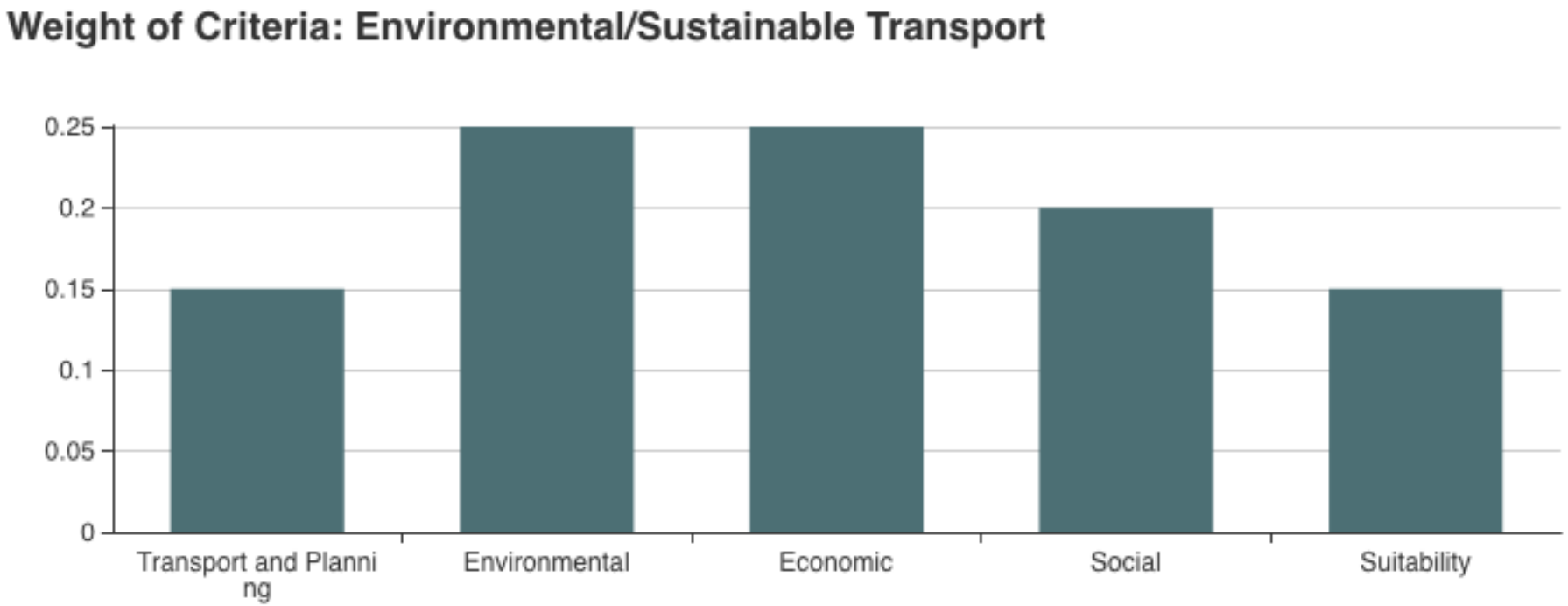
Feedback: Great for early scheme appraisal, a good mix of professionals is ideal great for brainstorming.

Group 3 Environmental focus / Sustainable Transport

As it was not possible to survey the Milton Keynes' Environmental Group, supporters of environment/low emission/sustainable transport modes, the members were invited to take part in a focus group. Participants represented UK TRAM, Local Cycling Forum, Milton Keynes based Electric Vehicle Experience Centre (EVEC). One of the participants was a consultant in economic and environmental matters (EVEC) whose employees

were experts in non-MRT (autonomous pods). This knowledge and expertise made the discussion and scoring informed and subsequently interesting. Group 3 selected BRT, Tram-L and non-MRT and prioritised environmental and economic factors.

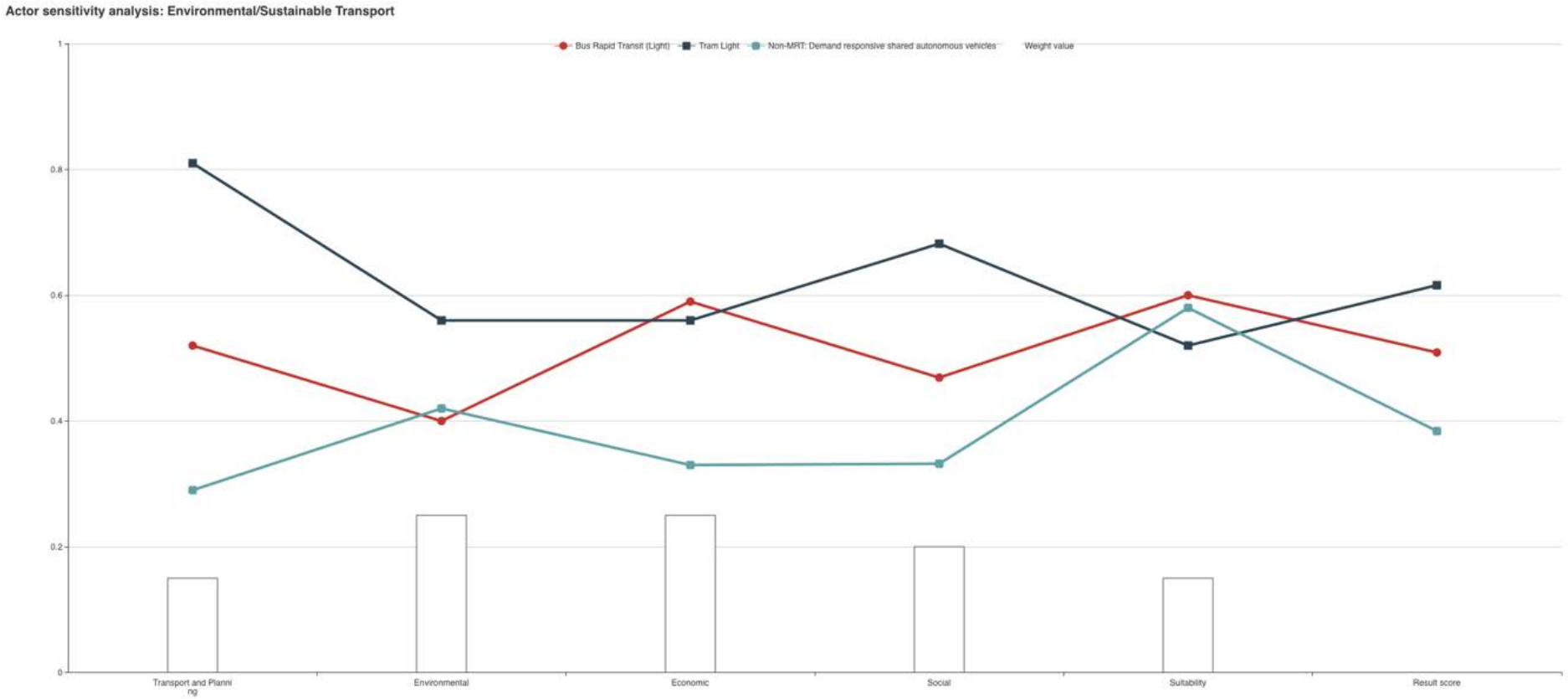
Figure 5 Environmental focus



This group focused on the practical aspects of MRT systems, such as comfort, travel times and speed, cost, practical feasibility/buildability and the overall impact on the safety of the City Carbon zero emission targets also scored high. The cost of the system was not necessarily seen as a disadvantage. The economist/environmentalist of the group acknowledged that “cost of the transport system can be offset by the benefits that it brings”. The group strongly favoured a rail-based system in a sense that it is likely to bring more benefits. One of the most interesting discussions in this group was about risks associated with each of the system, where it has been concluded that doing minimum or nothing is the safest option,

however doing maximum brings the most benefits. Conversation evolved around tracks for the tram and it being a more difficult, complex and above all a high-risk project.

Figure 6 Environmental focus



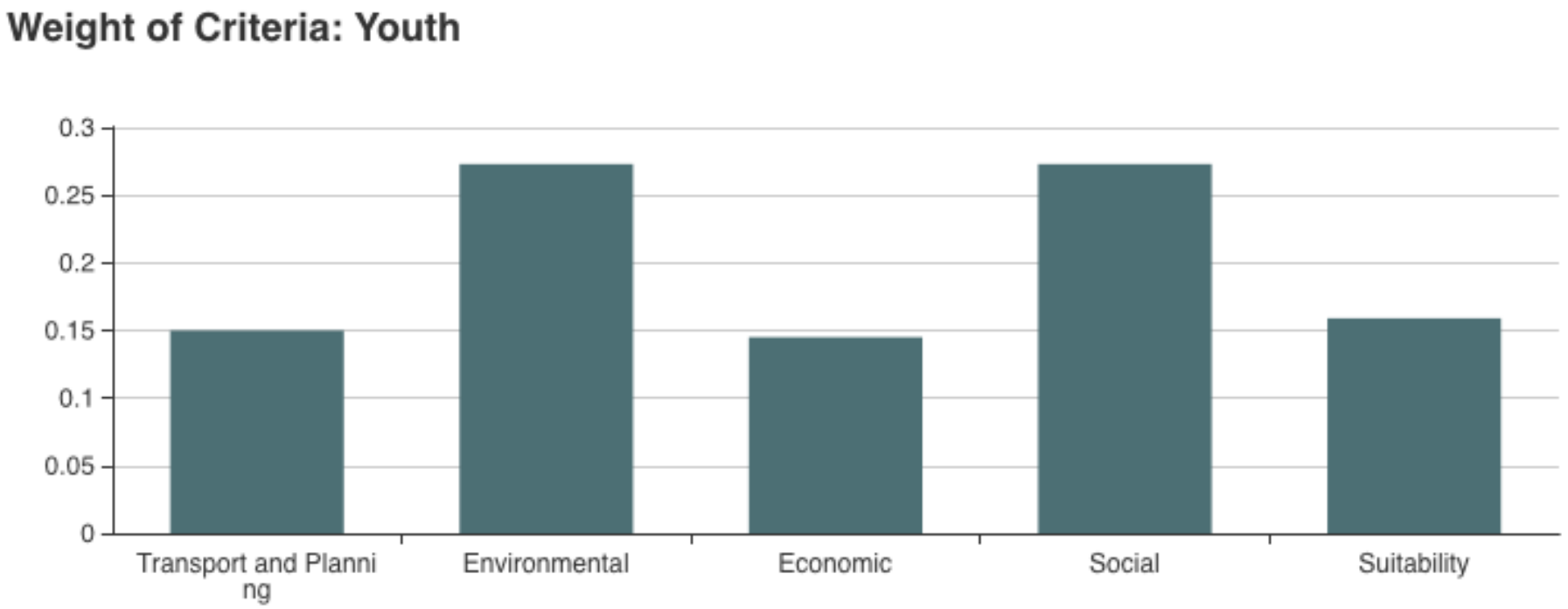
This group provided great insight and expertise on autonomous vehicles, where previous groups scored them very high in terms of comfort and where it gets you, this group having regularly experienced the service, scored it fairly low on this and other factors. The debate about the cost and benefits of each of the systems confirmed the author's disagreement with the assumption that BRT and Tram/Tram-L have the same benefits.

Some discussion took place about integration between MRT system and cyclists and while it is not possible to take a bike on board, the integration between the modes is important in terms of having a pedestrian/cycle access and parking near stations. Feedback: enjoyable, but too many objectives.

Group 4: Young professionals and Youth

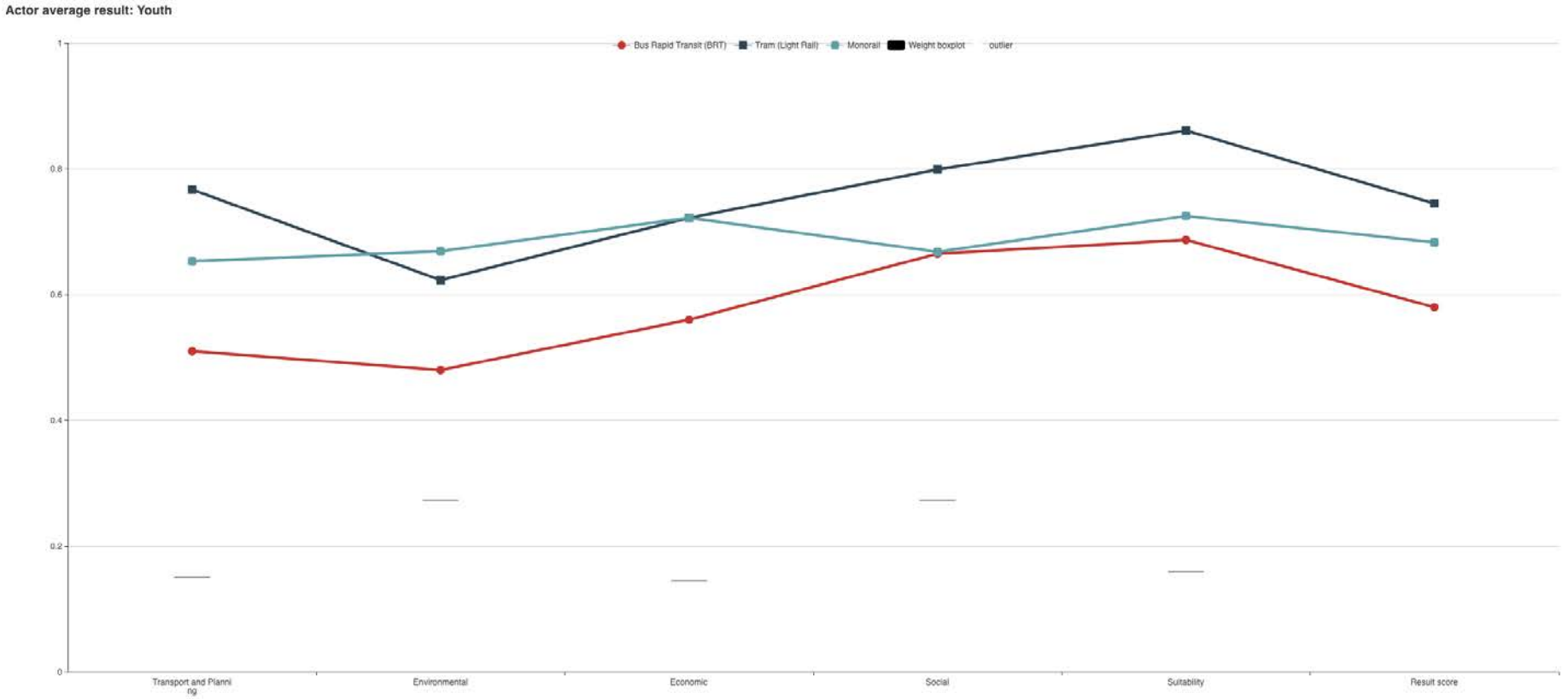
This group selected Monorail, Tram-L and BRT. Reason for choosing monorail was because the original plan of Milton Keynes proposed it and the group wanted to explore the feasibility of this system. They believed that it would be a unique selling point that would attract visitors and tourists to the innovative and futuristic Milton Keynes. Youth strongly prioritised environmental and social objectives.

Figure 7 Youth: weights



Sub-objectives were given reasonably well-balanced importance, with no evident priority given to any of the factors. Economic factors including new jobs and business growth and reduced unemployment scored in total 80 points leaving cost of the system minor concern at 20 points. Tram-L scored the highest, followed by a monorail and BRT came last. Group scored rail-based systems higher on carbon zero target, aesthetics, ability to attract car drivers, and economic benefits. Monorail scored extremely high in the following sub-objectives: priority over private cars, new jobs and businesses and futureproof/technology and automation. But it scored low on social objectives, in particular, the system's ability to serve the most vulnerable adults and cover large areas (connectivity).

Figure 8 Youth: scores



Group 4 further stated that the cost of a ticket would be important to them. This was not included as a sub-objective as it would not have helped to appraise the scheme. Operational matters were originally excluded from the equation.

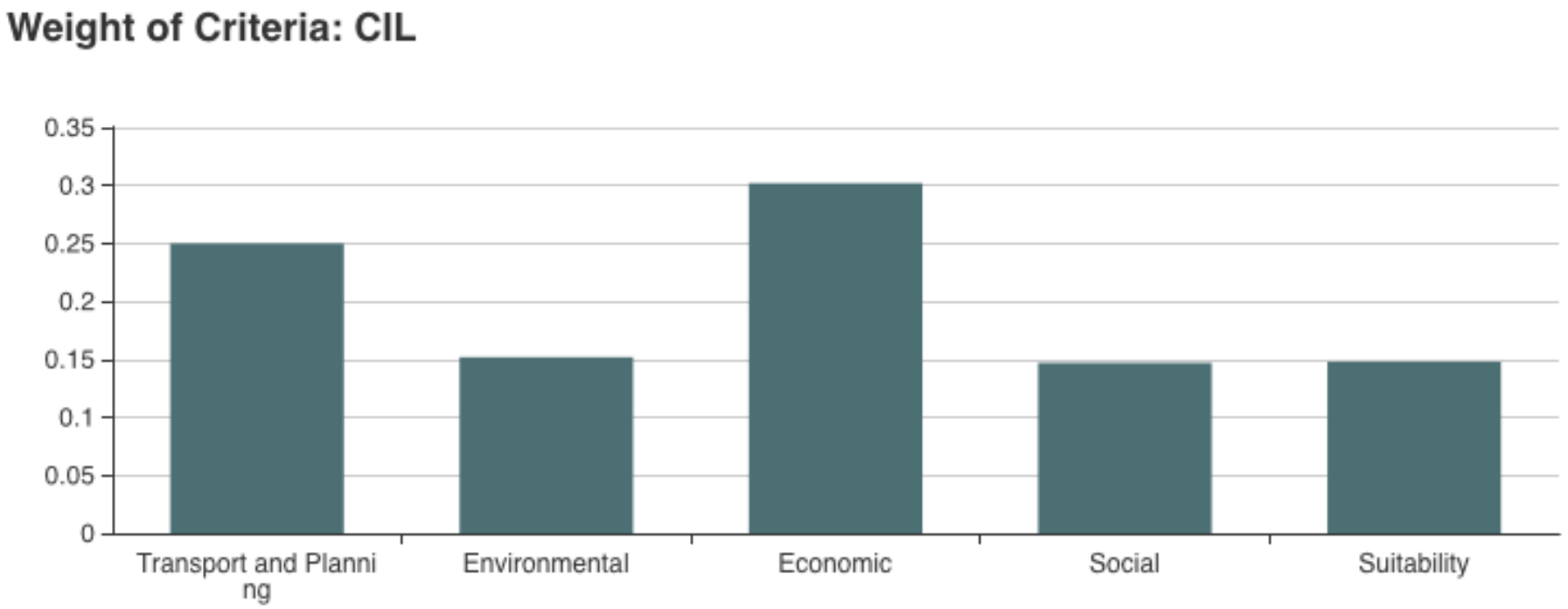
One of the most unexpected suggestions was to scrap the new MRT system, and invest instead in the existing bus network to operate frequent services along the grid roads (i.e. rapid bus service on every grid road, direct and fast). This suggestion was made before researching Jarrett

Walker's "Human Transit", which argues that the most effective transit network is the one that is operating along the grid system, and is frequent and reliable (transfer-based system where you need to change only once to get to you destination). Feedback: effective, thorough – great as it is participatory, and gets opinions

Group 5 Centre for Integrated Living (CIL)

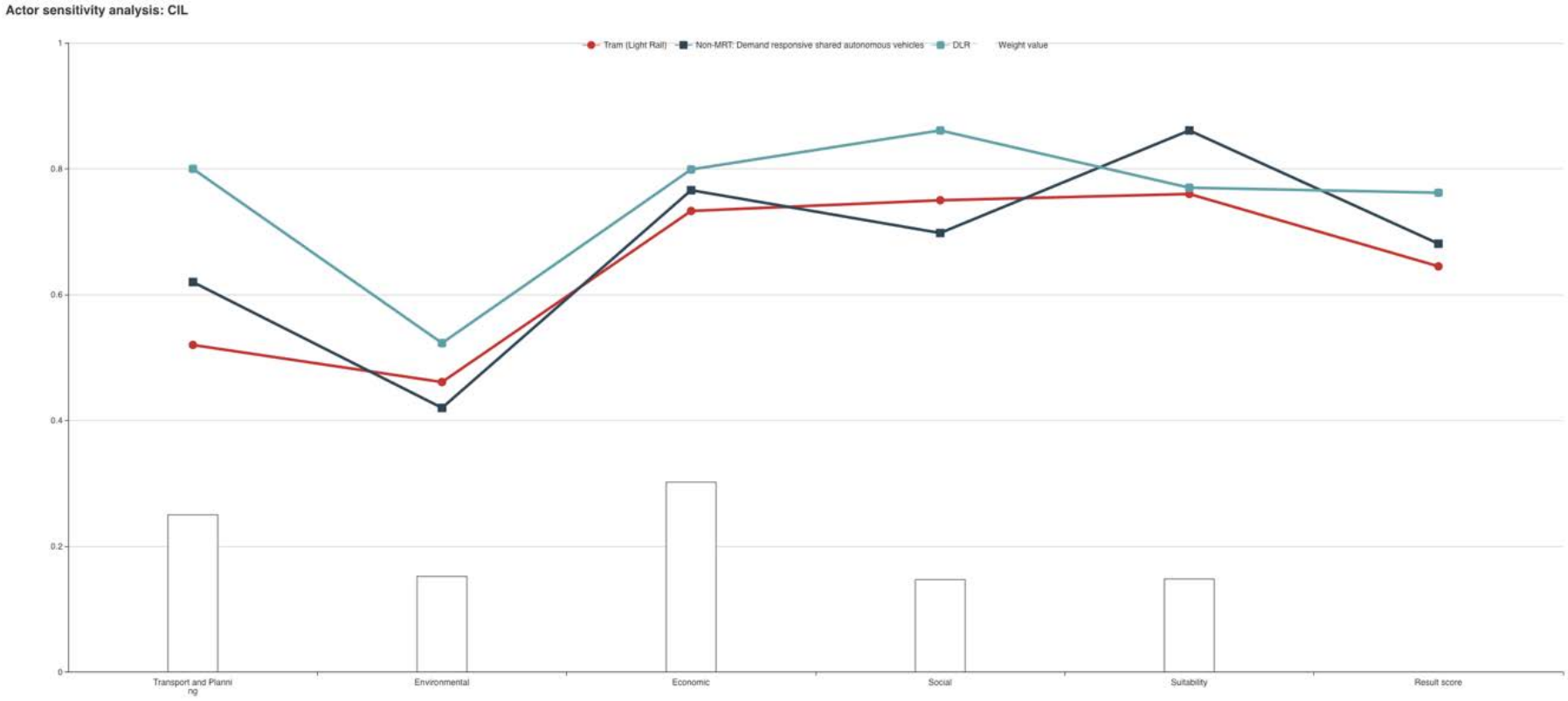
This group consisted of one participant only. The participant represented the views of people with disabilities and his professional experience included work on Jubilee line extension (former design and delivery manager). The modes selected were Tram-L, non-MRT and DLR-alike system (new system). This person prioritised economic objectives, though the cost sub-objective was completely excluded. The participant explained as a user, the cost of the system should not matter. He also scored transport and planning objectives slightly higher than the rest of the objectives.

Figure 29 CIL: weights



In terms of sub-objectives, travel speed of the system along with the safety of the system (new) were prioritised**.** Emphasis was placed on the ease of reaching the system (especially for vulnerable people). Though, the participant emphasised that that all modes can be accessible if designed properly. From the graph below it is evident that this group did not think that link between future MRT and environmental issues is particularly strong, which explains why all options scored low against environmental objectives. Since there was only one participant it was evident that he had bias towards one of the options – DLR, which scored higher on majority of the aspects. Non-MRT mode scored higher only on feasibility/buildability aspect.

Figure 10 CIL: scores

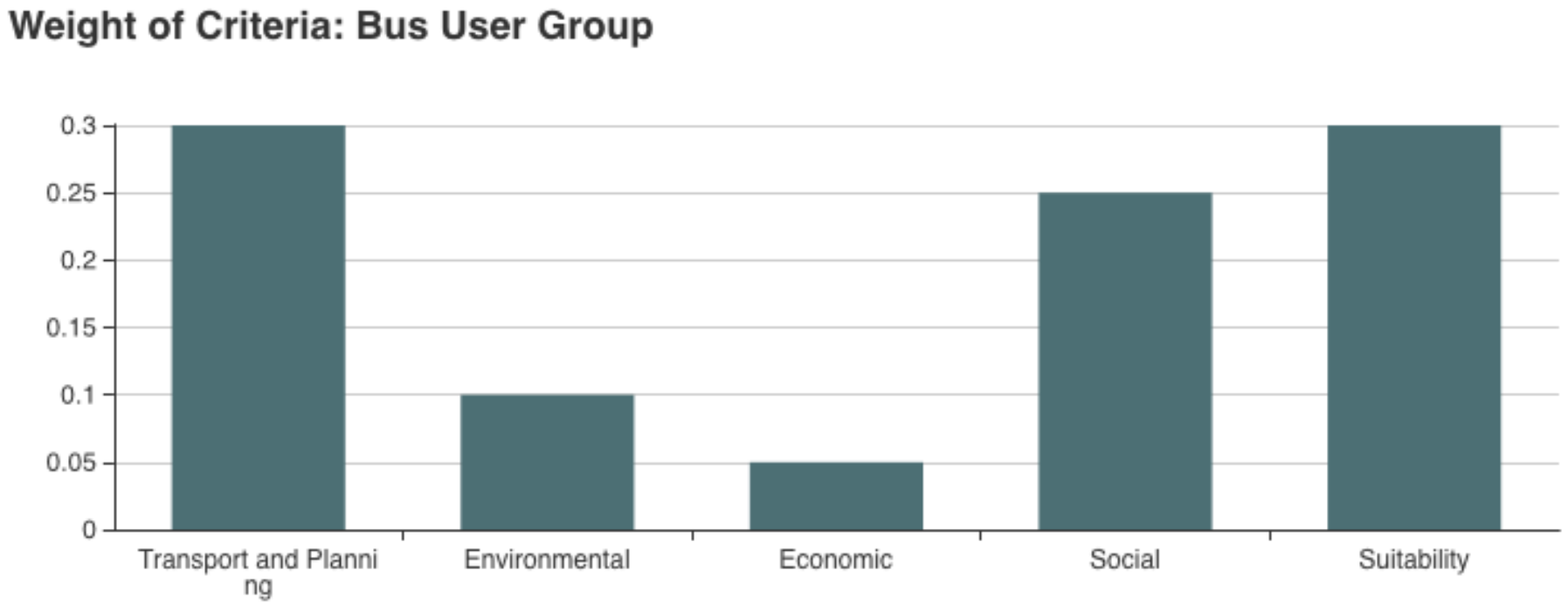


Critique: the participant described methodology as restrictive (having pre-offered objectives restricted thinking and limited creativity) added safety of the system as an additional objective and excluded cost of the system (as a user this should not be a concern).

Group 6 – Bus User Group (BUG)

This group chose BRT, BRT-L and Tram-L. The group was invited to focus on BUG's issues, like reliability of the public transport and attraction of car users, rather than taking the ultimate decision. This was a most interesting group allocation of points across the objectives: only five points were allocated to the economic objective (meaning cost), while suitability and transport and planning objectives were given 30 points each.

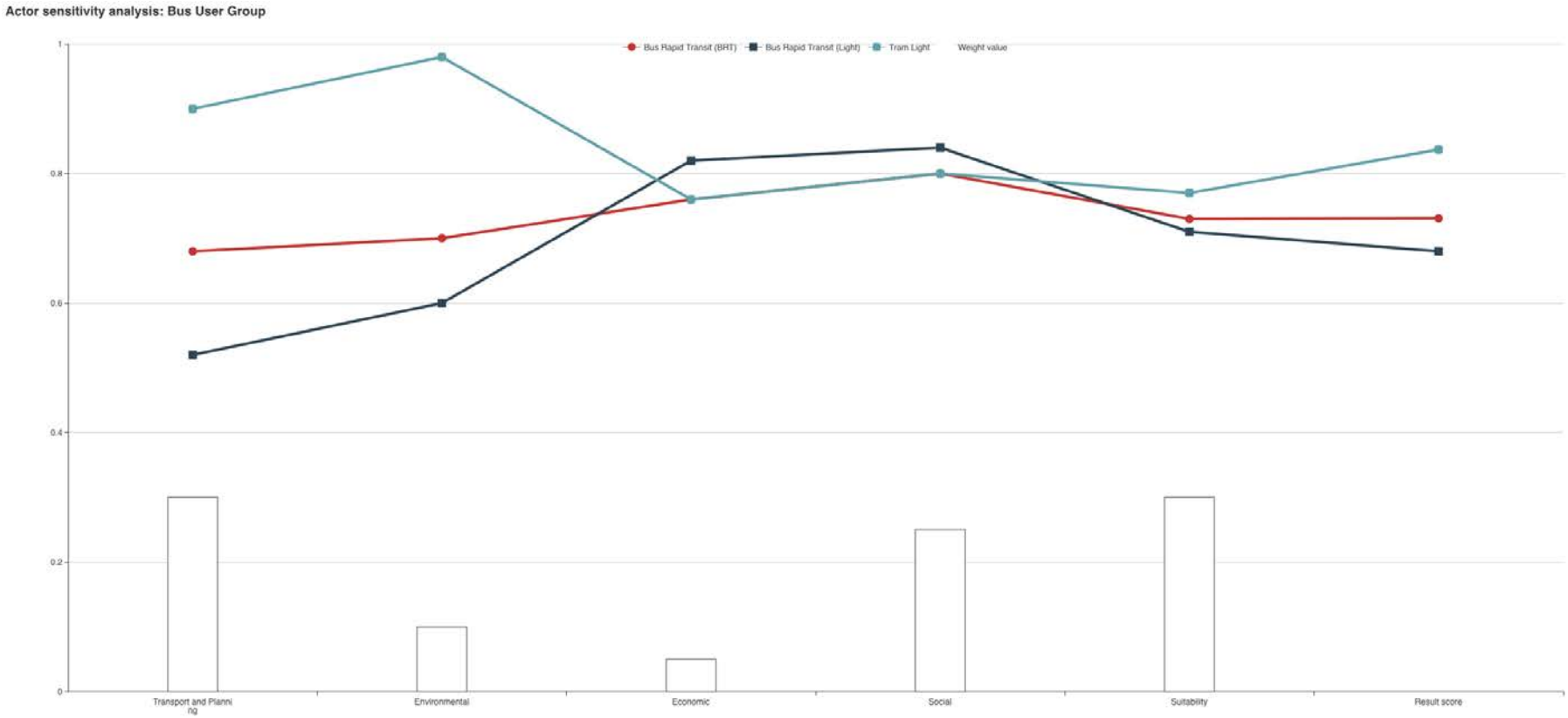
Figure 11 Bus User Group: weights



The group prioritised travel times and speed, meeting travel demands/gets people to their destinations sub-objectives – both serious issues for bus users at present. Further discussed took place about issues around bus routes, particularly, that they are monocentric while the town is polycentric. Group also discussed structural disadvantages and stressed that these should be acknowledged when implementing any of the systems. Furthermore, political risks were flagged up (i.e. turning a bus lane into parking spaces, as happened in Milton Keynes in the past, and

not implementing full BRT). Operational costs were excluded which group didn't like. The biggest surprise of this study was a bus user group supporting light rail. Tram-L scored significantly higher than BRT across several objectives, especially environmental objectives.

Figure 30 Bus User Group: scores

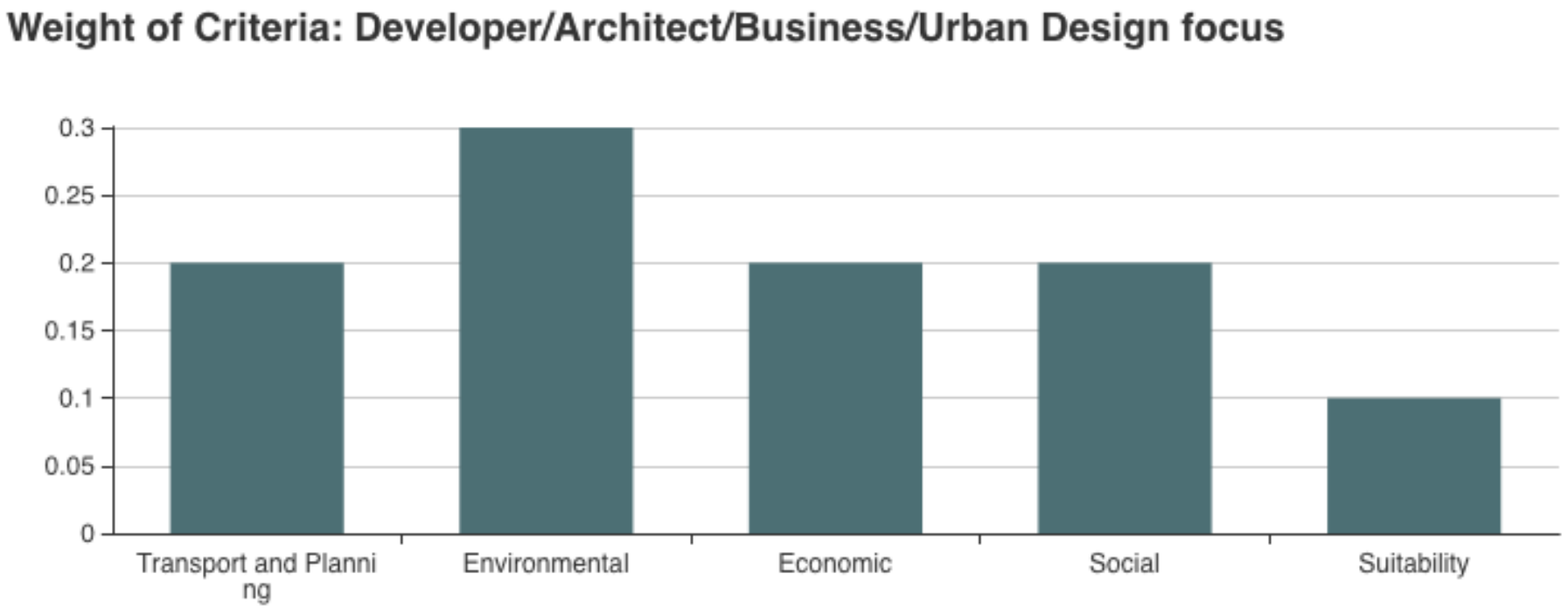


Feedback: Valuable tool to open a communication between people, challenging each other perceptions/misperceptions. Informal - Digging deep, making them work hard. Suggestion to get decision makers to take part in this. Critique – in MK wrong people get to decide the destiny for the town, get decision makers to do this study + few other groups.

Workshop 7: Business/ Developments/Architects/Urban Designers

The only group whom I told that I favour trams/light rail system, which arguably set a more critical approach to rail-based systems. This was the most diverse group, where contradicting views were present due to different views/professional backgrounds. This was the only team where a single member almost overpowered the discussion. Architect's views in particular have been dismissed the most, in particular when choosing the MRT modes and consequently, when choosing the sub-objectives and allocated the weights. Architect and another participant wanted to select monorail for appraisal simply from aesthetical point of view. The group decided to select BRT-L, Tram-L and Tram. Environmental objectives have been prioritised.

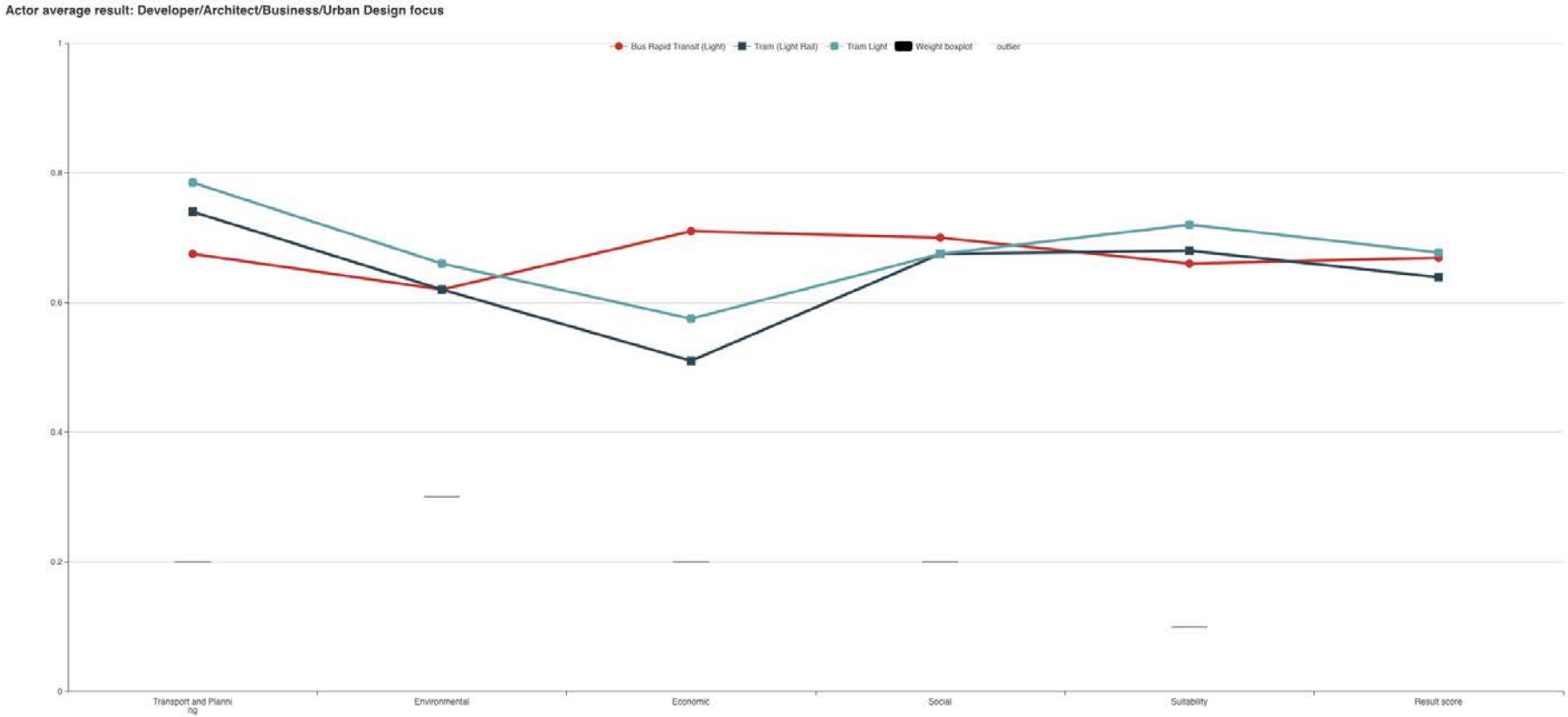
Figure 13 Mixed group: weights



The group modified more objectives than any other group, including moving some of the objectives from Transport and planning group to Suitability – Aesthetics. The group added the following extra sub-objectives:

- Severance
- Connectivity
- Operational costs

Figure 14 Mixed group: scores



Impact of the new system on Health and Wellbeing has been raised as an important aspect. It was confirmed by the Developer that new projects are prioritising sustainability and that rail-based systems are seen as a more desirable solution to sustainable transport due to being more reliable and potentially attracting more car users, whereas buses are seen as a transport for “lower classes”. All options scored fairly close with Tram-L leading followed by a BRT-L and Tram.

Feedback: **Businesses – this would have changed if we looked at regional connections. Urban Designer would be nice to see scenario work.** Weighting methodology was interesting, it is a planning tool more than anything that takes into consideration a broad spectrum of issues. Cost not being the most important.

Workshop 8: Academia

This group stressed that operational costs are important and that the cost of the system is one of the most important factors. Academia prioritised Transport and Planning and Economic objectives.

Figure 31 Academia: weights

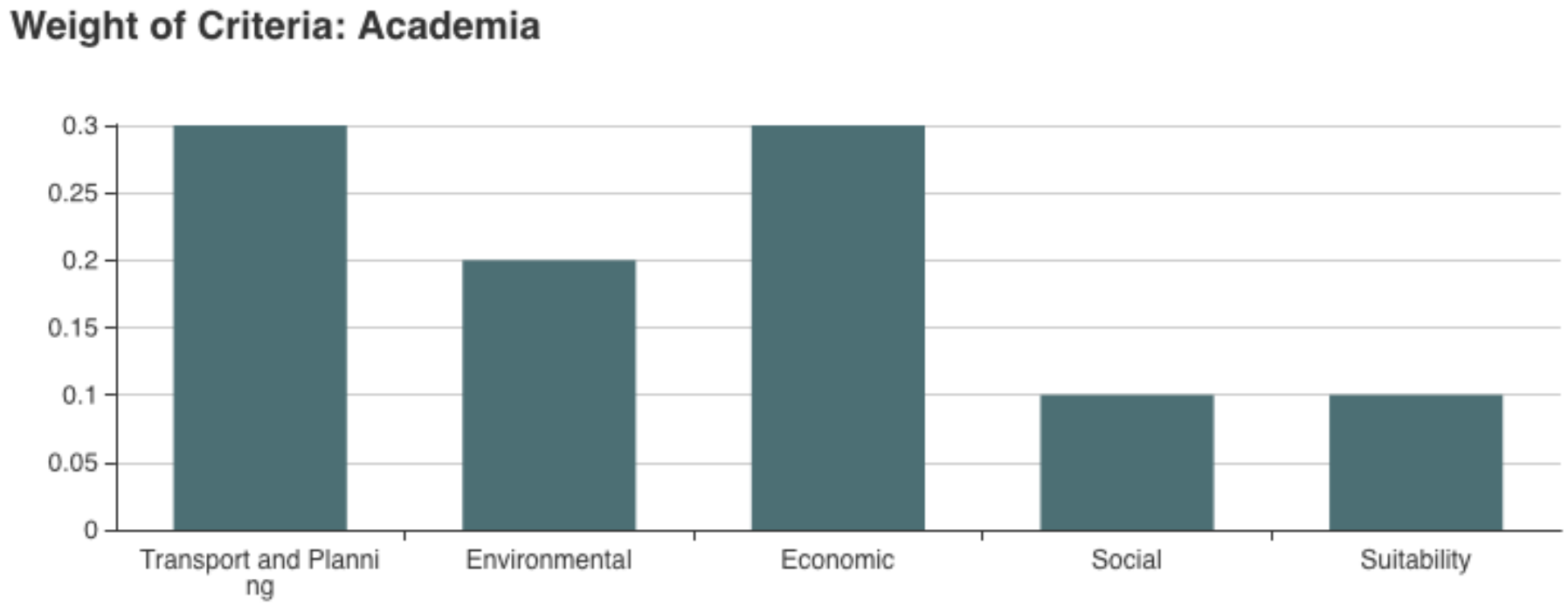
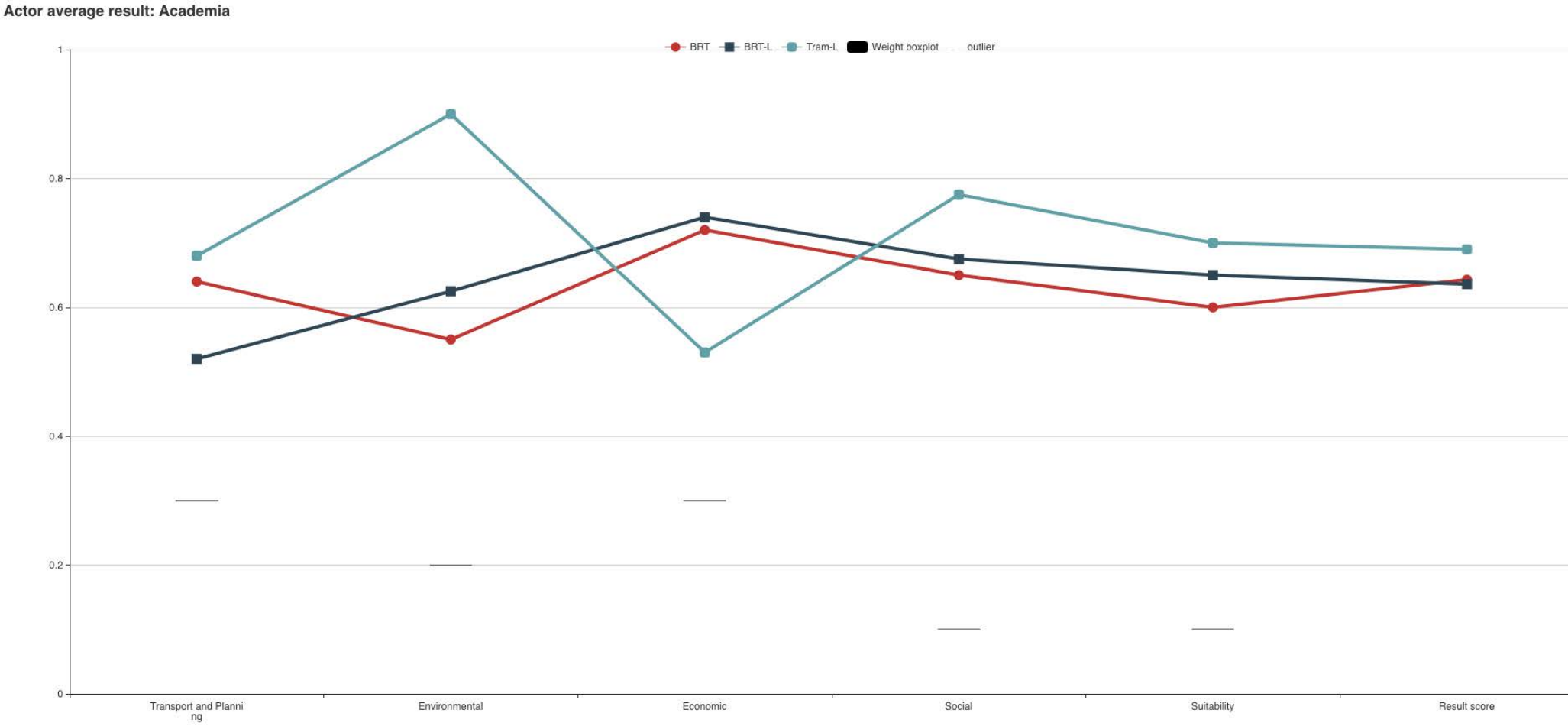


Figure 16 Academia: scores



Out of BRT, BRT-L and Tram-L, the latter scored the highest overall. It has been recognised that the cost of the Tram-L is the biggest disadvantage, through higher scored were given on Environmental and Social sub-objectives. Academia stressed the following with regards to the project:

- It is hard to get people out of car as cars remain to be attractive and convenient
- It is easier to do so when there is congestion as it is no longer so attractive (MK doesn't have congestion) - Do we leave MRT for now?
- You need to offer people a good alternative, high quality reliable public transport to get them out of cars, conventional buses do not work.
- Costs and income via fees is important, what system could a town of 250,000 to 500,000 afford?

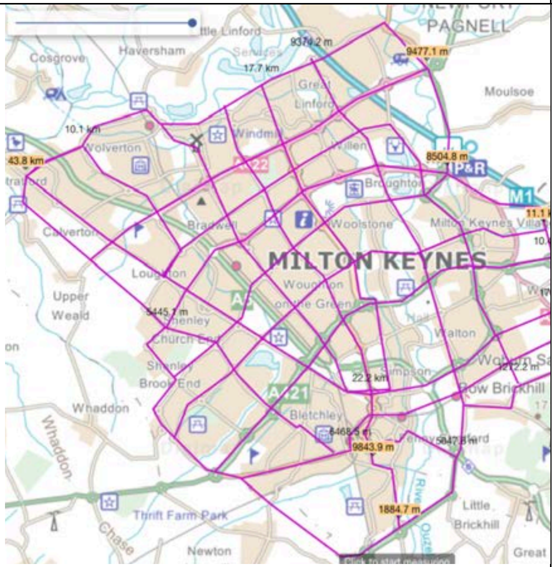
It has been noted that more expensive system can be more beneficial and attract more car users.

The group criticized the method for being arbitrary and not offering a detailed scenario to aid the scoring. It has been requested that further information is presented before scoring is done. Below is an attempt to define the three scenarios:

As discussed, existing bus network is not fit for needs of a poly-centric city. Table below reviews cost of three transport options – BRT, BRT-L and Tram-L. Notes: BRT and Tram-L aim to convert to monocentric routes to polycentric, while BRT-L is mainly building on the existing routes and can use existing vehicles. BRT-L can also exclude costly improvements of the multiple roundabouts by leaving them as they are (although no bus priority will be given). There are two proposed scenarios for the selected systems:

- Infrastructure max – to compare costs of the system based on the same parameters (routes, same number of vehicles)
- Infrastructure reasonable – functional measures to allow for each of the systems to be operational and productive:

Scenario 1 Maximum infrastructure for all routes 150 km

	BRT	BRT – L	Tram – L
Scenario 1 (maximum infrastructure)			
Amount of infrastructure	150km of segregated infrastructure	150km of segregated infrastructure	150km of segregated infrastructure
Cost of inf.	BRT cost p/km £3-5m/km	BRT-L cost p/km £3-5m/km	Tram-L cost p/km £10m/km
Cost of vehicles	Electric buses £0.25 – 0.5	Electric buses of old buses £0 – 0.25	Battery operated autonomous vehicles Assume £1m (as its £3m for a full-size tram)

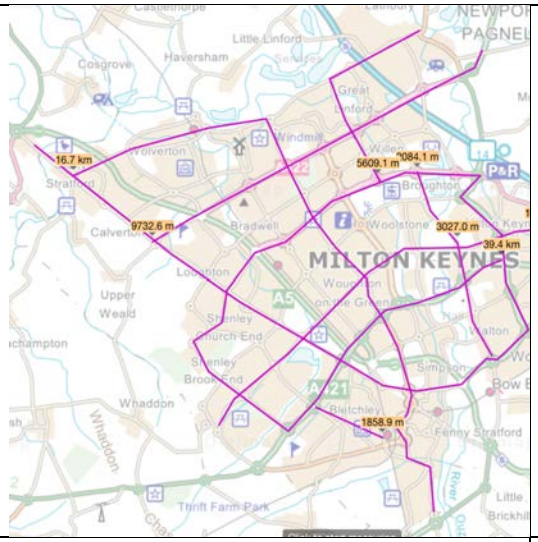
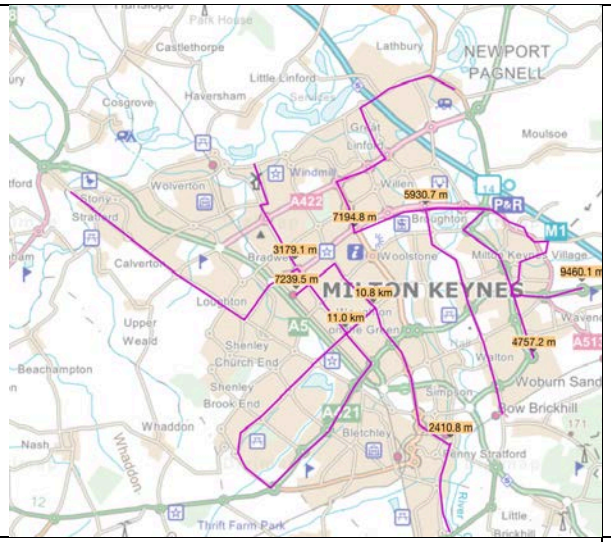
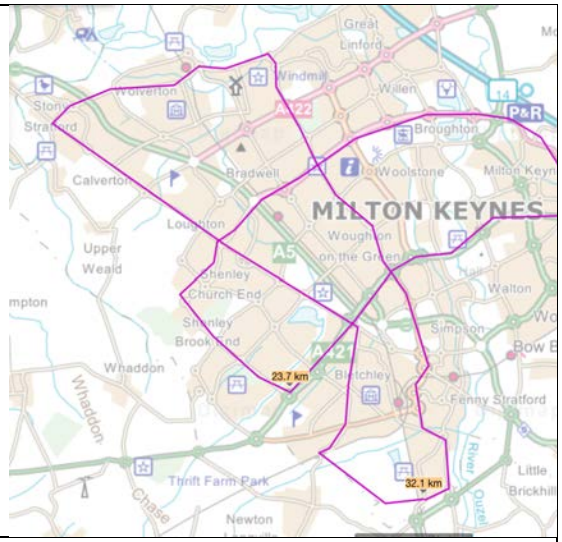
Vehicles required	20	20	20
Roundabouts (quantity)	150	150	150
Total cost infrastructure (ex roundb.)	£450-750m	£450-750m	£1,5b
Roundabouts	£975m	£975m (optional)	£975m
Vehicles total	£5m- 10m	£0-5m	£20m
Operational Costs [2]	xxx	xxx	-35%
TOTAL capital	£1.4-1.7b	£450 – 755m (+£975 optional)	£2.5bn

Priority at junctions: £6.5 m for a "Hamburger" style roundabout[3].

Scenario 2 – Reasonable infrastructure to ensure effective functioning of each of the systems:

	BRT	BRT – L	Tram – L

[2] Vehicle cost depreciation and maintenance, catenary depreciation and maintenance, labour, fuel, cost of capital. Labour can represent 35-75% operational costs.
[3] https://mycouncil.oxfordshire.gov.uk/documents/s25621/Kennington%20Hinksey%20Stage2-ProjectApproval.pdf

Scenario 2 reasonable amount of infrastructure			
Amount of infrastructure	100km of segregated infrastructure	60km of segregated infrastructure	50km of segregated tram infrastructure
Cost of inf.	BRT cost p/km £3-5m/km	BRT-L cost p/km £3-5m/km	Tram-L cost p/km £10m/km
Cost of vehicles	Electric buses £0.25 – 0.5	Electric buses of old buses £0 – 0.25	Battery operated autonomous vehicles Assume £1m (as its £3m for a full-size tram)
Vehicles required	10	n/a	8 vehicles (operating 24/7)
Roundabouts (quantity)	100	50 (optional)	50
Total cost infrastructure (ex roundb.)	£300-500m	£180-300m	£500m
Roundabouts	£650m	n/a or £390m	£375m

Vehicles total	£2,5m- 5m	£0-5m	£8m
Operational Costs [4]	xxx	xxx	-35%
Total capital	£1-1,2b	£180 – 305m (optional £390)	£883m [5]

[4] Vehicle cost depreciation and maintenance, catenary depreciation and maintenance, labour, fuel, cost of capital. Labour can represent 35-75% operational costs.

[5] This sounds too low, so assume we do 75km of rail (3rd circular route to serve Newport Pagnell area) + 2 additional vehicles. Total cost will be £1.1b.

11. Risk assessment form

1

RISK ASSESSMENT FORM
FIELD / LOCATION WORK

The Approved Code of Practice - Management of Fieldwork should be referred to when completing this form
http://www.ucl.ac.uk/estates/safetynet/guidance/fieldwork/acop.pdf

DEPARTMENT/SECTION **BARTLETT SCHOOL OF PLANNING**
LOCATION(S) **AGILE**
PERSONS COVERED BY THE RISK ASSESSMENT **Viktorija Jersova**

BRIEF DESCRIPTION OF FIELDWORK
Link does not work, I am not sure what this is asking me.

Consider, in turn, each hazard (white on black). If **NO** hazard exists select **NO** and move to next hazard section.
If a hazard does exist select **YES** and assess the risks that could arise from that hazard in the risk assessment box.
Where risks are identified that are not adequately controlled they must be brought to the attention of your Departmental Management who should put temporary control measures in place or stop the work. Detail such risks in the final section.

ENVIRONMENT	**The environment always represents a safety hazard. Use space below to identify and assess any risks associated with this hazard**
e.g. location, climate, terrain, neighbourhood, in outside organizations, pollution, animals.	Examples of risk: adverse weather, illness, hypothermia, assault, getting lost. Is the risk high / medium / low ? My working environment (home) does not represent environmental risks.

CONTROL MEASURES	**Indicate which procedures are in place to control the identified risk**
	work abroad incorporates Foreign Office advice
	participants have been trained and given all necessary information
	only accredited centres are used for rural field work
	participants will wear appropriate clothing and footwear for the specified environment
	trained leaders accompany the trip
	refuge is available
	work in outside organisations is subject to their having satisfactory H&S procedures in place
	OTHER CONTROL MEASURES: please specify any other control measures you have implemented:

EMERGENCIES	Where emergencies may arise use space below to identify and assess any risks
e.g. fire, accidents	Examples of risk: loss of property, loss of life Emergencies can happen, I am considering loss of properly, fire and accidents in my place, being locked out of my working space. Medium risk

CONTROL MEASURES	Indicate which procedures are in place to control the identified risk
	participants have registered with LOCATE at http://www.fco.gov.uk/en/travel-and-living-abroad/
Yes	fire fighting equipment is carried on the trip and participants know how to use it
Yes	contact numbers for emergency services are known to all participants
Yes	participants have means of contacting emergency services
Yes	participants have been trained and given all necessary information
	a plan for rescue has been formulated, all parties understand the procedure
	the plan for rescue /emergency has a reciprocal element
X	OTHER CONTROL MEASURES: please specify any other control measures you have implemented: Spare keys made and distributed

FIELDWORK 1

EQUIPMENT	Is equipment used?	YES	If 'No' move to next hazard If 'Yes' use space below to identify and assess any risks
e.g. clothing, outboard motors.	Examples of risk: inappropriate, failure, insufficient training to use or repair, injury. Is the risk high / medium / low ?		

I am using my new Apple Mac for work on my dissertation. It has 2 year warranty, but it can still break. Low risk

CONTROL MEASURES	Indicate which procedures are in place to control the identified risk
	the departmental written Arrangement for equipment is followed
	participants have been provided with any necessary equipment appropriate for the work
yes	all equipment has been inspected, before issue, by a competent person
	all users have been advised of correct use
	special equipment is only issued to persons trained in its use by a competent person
	OTHER CONTROL MEASURES: please specify any other control measures you have implemented:

LONE WORKING	Is lone working a possibility?	YES	If 'No' move to next hazard If 'Yes' use space below to identify and assess any risks
e.g. alone or in isolation lone interviews.	Examples of risk: difficult to summon help. Is the risk high / medium / low? Low risk I work from home hence lone working is as risky as living on my own. I am not sure what control measures for this could be		

CONTROL MEASURES	Indicate which procedures are in place to control the identified risk
	the departmental written Arrangement for lone/out of hours working for field work is followed
	lone or isolated working is not allowed
	location, route and expected time of return of lone workers is logged daily before work commences
Yes	all workers have the means of raising an alarm in the event of an emergency, e.g. phone, flare, whistle
	all workers are fully familiar with emergency procedures
	OTHER CONTROL MEASURES: please specify any other control measures you have implemented:

ILL HEALTH	The possibility of ill health always represents a safety hazard. Use space below to identify and assess any risks associated with this Hazard.
e.g. accident, illness, personal attack, special personal considerations or vulnerabilities.	Examples of risk: injury, asthma, allergies. Is the risk high / medium / low? Possibility of Ill health is High. High Risk Covid 19 has had an impact on my mental health and assignment delays have been affecting me, 3 months to complete a dissertation while working full time is unreasonable time and I am already showing visible signs of anxiety. April 2019 self-referral was made to mental health services. The assessment concluded that I am suffering from "severe anxiety". There is a high risk that pressure at work, pressure at university and covid-19 will affect my work. I have been given advice on how to manage my anxiety.

CONTROL MEASURES	Indicate which procedures are in place to control the identified risk
	an appropriate number of trained first-aiders and first aid kits are present on the field trip
	all participants have had the necessary inoculations/ carry appropriate prophylactics
	participants have been advised of the physical demands of the trip and are deemed to be physically suited
	participants have been adequate advice on harmful plants, animals and substances they may encounter
	participants who require medication have advised the leader of this and carry sufficient medication for their needs
x	OTHER CONTROL MEASURES: please specify any other control measures you have implemented: Self-referred to mental health clinic and sought support to manage my stress and anxiety.

TRANSPORT	Will transport be required	NO	X	Move to next hazard
		YES		Use space below to identify and assess any risks
e.g. hired vehicles	Examples of risk: accidents arising from lack of maintenance, suitability or training Is the risk high / medium / low?			

CONTROL MEASURES	Indicate which procedures are in place to control the identified risk
	only public transport will be used
	the vehicle will be hired from a reputable supplier
	transport must be properly maintained in compliance with relevant national regulations
	drivers comply with UCL Policy on Drivers http://www.ucl.ac.uk/hr/docs/college_drivers.php
	drivers have been trained and hold the appropriate licence
	there will be more than one driver to prevent driver/operator fatigue, and there will be adequate rest periods
	sufficient spare parts carried to meet foreseeable emergencies
	OTHER CONTROL MEASURES: please specify any other control measures you have implemented:

DEALING WITH THE PUBLIC	Will people be dealing with public	YES	If 'No' move to next hazard If 'Yes' use space below to identify and assess any risks
e.g. interviews, observing	Examples of risk: personal attack, causing offence, being misinterpreted. Is the risk high / medium / low? Dealing with public will be required as part of the survey process. Low response levels is a high risk,		

CONTROL MEASURES	Indicate which procedures are in place to control the identified risk
yes	all participants are trained in interviewing techniques
	interviews are contracted out to a third party
yes	advice and support from local groups has been sought
	participants do not wear clothes that might cause offence or attract unwanted attention
	interviews are conducted at neutral locations or where neither party could be at risk
	OTHER CONTROL MEASURES: please specify any other control measures you have implemented:

FIELDWORK **3**

WORKING ON OR NEAR WATER	Will people work on or near water?	NO	If 'No' move to next hazard If 'Yes' use space below to identify and assess any risks
e.g. rivers, marshland, sea.	Examples of risk: drowning, malaria, hepatitis A, parasites. Is the risk high / medium / low?		

CONTROL MEASURES	Indicate which procedures are in place to control the identified risk
	lone working on or near water will not be allowed
	coastguard information is understood; all work takes place outside those times when tides could prove a threat
	all participants are competent swimmers
	participants always wear adequate protective equipment, e.g. buoyancy aids, wellingtons

	boat is operated by a competent person
	all boats are equipped with an alternative means of propulsion e.g. oars
	participants have received any appropriate inoculations
	OTHER CONTROL MEASURES: please specify any other control measures you have implemented:

MANUAL HANDLING (MH)	**Do MH activities take place?**	**NO**	**If 'No' move to next hazard** **If 'Yes' use space below to identify and assess any risks**
e.g. lifting, carrying, moving large or heavy equipment, physical unsuitability for the task.	Examples of risk: strain, cuts, broken bones. Is the risk high / medium / low?		

CONTROL MEASURES	**Indicate which procedures are in place to control the identified risk**

	the departmental written Arrangement for MH is followed
	the supervisor has attended a MH risk assessment course
	all tasks are within reasonable limits, persons physically unsuited to the MH task are prohibited from such activities
	all persons performing MH tasks are adequately trained
	equipment components will be assembled on site
	any MH task outside the competence of staff will be done by contractors
	OTHER CONTROL MEASURES: please specify any other control measures you have implemented:

FIELDWORK

SUBSTANCES	**Will participants work with substances**	**NO**	**If 'No' move to next hazard** **If 'Yes' use space below to identify and assess any risks**
e.g. plants, chemical, biohazard, waste	Examples of risk: ill health - poisoning, infection, illness, burns, cuts. Is the risk high / medium / low?		
CONTROL MEASURES	**Indicate which procedures are in place to control the identified risk**		

	the departmental written Arrangements for dealing with hazardous substances and waste are followed
	all participants are given information, training and protective equipment for hazardous substances they may encounter
	participants who have allergies have advised the leader of this and carry sufficient medication for their needs
	waste is disposed of in a responsible manner
	suitable containers are provided for hazardous waste
	OTHER CONTROL MEASURES: please specify any other control measures you have implemented:

OTHER HAZARDS	**Have you identified any other hazards?**	**YES**	**If 'No' move to next section** **If 'Yes' use space below to identify and assess any risks**
i.e. any other hazards must be noted and assessed here.	Hazard: Pandemic Risk: is the risk	**HIGH**	
CONTROL MEASURES	**Give details of control measures in place to control the identified risks**		

Since March 2020 Covid-19 has caused a global pandemic. The world has experienced a lockdown and this has significantly affected everyone's life. This has had a huge impact on my work, studies and life in general. In respect to my dissertation which is on Public transport, this will have an impact on how I conduct surveys and sources of information that I will be using

Have you identified any risks that are not adequately controlled?			
	NO		**Move to Declaration**
	YES	**X**	**Use space below to identify the risk and what action was taken**

Is this project subject to the UCL requirements on the ethics of Non-NHS Human Research? no

If yes, please state your Project ID Number

For more information, please refer to: http://ethics.grad.ucl.ac.uk/

DECLARATION	The work will be reassessed whenever there is a significant change and at least annually. Those participating in the work have read the assessment.

Select the appropriate statement:

x	I the undersigned have assessed the activity and associated risks and declare that there is no significant residual risk
X	I the undersigned have assessed the activity and associated risks and declare that the risk will be controlled by the method(s) listed above

NAME OF SUPERVISOR Tim Pharoah

FIELDWORK 5 September 2020