

Control Centres and Travel Demand Management in a Growing City Region

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1 Introduction

- 1.1 The objective of this study is to determine how technology can contribute to facilitating and improving Travel Demand Management (TDM), particularly in relation to Incident Response TDM.
- 1.2 This paper is the product of a detailed study which included the collection, analysis and evaluation of primary and secondary data, from academic sources, policy literature, Transport for Greater Manchester (TfGM) and Transport for London (TfL) officers.
- 1.3 Technology offers the opportunity to improve efficiency and effectiveness in transport service operation and delivery. However, to identify the innovations and technological opportunities which will obtain the greatest positive impact, current procedures need to be scrutinised to understand areas of weakness, and potential for improvement.
- 1.4 The paper discusses the following topics: the importance of TDM in facilitating efficient transport movement and usage; technology enhanced TDM; an explanation of how incidents are managed at TfGM; the role of technology to support Incident Management at TfGM; and, how this might be improved.
- 1.5 The role technology has played in enabling more effective and efficient Incident Response and TDM will be identified and evaluated, alongside any weaknesses and potential for improvement in the technology that has already been implemented.

2 Travel Demand Management and Transport

- 2.1 Transport networks and service delivery mechanisms, in a number of cities and city regions across the UK, are struggling to facilitate the efficient movement of people. This is for a number of reasons, including: the highways network suffering from significant congestion; ageing infrastructure struggling to cope with increasing patronage; and, public transport networks experiencing demand levels above capacity supplied.
- 2.2 The ability to plan transport effectively, across a range of modes, is vital to ensuring residents and visitors are able to access transport for employment, education and social inclusion. As of 2014, over 50% of the world's population live in urban areas. In Europe, over 70% of citizens live in urban

areas. Currently, 90% of the UK population resides in urban areas, with this number predicted to rise to 92% by 2030¹.

- 2.3 Cities and city regions face multiple transport related challenges, including congestion, poor air quality from emissions pollution and accessibility. TDM plays a key role in minimising the negative impacts of transport and exploiting areas of the transport network which could be better utilised.
- 2.4 TDM utilises the “4 R’s”: re-route, re-mode, re-time and reduce. Through the implementation of a variety of measures, TDM informs users of their current choices, the impacts choices have on journey times and mode availability, and how changing these choices can improve travel. For example, a journey may cost less, take less time or involve a mode that offers physical exercise.
- 2.5 TDM has applications across daily routines, event management and incident management. Table one highlights possible use cases for TDM.

Table 1. Types of Travel Demand Management

Travel Demand Management Type	Use cases
Day to day	Daily TDM can enable residents and visitors to make sustainable travel choices as they go about their daily lives.
Event	Event management requires pre-planning to ensure adequate services are able to cover demand.
Incident	Incident management occurs when there is a disruption to services and the transport authority must respond to the problem, resolve the incident, replace services where necessary and communicate any changes with travellers. This method is often continuously changing as the incident evolves and requires frameworks and agreements to be in place prior to the incident, and also includes pre-planning to ensure the effects on services are minimised.

¹ World Resources Institute. (n.d). Population, Health and Human Well-being - Urban and Rural Areas: Urban population as a percent of total population. Access on 11/12/2016, from: <https://docs.google.com/spreadsheets/d/1CN5n085EWsxlKnJBvgGiGFZHtfl-WUCeGyaLehEPI0Q/edit#gid=0>

3 The Role of Technology in Travel Demand Management

3.1 Significant changes to how citizens in the UK, and globally, access transport services has brought about new challenges in cities. This presents new opportunities in TDM. This section details some examples of how technology has impacted TDM.

3.2 Communications and Information Technology

3.2.1 The emergence and evolution of new information and communications technologies has had a significant effect on TDM, although not always in ways predicted. For example, whilst some initial expectations for information technology included removing the need to travel with new applications in flexible working, and reduced office-based work, this aspect of TDM has been slow to influence travel demand patterns.

3.2.2 However, instead information and communication technologies have enabled the sharing of real-time information through social media. Customers and stakeholders can utilise this, along with “nudges” and suggestions about transport alternatives, to make sustainable travel choices over the long term. Travellers are also better informed to react to unforeseen changes with minimal notice, using information such as provided by Variable Message Signs which direct travellers from a congested motorway to the nearest Park and Ride site.

3.3 Smart Ticketing

3.3.1 TfL have the most comprehensive multimodal smart ticketing platform in the United Kingdom, through contactless payment and the Oyster Card. With the ability to integrate modes and offer services through a smart payment method, which offers convenience and reliability to the consumer, TfL have created a system which collects large amounts of data on travel every day.

3.3.2 By effectively utilising this data, TfL is able to influence customers to offer a variety of transport options which may not have been considered previously. Day-to-day information provision includes transport “hot-spot” areas which suffer from high volumes of people, at peak times. During prolonged incidents and engineering works, TfL are able to offer alternatives and effectively communicate these to transport users through a range of media (both social and traditional) and monitor the effects of the TDM on the network.

3.4 Online Services

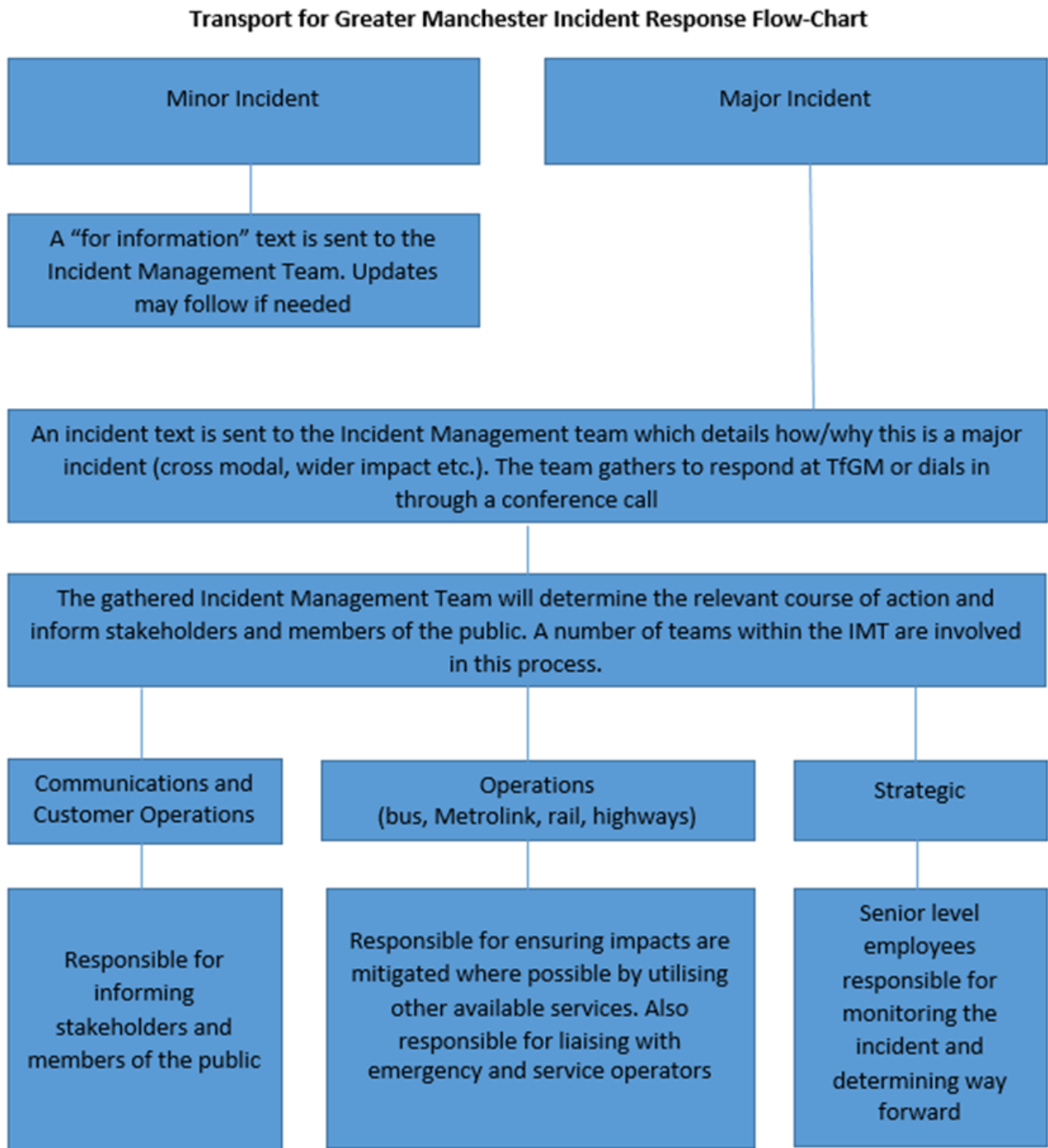
- 3.4.1 Traditionally services such as shopping, banking and health services would have to be accessed in person. However, through the evolution of the internet, and by extension, online shopping and services, more citizens are now able to access information and materials online.
- 3.4.2 This has enabled changes to transport patterns and how services can be offered. For example, in Greater Manchester, the majority of trips outside the peak are conducted for shopping purposes. Technology in the future may enable fewer longer distance trips to large shopping centres, and shorter local trips to leisure outlets.

4 Context in Greater Manchester

- 4.1 Greater Manchester is expanding at a rapid rate, both in population numbers and economically. Over 300,000 more people are expected to live in the city region by 2040. Effective travel planning will be essential to maintaining a functioning transport network, particularly during incident management. Travellers often have limited information, provided by a number of sources, that is not always up to date or accurate. With fragmented and inaccurate information on planned services, delays and disruptions, travellers will often rely on past experience to determine how and when they will travel, which can create delays and congestion across the transport network.
- 4.2 Transport for Greater Manchester (TfGM) has recently begun investigating ways to expand the current TDM process in Greater Manchester, recognising the positive impacts effective management can have across the network, particularly in incident management.

5 Current Processes in Incident Travel Demand Management at Transport for Greater Manchester

5.1 The flowchart in figure one highlights the incident management response in



TfGM.

Fig.1 Incident response flow chart

- 5.2 TfGM recognise that each incident will vary in size, complexity, impact and duration, and will require significant flexibility and continuous evaluation throughout the incident management process.
- 5.3 As such, the incident response techniques utilised will take a number of factors into account, and will reflect the available resources and needs of the affected area, modes and people. To ensure the response is adequate and befits the level of incident, TfGM have developed a Command & Control framework that considers incidents across modes (see Table 2).

Table 2. Incident Management Procedure

Incident Type	Reasons for Classification
Major Incident Management Team (IMT) Alert: IMT response required	A major incident has/is occurring, which requires an immediate response from TfGM. There is a large risk exposure with disruption affecting more than 2 modes, or the disruption may require prioritisation &/or suspension of non-essential services
Minor IMT Alert: Information only required/impact assessment required	No requirement for a special response due to low-level, localised disruption affecting a single mode

- 5.4 Incidents can be partially expected, such as severe weather, or unexpected, such as public disorder/disturbance. The incident is initially managed at the lowest possible level, with the officers involved retaining the ability to escalate to more senior levels if necessary (see table three for reasons to escalate).

Table 3. Incident Response Escalation

Incident Type	Actions
Major	An IMT text alert will be sent to activate the IMT. The IMT Lead are briefed on the circumstances and key partners are contacted to share intelligence and updates. Relevant TfGM service areas are alerted and resource requirements identified. Updates are also sent to the

	CEO/Leading Members
Minor	Details of the incident are recorded and notifications communicated to relevant officers (including senior) within the required modes. IMT text alerts are sent and intelligence is shared with relevant service managers/leads

5.5 Incident Management

5.5.1 There are three levels/versions of Incident Management at TfGM: Operational, Tactical and Strategic. The level of response required is determined by the type of incident. In the case of a major incident a Strategic response is required. However, a Strategic response may be required for a minor incident, depending on the level of impact to each mode or the size of the impact geographically. Initially, the level of response will be determined by the person who receives the incident information first.

5.6 Operational: Incident Responder

5.6.1 The person/officer who receives the incident information in the first instance, becomes the Incident Responder. This could be via a relevant officer for a mode or a staff member in their day-to-day role. If there is limited disruption (low level impact and effecting on one mode), it is expected that this would be escalated within the relevant mode only.

5.6.2 The role of this person is to make an initial impact assessment and respond accordingly. This may include escalating the response (via text alert) to a full IMT meeting if necessary.

5.7 Tactical: Local Incident Management Team

5.7.1 When an incident has greater impacts on an area, the relevant modes may wish to form a Local Incident Management Team (LIMT). The LIMT will co-ordinate the tactical response at a local level. The LIMT provide regular updates to the IMT members through the text alert system, and, if appropriate, call together a fully gathered IMT.

5.8 Strategic: The Incident Management Team

5.8.1 The IMT is responsible for managing and co-ordinating the TfGM response to the incident. The IMT comprises senior managers from across the

organisation including each mode, a nominated deputy, and relevant officers from other departments including communications and customer operations. Other relevant specialists are called when necessary to support the decision-making around the incident response, particularly legal and financial teams.

5.8.2 The IMT meets in a dedicated space at TfGMs offices and/or via conference call over telephone. Once the IMT has been called together the Urban Traffic Control Centre (UTC) would be “stood up” (if out of normal operating hours) and the Duty Manager at the time (who may be on-call) would support the IMT.

5.9 Communications

5.9.1 The communications team is responsible for both internal and external communications and ensuring information is handled in a correct manner throughout the entirety of the incident. The communications team responsibilities include:

- Devising a communications protocol at the onset of an incident;
- Creating a priority list for ensure the correct audiences are informed at the correct times;
- Drafting media releases for approval from the IMT;
- Delivering messages to key stakeholders and members of the public through appropriate channels;
- Liaising with the media where appropriate;
- Co-ordinate the request for information and interviews.

5.10 Customer Operations

5.10.1 Customer Operations includes the Customer Contact Centre, which is vital in an incident to deliver communication messages to the public.

5.11 Information Services

5.11.1 In order to respond to an incident effectively the IMT may require specialist support, including mapping facilities. On call Information Services officers may be called upon by the IMT to provide internal technical support.

6 The Role of Technology in Incident Travel Demand Management at Transport for Greater Manchester

- 6.1 Incident management involves a number of complex processes, particularly in transport, which require pre-arranged agreements to be in place between operators and stakeholders, to ensure swift and effective decisions can be made in the event of an incident.
- 6.2 A major incident, such as a weather incident, can affect multiple modes and may not have a clear end point. Major incidents require communication, between decision makers and the public to ensure travel demand does not overwhelm remaining services. Ensuring customers have details of replacement services is also vital, to prevent customer complaints, delays and to minimise congestion across the network.
- 6.3 This section will highlight the use of technology at each key section highlighted on the flowchart in Section Five, to facilitate and improve the incident response.
- 6.4 An Incident Occurs
- 6.4.1 When an incident occurs in Greater Manchester, TfGM officers can be alerted through a number of process, including:
- Via social media: immediate responses from travellers are disseminated via Twitter. The communications team would pick up the information and relay it to the relevant modal officers;
 - Via the Urban Traffic Control Centre: the Urban Traffic Control Centre (UTC) monitors and maintains efficiency on the highways network, primarily CCTV monitoring and the monitoring of traffic flows via inductive loops fitted under the ground and Bluetooth sensors strategically placed in the city region. Incidents can be picked up through the CCTV network and relayed to the relevant officers via email, telephone etc.;
 - Through the Customer Contact Centre: Members of the public can ring up and inform TfGM of an incident which they have witnessed or been personally involved in themselves; and,
 - Through the Metrolink Transport Management Service (TMS): The TMS provides the ability to monitor the movements of trams across a number of routes on the whole Metrolink network. The TMS has the ability to notify the control room (based in Trafford) of any incidents and errors/unexpected changes to service patterns. This information is then passed on to the relevant officers at TfGM via telephone and/or email.
- 6.5 Minor vs. Major Incident

- 6.5.1 As previously mentioned, when an incident occurs which requires input from the IMT, a text alert is sent to the relevant teams.
- 6.5.2 The text alert system enables relevant officers to share impact on their modes/services. If the incident is a minor one, “for information” texts are sent between IMT members to keep each team and mode informed. If an incident requires an escalated response the relevant teams are informed through this method.
- 6.5.3 The utilisation of text message technology in this way enables the message to reach the maximum number of people as quickly as possible. If the message was sent via email there could be a delay in responding due to the lengthy nature of emails and the inability of some people to access them due to connectivity issues.
- 6.5.4 If an anomaly or incident has been identified by the TMS, and could result in an incident or investigation, the relevant TfGM officers in the Metrolink Operations team at TfGM will be notified. As previously mentioned the TMS has the ability to notify the Metrolink control room of any incidents or errors.
- 6.5.5 These can be either significant issues, or minor ones which could evolve into major incidents, such as when a tram passes a stop signal. If a tram passes a stop signal, this may result in an incident on the Metrolink network and/or another mode. As such, the TMS will notify the Metrolink control centre accordingly to pass on information relating to the cause of the incident and whether or not further evaluation or investigation is required (which would be carried out by the operator).
- 6.5.6 Anomalies or incidents detected through the UTC are identified via CCTV and corroborated through SCOOT (a traffic monitoring and control system), which can highlight changes in traffic patterns. This identification allows TfGM officers to ascertain whether or not it is a major incident, or if it can be dealt with operationally. Where necessary, the UTC officers will remove control of the traffic light system from SCOOT and adjust the traffic light system manually to ensure the flow of traffic is maintained.

6.6 A Major Incident

- 6.6.1 The IMT room contains areas for each mode to detail the level of impact on their services. Senior members of the team will devise a plan based on all collated information available. Periodic Situation Reports are prepared to inform the IMT of impacts across modes and actions to date. These are communicated via email to relevant officers, who can then share information with stakeholders via telephone or email.

6.6.2 During this phase technology is utilised in a monitoring capacity, across multiple modes through the UTC and TMS. However, due to the UTC operating hours, which are not 24/7, their ability to “stand up” in an incident may be slower than it could be, or may not be possible at depending on officer availability. The TMS are able to monitor the movement and performance of the trams across the network, including any delays due to the incident.

6.6.3 In the event of a major incident different organisations are responsible for clearing the incident:

- If there is a guided busway incident, or an issue with signals, then TfGM expedite clean-up/recovery as TfGM have responsibility/ownership;
- If this is highways incident then that would fall to the district as the highways authority; and,
- If Metrolink or bus clear up is required then it would fall to the relevant operator.

6.6.4 The IMT is kept informed of the recovery, through telephone and email channels, throughout the process to ensure the relevant service impact can be mitigated and stakeholders and the public can be informed of changes to service availability. In the event of a long-term recovery period, the specific transport modes will lead the recovery in collaboration with relevant stakeholders, including districts and clear-up organisations.

6.7 Communicating the Incident to Travellers and Stakeholders

6.7.1 The evolution of communications, as previously stated, has had a significant impact on TDM. In incident management this is equally true. The communications team work closely with customer operations in the event of an emergency.

6.7.2 The communications procedure of incident TDM in TfGM has the most sophisticated utilisation of technology. Whilst the method of determining the content of communications is largely based on human decisions, the approach to distributing the content has changed considerably over the years.

6.7.3 Traditional media, such as radio, television and print, is still utilised to reach a large number of people, but alerts are often published on media websites, as this is quicker and easier to arrange. Alongside this, social media is used to offer customers real-time information on delays and alternative travel options through Twitter, which have been arranged by TfGM and transport operators. Situation Reports are written and sent out to the relevant officers

and stakeholders via email, which enables information to be shared quickly and to a large number of people simultaneously.

6.8 In the case of long-term disruptions due to incidents, information can be shared through the TfGM application for mobile devices. In future this could be extended to include real-time updates via the application, alongside information brought in through social media.

6.9 Areas for Improving the Use of Technology

6.10 This section has highlighted the role of technology in the incident management process at TfGM. Some sections of the incident travel demand process are still fragmented and inefficient, and could significantly benefit from utilising more technology.

6.11 Areas that require more attention include:

- The lack of data collection on the impact of incidents and Incident TDM measures on each mode and across the network as a whole. Currently, no information is collected due to an inability to measure any patronage changes across modes in an incident;
- The ability to swiftly and efficiently clear-up and recover from incidents, including those which are high risk or expose the recovery crews to increased levels of danger;
- The lack of integration across modes in an everyday context means the impact is considered separately and lacks a “network perspective”; and,
- The role of technology in visually monitoring an incident and recovery/clear up is fragmented and varies across modes, districts and incidents.

7 Future Processes and Recommendations

7.1 This section will identify ways in which to mitigate the issues presented in the latter part of the previous section. Alongside this, additional opportunities for technology to improve the overall incident management and clear up process have been identified below.

7.2 Short-term Opportunities in Technology

7.2.1 The following concepts represent innovations which are already being considered, developed or implemented elsewhere.

7.3 Applications

- 7.3.1 Mobile device applications, or “apps”, have seen their popularity increase drastically in the past decade. Over 2.9 million apps are available of the Apple App Store alone. Many transport authorities, journey planners and transport operators now have their own app for customers to use. Some of these may offer information in real-time, others detail service schedules.
- 7.3.2 TfGM could better utilise apps by featuring specific areas which detail incidents, and the implications across modes, as they occur. Whilst it is understandable that time should be spent co-ordinating a response to the incident and a public “message”, apps represent another opportunity to ensure it is distributed as widely as possible, and as quickly as possible.
- 7.3.3 Alongside information distribution to travellers, apps could be used to pass key information between the IMT, stakeholders (such as districts and service operators) and organisations responsible for recovering/clearing the incident. The app could also contain a list of contacts which may be necessary in the event of an incident, a way to collate modal impact information, and a system which analyses the processes so the evaluation of response can occur as the incident progresses.

7.4 Internet of Things and Big Data

- 7.4.1 Over 2.5 quintillion bytes of data is collected globally every day, and 90% of the data in the world today was created less than two years ago. Data is a resource which is vast, continuously growing, and incredibly under-utilised. It is gathered from sensors, mobile phones, and through geo-tagging in pictures (among many other collection techniques).
- 7.4.2 To utilise this effectively in incident management, information on passenger and vehicle movements, ticket sales, and the impact of Incident TDM must be gathered, managed effectively and analysed quickly to reap real and useful benefits. Not only will this help with the management of an incident as it is occurring, but also in the evaluation methods afterwards. Without adequate information a better understanding of the impact of incident TDM and future targets for management cannot be set.

7.5 Sensors

- 7.5.1 A wider application of sensors to collect the information highlighted in para 7.5.2 (the Internet of Things suggestion), will enable better transport monitoring in future, which would extend to Incident TDM. There are currently over one million connected cars in the UK. With the oncoming rise in automation expected in private and public transport vehicles expected in the next decade, there will be increasing opportunities to monitor travel movements across the network. This would enable better planning for

incidents and also better information gathering to determine the impact of Incident TDM.

7.6 Smart Ticketing

- 7.6.1 One opportunity to utilise big data collection is through smart ticketing across modes. TfL have pioneered this through their use of the Oyster Card, and, as a result, targeted TDM marketing to travellers in their day-to-day journeys and during events and incidents. Not only does this offer convenience for travellers in their day-to-day travel choices, but also enables transport authorities to contact travellers who would be impacted quickly and efficiently.
- 7.6.2 Alongside positively impacting customers, the Oyster card also enables TfL to collect information on passenger movements and the effect TDM initiatives can have on travellers. In the case of Incident TDM, a smart travel card would highlight changes in traveller behaviour, which would enable a more effective evaluation process of the usefulness of alternative transport opportunities for travellers, for Incident TDM at TfGM.

7.7 The Urban Traffic Control Centre

- 7.7.1 Currently the UTC utilise a network monitoring technology called “SCOOT”, which provides traffic signal management to the UTC. This means the signals operate on a pre-determined, automated system, which adjusts the traffic signal system in real-time based on the flow of traffic. As previously mentioned, in the event of an incident the UTC officers can manually control the system to ensure the traffic lights facilitate the most efficient movement patterns.
- 7.7.2 In future, a more sophisticated system, which could take incidents into account and manage changes on the network in real-time across modes, based on information that is continuously gathered, would be more effective. Extending UTC hours would have a positive impact on the incident management process, as it currently works on extended work hours.

7.8 Long-term Opportunities for Technology

- 7.8.1 The following innovations require significant regulatory or technological advancements before they could be deployed in a “real-world” scenario and relied upon in incident management. However, they are still worth being explored for future implementation.

7.9 Drones

- 7.9.1 The ability to visually monitor an incident development and clear up in real-time, along with sections of the transport network that have been impacted by an incident, is currently an issue at TfGM.
- 7.9.2 Drones, or Unmanned Aerial Vehicles, are emerging and developing in a number of industries. From military applications, to cheaper models which enable people to film scenery around them, the technology has evolved very quickly. Drones represent an opportunity for effectively monitoring not just the incident area, but also the parts of the wider transport network that have been impacted.
- 7.9.3 With a cost that would be significantly lower than manned aircraft monitoring, this opportunity would require a number of legislative changes. Currently drones cannot be flown over 120m from ground level, within 150m of a built up area or crowd, or within 50m of any person or property except during take-off and landing.
- 7.10 Swarm Robotics
- 7.10.1 Swarm robotics would be exceptionally useful to monitor and recover/clear up incidents across the transport network, particularly in areas which are classed as “high risk” for humans, such as sections of the network which are electrified or present a higher than average level of danger.
- 7.10.2 Swarm robotics works on the principle of multiple, sometimes relatively unsophisticated, physical robots which can work jointly on a task, but independently from each other or an overall controller (a central decision maker), to complete/exhibit a desired outcome. This requires a process of “mutual influence”², for the swarm to understand tasks which are being carried out by other members of the swarm, to avoid repetition or replication. These robots can complete simple tasks such as cutting through debris or evaluating damage to infrastructure in high risk or difficult to reach areas.
- 7.10.3 To facilitate this action significant improvements in connectivity would be required across the city region, along with a policy on who would be responsible to controlling the swarm whilst in use, along with the management of data protection and collection procedures. The technology itself is also in early stages of development and requires more trials and testing before being applied in a “real-world” scenario.
- 7.11 Predictive Modelling

² Hamann, H. (2010). Space-Time Continuous Models of Swarm Robotic Systems: Supporting Global-to-Local Programming. Berlin: Springer Berlin Heidelberg

- 7.11.1 As previously highlighted, incidents are often unpredictable and complex. Predictive modelling uses data, probability and statistics to forecast possible future actions, based on what is currently occurring on the network. In relation to incident management and incident travel demand management, an on-line predictive model, which updates in real-time and uses historic data to predict what would happen in the next hour, would enable a significantly different type of management response.
- 7.11.2 A set number of scenarios could be created, with varying percentages of accuracy based on the data used for each one. This type of model is currently being researched at TfL (and a wide variety of technology businesses). However, it would require a significant amount of trust in the capability of the model and data it is utilising. This type of model is likely to be implemented and more accurate with the emergence of connected and autonomous vehicles, which could transmit more information to transport authorities throughout a journey.

7.12 Non-technology related opportunities

- 7.12.1 As previously mentioned, the responsibility for recovery and clear up in an incident depends on the type or location of an incident. This can slow down the clear up and prevent efficient management of the incident process, thus slowing down the “return to normal” for travellers.
- 7.12.2 In the event of a large, transport related, incident emergency powers could be passed to TfGM, on behalf of the GMCA. This would enable TfGM to act accordingly and organise and monitor clear up coherently and concisely. By stream lining this part of the process, the incident could be resolved more efficiently and normal transport options restored quicker than through current measures.

8 Conclusion

- 8.1 This paper has demonstrated the complexity of the incident management process at TfGM, the need for adequate Travel Demand Management in the face of an incident, and how technology is able to play a role today and in the future.
- 8.2 Processes in the past have relied almost entirely on human interventions in the face of an incident. Technology is already being used to make incident response more efficient, particularly in communications and incident monitoring. However, this could be further improved to facilitate the Incident Management process in future.

