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Project Title: Train Overcrowding: Assessing and Prioritising Demand Management Strategies by Key Stakeholders

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Abstract

Train overcrowding has been associated with a number of negative outcomes, including psychological stress, negative health effects, negative behavioural reactions, and spillover effects. Despite the seriousness of this issue, there is little agreement on the appropriate demand management strategies to deal with the increasing passenger numbers, particularly on rail services in Malaysia, which, in turn, warrants a closer examination of existing scientific evidence. To address this need, a survey with 13 individuals from organisations that are likely to affect and be affected by the demand management issue was conducted. Two aims were addressed: (1) to identify a set of demand management strategies that addresses growing passenger numbers, and (2) to examine the feasibility, effectiveness, and cost of these strategies, as perceived by the stakeholders. Participants ranked three sets of demand management strategies (i.e., pricing, service quality, and policy), which was obtained from a systematic review of literature, based on their feasibility, effectiveness, and cost. Using Kendall's coefficient of concordance (Kendall's W), findings showed weak agreement among participants across all strategies on their feasibility, effectiveness, and cost. Despite these differing views, it appears that high priority was placed on four strategies (i.e., free early bird incentives, discounted early bird or off peak fares, increasing train frequency, and travel demand management program), implying their potential applications for peak smoothing in Malaysian urban rail systems. It is suggested that the identified strategies should be targeted for intervention and evaluation in order to further refine our understanding of sustainable, effective, and cost-efficient ways in addressing current and future train overcrowding issues.

Keywords**:** *rail, crowding, demand management, peak period, stakeholder, sustainability*

1. INTRODUCTION

Train overcrowding has been associated with a number of negative outcomes, including psychological and physiological stress, negative health effects, negative behavioural reactions, and spillover effects (Cox, Houdmont, & Griffiths, 2006; Mohd Mahudin, 2012, Turner et al., 2004). Despite the widely admitted seriousness of this issue, there is little agreement on the appropriate demand management strategies to deal with the increasing passenger numbers. Demand management refers to the collection of operational, administrative, and economic policies designed to ensure that demand for the utilisation of rail transportation resources is kept at a manageable level, especially during peak commuting periods (Online TDM Encyclopedia, 2013). A number of viable strategies have been proposed to address this issue; these include trip suppression, trip redistribution, shifting demand, mode switch, and peak fare pricing (Online TDM Encyclopedia, 2013).

While studies exploring the potential of establishing demand management as a legitimate resource option for crowding mitigation have been conducted elsewhere (e.g., in Australia by Henn, Karpouzis, and Sloan, 2010; in the USA by Nelson Nygaard Consulting Associates, 2008; and in the UK by Maunsell, 2007), less attention has been paid to the more immediate concerns in the Malaysian rail industry. This is an important deficit - particularly as researchers have observed a connection between demand management strategies and service quality improvements. For instance, in the case of Australia and the United States, Hale and Charles (2009) show how pricing and communication strategies can be effectively used to address peak demand and reduce train overcrowding. As yet however, little is known about the existence and feasibility of such strategies in Malaysia, other than the observation that train overcrowding is indeed stressful for the

commuters and has the potential to spill over to other aspects of their life and work (Mohd Mahudin, 2012).

One reason for the current state of the field is that existing research is generally restricted to individual country case studies with limited comparison of different cases or over time. In addition, some of the identifiable strategies suggested in prior work are mainly in very early stages and only at discussion level among the rail stakeholders in the localised areas. As a result, little is known about the feasibility, effectiveness, or cost-effectiveness of these demand management strategies in the Malaysian setting. The questions of what measures would be most effective in mitigating train overcrowding and whether they are actually feasible in administrative terms are of theoretical and substantive importance. In order to address these questions, the current study focuses on one broad area of contention: to explore stakeholders' perceptions of feasibility, effectiveness, and cost of demand management strategies for reducing train overcrowding in Malaysia.

2. BACKGROUND

Rail operators are challenged to operate with limited systems capacity while simultaneously catering to a steadily increasing passenger constituency. As the demand for rail travel continues to grow, along with fuel price increases, traffic congestion, as well as employment and population growth, overcrowding of rail services is fast becoming a pressing concern worldwide, including in Malaysia. Current estimates show that the main rail lines in Malaysia are functioning at over 140% and 180% of design capacity (Performance Management and Delivery Unit (PEMANDU), 2010). The notion that passengers are being crammed into trains like cattle or cramped like sardines in a small tin on the trains is also not uncommon elsewhere (Cox, Houdmont,

& Griffiths, 2006). These scenarios present daunting issues for train companies because operating overcrowded trains has been associated with delays in services (Lam, Cheung, & Lam, 1999), injuries to staff and passengers (Turner, et al.. 2004), psychological stress and spillover effects (Mohd Mahudin, 2012), wider health and safety issues (Cox, Houdmont, & Griffiths, 2006), as well as being a vehicle for the spread of illness and disease (Gershon, et al., 2005). For this reason, an in-depth look into comprehensive and strategic demand management approaches is warranted.

Increasing the capacity and decreasing the demand are the two typical strategies of balancing the mismatch between demand and capacity. Capacity enhancement strategies, such as adding more train coaches, building new rail infrastructures, constructing new rail lines, or redesigning existing infrastructures are usually investment intensive, require long time frames, and may not be feasible in several situations due to geographical, environmental, socio-economical, or political issues associated with such large projects. On the other hand, demand management strategies, which mainly aim at distributing the peak period demand to before and after the critical period, have the potential to improve the demand-capacity balance over a medium to short time period with relatively less investment. As a result of renegotiating the demand distribution, a general flattening of the travel demand profile across a broader time period is obtained (Holyoak & Chang, 2006).

Various types of demand management strategies have been discussed in the literature. For example, Henn, Karpouzis, and Sloan (2010) identified five broad categories of strategies in their review that examined how peak demand is addressed in Australian urban rail systems. Of these categories, the financial and pricing strategies, which vary from peak fare pricing, station-specific surcharges, and fare pass programmes to market rate parking pricing and peak parking pricing, are regarded as easy to implement, but politically unpopular; hence mixed success was reported.

Meanwhile, service delivery strategies, such as improving service frequency as well as enhancing wayfinding and passenger flow mechanisms, have the potential for peak smoothing and expansion of rail capacity but need careful consideration for implementation as they involve considerable cost (Henn, Karpouzis, & Sloan, 2010). Another two categories of strategies, i.e., reducing underlying need for the service (e.g., land use and transit oriented development policies) and changing way needs are met (e.g., promotion of integrated transport policy framework) are deemed as important strategies with longer term spatial impact. However, rail operators have little control over these policies as it is challenging to foster coordination and cooperation with non-transport organisations and other competing transport mechanisms (Henn, Karpouzis, & Sloan, 2010). Finally, education, particularly dissemination of information about peak fares and crowding levels, has strong potential to shift passenger behaviours by making them aware of crowding conditions or alternative transport or route options (Henn, Karpouzis, & Sloan, 2010).

Although these strategies are useful individually, Henn, Karpouzis, and Sloan (2010) suggest that two criteria should be placed for maximum impact. First, instead of applying the strategies singly, a combination of strategies tailored to the particular circumstances of each urban area is a better way to manage congestion. For example, combining fare and pricing strategies with office hour flexibility campaigns and employer incentives and disincentives would be able to address the range of factors contributing to train overcrowding. Second, the strategies need to be customised according to context. This is because it is possible that strategies that work effectively in one situation, may fail in another. One such example is by Cervero (1990) who reported that geographically targeted free fare programmes have been more successful than system wide free fare programmes.

Other studies that investigated rail demand management such as Nelson Nygaard Consulting Associates (2008) in the US and Maunsell (2007) in the UK also reported more or less similar strategies. Therefore, based on the past studies, it is evident that various demand management strategies are available and practiced at a range of scales. What is lacking in the literature, however, are investigations into what is perceived as demand management strategies in Malaysia and to what extent is there any consensus on their feasibility, effectiveness, and cost within the rail industry in the country. An overview of demand management strategies, which warrants further investigation in addressing Malaysia's urban rail issues, is thus required. Consequently, the current research addresses this gap by conducting an exploratory study on how stakeholders perceive and prioritise the demand management strategies identified in the literature.

Objectives

Specific research objectives addressed in this study are:

1. To identify a set of demand management strategies that addresses growing passenger numbers, and
2. To examine the feasibility, effectiveness, and cost of these strategies, as perceived by the stakeholders.

3. METHOD

3.1 Study design

A systematic review of published studies was conducted in order to address the first research objective, i.e., to identify and establish what is known regarding demand management strategies in rail passenger services. This method is required so that an updated information that incorporate the most recent developments and applications in the area can be obtained.

To address the second objective, a survey with transport stakeholders was conducted. In this survey, participants ranked the range of strategies identified in the systematic review based on their feasibility, effectiveness, and cost. In summary, both the systematic review and survey methods are appropriate for the study because they gathered the critical information from diverse sources relevant to achieving the study objectives.

3.2 Participants

A purposive sample of 13 individuals representing organisation stakeholders participated in the survey. In this study, a stakeholder is defined as those organisations who are likely to affect and be affected by the demand management issue; they may include transport professionals, rail operators, and regulatory authorities with a known or stated interest in transportation issues.

3.3 Materials

For the systematic review, nine scholarly databases (i.e., PSYCArticles, Thomson's Web of Knowledge, ScienceDirect, Wiley, Emerald, TRID Database, Google Scholar, World Transit Research, and Rail Knowledge Bank) were used to search the relevant publications for the study. These databases were chosen because they provide comprehensive coverage of both refereed and non-refereed social, psychological, and technological research involving demand management, crowding, and transportation.

From the systematic review, eight broad categories of approaches for managing peak demand were identified. These include: pricing approaches, service quality approaches, management-based approaches, policy approaches, educational approaches, communication approaches, engineering-design approaches, and infrastructure-based approaches. These approaches are further categorised into three groups of strategies: pricing, service quality, and policy, which then formed the final strategies to be ranked by the stakeholders in the subsequent

survey. Consequently, the final survey items consisted of six strategies related to pricing, ten strategies about service quality, and six strategies associated with policy (*Questionnaire available from author on request*).

3.4 Procedure

A list of potential demand management strategies in rail industry along with their descriptions was generated from the systematic literature review. In the final iteration, 16 strategies, which are divided in three different groups, became the questionnaire items.

Each identified stakeholders was contacted via e-mail and face-to-face meetings, in which they were provided with an explanation of the purpose of the study, the procedure, and the survey questionnaire. Stakeholder participants, who acted as raters, were asked to rank the items for each of the identified strategies listed in the questionnaire by order of what they believe to be "*Most*" to "*Least*" based on their feasibility, effectiveness, and cost. For pricing and policy strategies, these values were ranked using a scoring system that ranges from one to six (i.e., one being most preferred, six being least preferred). Meanwhile, for service quality strategies, these values were ranked using a scoring system, ranging from one to ten (i.e., one being most preferred, ten being least preferred).

3.5 Data analysis

In each group of strategies, strategy that received the highest ranking (i.e., 1 = most preferred) is regarded as the most prioritised strategy for managing peak demand and overcrowding. More specifically, ranked strategies obtained were examined in terms of their feasibility, effectiveness, and cost, with the level of agreement among the raters was determined using Kendall's coefficient of concordance (Kendall's W). This statistics is recognised as the best metric for measuring non-parametric rankings (Okoli & Pawlowski 2004). Kendall's W ranges

from 0 (no agreement) to 1 (full agreement) (Kendall & Gibbons 1990). In this study, Kendall's W values are interpreted using a guideline set by Schmidt (1997) (see Table 1.0).

Table 1.0 *Kendall's value interpretation (Schmidt, 1997)*

W	Interpretation	Confidence in rankings
0.1	Very weak agreement	None
0.3	Weak agreement	Low
0.5	Moderate agreement	Fair
0.7	Strong agreement	High
0.9	Unusually strong agreement	Very high

4. RESULTS AND DISCUSSION

As can be seen from Table 2.0 on *Feasibility*, the Kendall's W values for pricing and service quality strategies are 0.216 and 0.213 respectively, which suggest weak agreement among the participants. Kendall's W also shows very weak agreement among participants in the policy strategies (0.092).

Participants also ranked the strategies according to their perceived *Effectiveness* and these results are tabulated in Table 3.0. Kendall's W values obtained are as follows: pricing = 0.129, service quality = 0.243, and policy = 0.098, indicating again less agreement among the participants.

Similar pattern of results are obtained in *Cost* (see Table 4.0), with Kendall's W values of 0.042 for pricing, 0.342 for service quality, and 0.172 for policy.

Table 2.0 *Kendall's W results for Feasibility*

Category	Item	*Mean Rank*	*Kendall's W*	*df*	*p*
Pricing	Increase peak period fares	3.88	0.216	5	.016
	Free early bird incentives	2.58			
	Discounted early bird or off peak fares	2.65			
	Surcharges at specific stations	4.35			
	Reduce or restrict parking availability at stations	4.35			
	Employer incentives and disincentives	3.19			
Service quality	Increase train frequency	3.75	0.213	9	.006
	Increase seating capacity	6.71			
	Redesign standing and seated areas	5.88			
	Enhance passenger flow	6.67			
	Standardise entry and exit protocols	6.33			
	Efficient ticketing systems	4.92			
	Traveller information services	3.92			
	Express services	3.54			
	Provide feeder services and park-and-ride facilities	7.04			
	Build more transport infrastructure	6.25			
Policy	Policy-induced change in travel time	3.58	0.092	5	.311
	Flexible working hours policy	3.46			
	Land use and population policy	4.31			
	Travel demand management	3.04			
	Policy-driven traffic management systems	3.77			
	Public awareness and educational campaigns	2.85			

Table 3.0 *Kendall's W results for Effectiveness*

Category	Item	*Mean Rank*	*Kendall's W*	*df*	*p*
Pricing	Increase peak period fares	3.27	0.129	5	.138
	Free early bird incentives	3.12			
	Discounted early bird or off peak fares	3.00			
	Surcharges at specific stations	4.15			
	Reduce or restrict parking availability at stations	4.42			
	Employer incentives and disincentives	3.04			
Service quality	Increase train frequency	3.08	0.243	9	.001
	Increase seating capacity	4.81			
	Redesign standing and seated areas	6.23			
	Enhance passenger flow	6.50			
	Standardise entry and exit protocols	7.96			
	Efficient ticketing systems	4.50			
	Traveller information services	5.31			
	Express services	5.42			
	Provide feeder services and park-and-ride facilities	6.38			
	Build more transport infrastructure	4.81			
Policy	Policy-induced change in travel time	3.63	0.098	5	.321
	Flexible working hours policy	3.29			
	Land use and population policy	3.21			
	Travel demand management	3.13			
	Policy-driven traffic management systems	3.21			
	Public awareness and educational campaigns	4.54			

Table 4.0 *Kendall's W results for Cost*

Category	Item	*Mean Rank*	*Kendall's W*	*df*	*p*
Pricing	Increase peak period fares	3.92	0.042	5	.746
	Free early bird incentives	3.35			
	Discounted early bird or off peak fares	3.31			
	Surcharges at specific stations	3.58			
	Reduce or restrict parking availability at stations	3.85			
	Employer incentives and disincentives	3.00			
Service quality	Increase train frequency	4.65	0.342	9	.001
	Increase seating capacity	4.50			
	Redesign standing and seated areas	4.27			
	Enhance passenger flow	6.15			
	Standardise entry and exit protocols	8.27			
	Efficient ticketing systems	5.69			
	Traveller information services	6.77			
	Express services	7.50			
	Provide feeder services and park-and-ride facilities	4.54			
	Build more transport infrastructure	2.65			
Policy	Policy-induced change in travel time	3.46	0.172	5	.067
	Flexible working hours policy	4.96			
	Land use and population policy	3.13			
	Travel demand management	3.25			
	Policy-driven traffic management systems	3.21			
	Public awareness and educational campaigns	3.00			

To facilitate easy understanding of participants' level of agreement results, all Kendall's W values herein are summarised in Table 5.0.

Table 5.0 *Summary of Kendall's W results*

Category of strategies	*Kendall's W*		
	Feasibility	Effectiveness	Cost
Pricing	0.216	0.129	0.042
Service quality	0.213	0.243	0.342
Policy	0.092	0.098	0.172

The ranked of all strategies is then tabulated in Table 6.0. In pricing strategies, free early bird incentives were ranked first for Feasibility, but third in Effectiveness, and Cost. Meanwhile, discounted early bird or off peak fares were ranked first for Effectiveness, but second for Feasibility and Cost. Employer incentives and disincentives were ranked as most Costly, but third in Feasibility and Effectiveness. In this category, the least Feasible strategy but less Costly for rail industry is to increase peak period fares whereas the least Effective is to reduce or restrict parking availability at stations.

For service quality strategies, providing express services was ranked first for Feasibility but sixth and ninth for Effectiveness and Cost respectively. Most Effective strategy as perceived by the participants is increase train frequency, which was ranked as second and fifth for Feasibility and Cost. Building more transport infrastructure was ranked first in Cost, sixth in Feasibility, and third in Effectiveness. Participants rated providing feeder services and park-and-ride facilities as the least Feasible strategy and standardising entry and exit protocols to manage crowds as the least Effective but least Costly.

Table 6.0 *Final rank for all strategies based on Feasibility, Effectiveness, and Cost*

Category	Item	Final Rank		
		Feasibility	Effectiveness	Cost
Pricing	Increase peak period fares	6	4	6
	Free early bird incentives	1	3	3
	Discounted early bird or off peak fares	2	1	2
	Surcharges at specific stations	4	5	4
	Reduce or restrict parking availability at stations	4	6	5
	Employer incentives and disincentives	3	2	1
Service quality	Increase train frequency	2	1	5
	Increase seating capacity	9	3	3
	Redesign standing and seated areas	5	7	2
	Enhance passenger flow	8	9	7
	Standardise entry and exit protocols	7	10	10
	Efficient ticketing systems	4	2	6
	Traveller information services	3	5	8
	Express services	1	6	9
	Provide feeder services and park-and-ride facilities	10	8	4
	Build more transport infrastructure	6	3	1
Policy	Policy-induced change in travel time	4	5	5
	Flexible working hours policy	3	4	6
	Land use and population policy	6	2	2
	Travel demand management	2	1	4
	Policy-driven traffic management systems	5	2	3
	Public awareness and educational campaigns	1	6	1

Finally, in the policy strategies, public awareness and educational campaigns were ranked first in terms of Feasibility and Cost but last in Effectiveness. Meanwhile, travel demand management was ranked first for Effectiveness but second and fourth for Feasibility and Cost respectively. Among the strategies, land use and population policy is the least preferred for its Feasibility; public awareness and educational campaigns is the least preferred for its Effectiveness; and flexible working hours policy was ranked last for Cost.

To summarise these results, the ranked of the *Most* and *Least* strategies is tabulated in Table 7.0 below.

Table 7.0 *Rank for MOST and LEAST strategies based on Feasibility, Effectiveness, and Cost*

Categories of strategies	Feasibility		Effectiveness		Cost	
	Most	Least	Most	Least	Most	Least
Pricing	Free early bird incentives	Increase peak period fares	Discounted early bird or off peak fares	Reduce or restrict parking availability at stations	Employer incentives and disincentives	Increase peak period fares
Service quality	Express services	Feeder services and park-and-ride facilities	Increase train frequency	Standardising entry and exit protocols	More transport infrastructure	Standardising entry and exit protocols
Policy	Public awareness and educational campaigns	Land use and population policy	Travel demand management	Public awareness and educational campaigns	Public awareness and educational campaigns	Flexible working hours policy

5. CONCLUSIONS

In this study, a set of demand management strategies that could address train overcrowding has been derived and examined in terms of their feasibility, effectiveness, and cost. In particular, six strategies related to pricing, ten strategies about service quality, and six strategies associated with policy have been identified through systematic review of the existing literature. However, the agreement among the stakeholders on these strategies is considered weak. This weak agreement was probably found because the research area is a largely unexplored domain in Malaysia in which there is no background to provide structure to ensuing works, and also because stakeholders tend to not be as forthcoming as they could be.

Despite the differences of views among the participants, it appears that high priority was placed on four strategies: (1) free early bird incentives, (2) discounted early bird or off peak fares, (3) increasing train frequency, and (4) travel demand management program. The agreement on these strategies indicates their general importance to stakeholders across organisations. Therefore, these strategies seemed to have most potential for peak smoothing in Malaysian urban rail systems. While it is understandable that increasing peak period fares is considered least feasible, it is unclear why stakeholders assigned less importance to strategies such as reduction or restriction of parking availability at stations, provision of feeder services and park-and-ride facilities, and standardisation of entry and exit protocols in mitigating overcrowding issues. This suggests areas of focus for future research efforts.

Another implication arising from the findings is that there is a need for a feasible and cost-effective, if not cheap, measure for addressing issues associated with peak demand and passenger growth. With an understanding of the financial and management constraints affecting the industry, an integrated approach of cost-effective strategies tailored to the particular circumstances of each

rail system seems to offer the best prospect for managing passenger crowding. One way of doing this is to use psychologically targeted strategies that are both cost-effective in managing the growing demand on the rail services and in contributing to improvement in service (Cox, Houdmont, & Griffiths, 2006; Mohd Mahudin, 2012). The potential use of psychological or non-engineering strategies that can effectively mitigate peak demand growth should therefore be further explored.

To conclude, this research provides valuable information that can advance the literature on demand management by informing the specific strategies that are deemed high priorities in addressing train overcrowding, and, by extension, improving service quality and passenger satisfaction with rail services. In particular, the findings will be instrumental in advocating to rail stakeholders and relevant authorities in Malaysia the importance of managing peak crowding and passenger demand within the rail transport sector. It follows that the identified strategies should be targeted for intervention and evaluation. Confirmation of these results through additional research and assessments are thus needed to further refine our understanding of sustainable, effective, and cost-efficient ways to address current and future train overcrowding issues.

6. FUTURE PLAN OF THE RESEARCH

It is essential that future studies evaluate the prioritised interventions for their effectiveness in managing passenger demand and peak train crowding. One such study could be a quasi-experimental, longitudinal research that implement and test the prioritised strategies along the existing rail lines. In this way, the effectiveness of these strategies could be assessed over time. An investigation into strengthening the successful strategies is likewise recommended to be added in

the future plan of the research project. This line of work is essential to ensure that the effectiveness of the strategies can be sustained and even enhanced.

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