Keynote Paper:
Integrated Management System of a World-class Railway – With an 18-Year Longitudinal Study

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ABSTRACT
This paper is to present results of the study on the effectiveness of the Integrated Management System IMS) model which was developed and implemented in 1998. The aim to provide a factual evidence that the IMS model is continuously supporting operations of the Mass Transit Railway Corporation Ltd. (MTR) to cope with its enormous business growth. This study analyses the 18 years trend of global business performance indicators, service performance ratios, comparison results of international benchmarking with other similar railways in other countries as well as business results of MTR's international subsidiaries. All these results demonstrated a positive trend has again evidenced that the IMS was continued to be effective in sustaining railway operational excellence and supporting MTR's substantial railway network expansion over the past 18 years.

Keywords: IMS, AMOS, BSC, Organizational Performance, Longitudinal Study

1. Formulation of the Integrated Management System Framework

1.1 Introduction

The IMS is defined as a management system model, which focuses on core business processes, integrates various management standards, embraces the business excellence model criteria, and is able to manage the total railway operations with a view to improving overall organisational performance (Chan, 1999,2000,2002; Chan and Ip, 1997). To this end, the following considerations have been incorporated:

1. The system should be based on ISO 9000 management framework (i.e. a systematic documentation structure with system assurance features – management review and audit);
2. It should be able to integrate all necessary management standards (e.g. ISO 9000, ISO 14000, OSHS18000, etc.) into a single management framework which focuses on core business processes;
3. It should be able to integrate all railway related standards, such as railway, safety, security and asset management; and
4. Incorporation of the Business Excellence Model based on National Quality Award (NQA) Criteria (Deming Prize, 1996, European Foundation for Quality Management, 1996, Malcolm Baldrige National quality Award,1997, 1999, Australia National Quality Award Criteria, 1997)

These critical factors have addressed the development needs of the MTR. The dynamic relationship of the IMS seven critical factors forms the proposed basic IMS framework as shown in Figure 1 below:

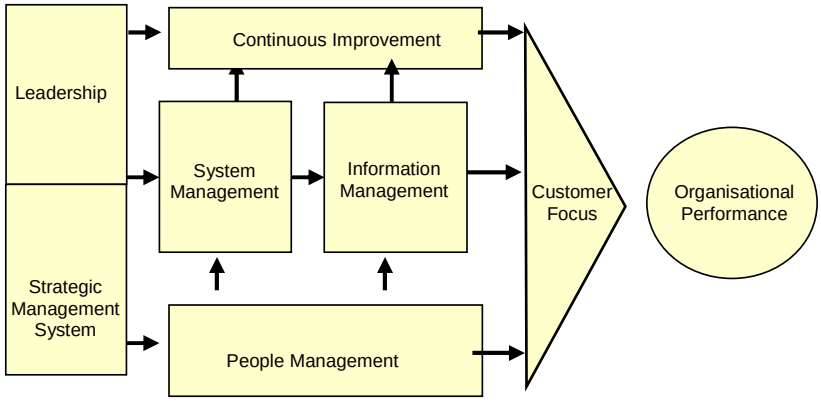


Figure 1: The Basic framework of the IMS

1.2 IMS Implementation Instrument

A comprehensive implementation instrument has then been formulated by establishing a customised self-assessment questionnaire. The questionnaire has subsequently formed an important part of the annual management review process with the aim to assess the extent of the IMS implementation and its effect on organisational performance (Chan, et al., 2003).

1.3 Data Validation

The survey was based on a stratified random sample of 279 among 1116 staff covering all staff at every level across the Operation Division. A total of 261 survey questionnaires in anonymity were returned and the response rate came out to be 94%. The internal consistency test (Bentler, 1987; Carmins and Zeller, 1979) indicated that the Cronbach's alpha ratios for all the components of the questionnaire are greater then 0.8, thus the responses within each main component are regarded to be reliable. The item analysis as suggested by Bentler (1990) concluded that all items in the questionnaire had been appropriately assigned to scales. The confirmatory Factor Analysis with a cutoff loading of 0.55 has reduced the variables from 49 to 31. The reliability and validity analyses concluded that the data obtained through this instrument could be used in subsequent data analysis.

1.4 Development of the IMS Theoretical Model

Over the last 25 years, Structural Equation Modeling (SE) has become one of the most important data analysis techniques in social science (Kaplan, 1995). In order to empirically test the theoretical models hypothesised in this study, it is first necessary to formulate these theoretical constructs so that empirical investigation is possible. Therefore, a set of items to measure the constructs of the IMS model (consisting of leadership, people management, process management, information management, and continuous improvement, and customer focus) and constructs of organisational performance (including process performance, staff efficiency, safety performance, customer satisfaction and financial performance) has to be carefully developed. Items have been developed to tap as comprehensively as possible the conceptual domain of the theoretical constructs. The following diagram (Figure 2), which is translated from the proposed basic IMS framework (Figure 1), demonstrates the hypotheses made for these constructs:

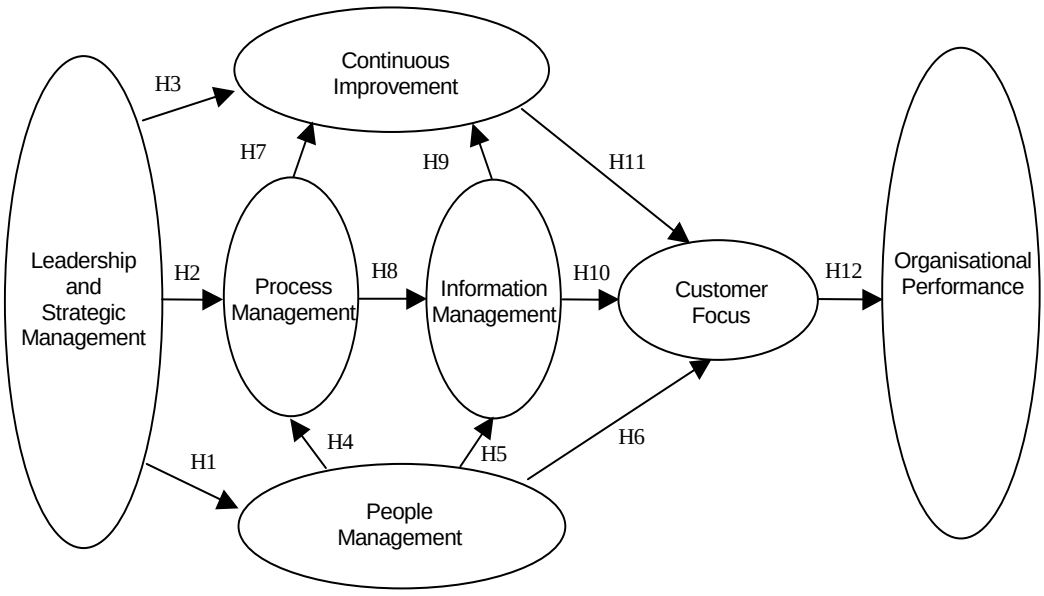


Figure 2: The Initial Theoretical Model of the IMS

This study investigates 12 hypotheses concerning the relationships among Leadership and Strategic Management, People Management, Process Management, Information Management, Continuous Improvement, Customer Focus and Organisational Performance. The 12 hypotheses to be tested are as follows:

Hypothesis H1: Leadership has a positive effect on people management
Hypothesis H2: Leadership has a positive effect on process management
Hypothesis H3: Leadership has a positive effect on continuous improvement
Hypothesis H4: People management has a positive effect on process management
Hypothesis H5: People management has a positive effect on information management
Hypothesis H6: People management has a positive effect on customer focus
Hypothesis H7: Process management has a positive effect on continuous improvement
Hypothesis H8: Process management has a positive effect on information management
Hypothesis H9: Information management has a positive effect on continuous improvement
Hypothesis H10: Information management has a positive effect on customer focus
Hypothesis H11: Continuous improvement has a positive effect on customer focus
Hypothesis H12: Customer focus has a positive effect on overall organisational performance

In these 12 hypotheses, organisational performance is a dependent variable, and the other six are independent variables.

1.5 Model Estimation

AMOS provides the Critical Ratio (CR) to identify whether the estimated path coefficients are significant or not, and have the hypothesised sign. In fact, the CRs are the t-values, which are the ratio of parameters estimated to the respective standard errors. For one-tail tests, a CR larger than 1.282 corresponding to p value<0.10 (weakly significant), a CR larger than 1.645 corresponds to p-value<0.05 (Moderately significant), and a CR larger than 2.326 corresponds to p-value<0.01 (Strongly significant) (Haenett and Murphy, 1985). It is noted that p-value (p) represents 1-p confidence that the relationship in the path are confirmed. The estimate (path coefficient) is the dependent or mediating variable for each unit change in the variable predicting it.

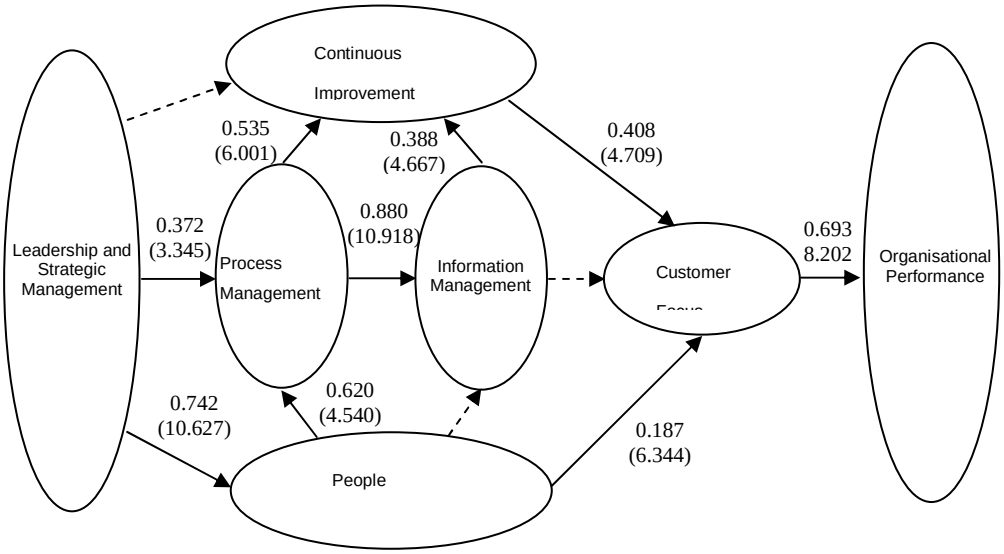
The estimates of the proposed model are listed in the second column and their CRs, which demonstrate whether these estimates are statistically significant or not, are shown in the third column of Table 1.

Table 1: Estimates and CRs of the Proposed and Revised Models

Path			Proposed Model		Revised Model	
			Estimate 1	CR 2	Estimate 3	CR 4
People Management	←	Leadership	0.739	10.645	0.741	10.663
Process Management	←	People Management	0.682	4.826	0.684	4.853
Process Management	←	Leadership	0.314	2.795	0.310	2.770
Information Management	←	Process Management	0.939	5.316	0.891	10.759
Information Management	←	People Management	-0.057	-0.310	Deleted	-
Continuous Improvement	←	Information Management	0.283	3.339	0.291	3.680
Continuous Improvement	←	Process Management	0.623	4.361	0.621	6.667
Continuous Improvement	←	Leadership	0.006	0.065	Deleted	-
Customer Focus	←	People Management	0.703	6.349	0.727	6.560
Customer Focus	←	Continuous Improvement	0.282	6.349	0.368	4.248
Customer Focus	←	Information Management	0.109	1.098	Deleted	-
Organisational Performance	←	Customer Focus	0.693	8.202	0.692	8.196

1.6 Overall Model Fit

Carmines and Mclver (1981) state that relative chi-square should be in the range of 2 to 3 for an acceptable model. Kline (1998) says 3 or less is acceptable. Some researchers allow as high as 5 to consider a model adequate fit, while others insist relative chi-square be two or less. AMOS lists relative chi-square as CMIN / DF (minimum sample discrepancy/degree of freedom). In this study, it is 2.09 (CMIN = 1374.53, DF = 656, CMIN / DF = 2.09), which is in the range of 2 to 3 used by convention, the null hypothesis that the model fits the data is accepted. The theoretical model of IMS is illustrated in Figure 5 below:



1. Upper figures estimate of path coefficients
2. The figures in the brackets are CRs.

Figure 3: The Final Theoretical Model of the IMS

The final IMS model is in fact a reflection of various implementation initiatives launched to facilitate the implementation of the IMS in both the Railway operations. The response of the questionnaire has outlined the perception of the staff on IMS implementation in railway operations during the past few years. Though this empirical study verifies the cause and effect relationship of the seven constructs of the IMS model, it has been customised for application in the MTR. Hence the model is not the generic model that can be applied in other railways or other industries without further study. This longitudinal study aims to fill this research gap.

2. The Organisational Performance Model (OPM)

2.1 Introduction

With a view to evaluate the effect of IMS implementation on organisational performance, an organisational performance model has been developed. Kaplan and Norton (1992, 1993, 1996) describe balanced performance measures as a set of hypotheses about cause and effect. The scorecard makes the relationships (hypotheses) among objectives (measures) in the four perspectives (five in the MTR's balanced scorecard (Chan, 1999b) explicit so that they can be managed and validated. It should portray the cause and effect relationships between outcome measures (i.e. in the financial perspective) and the performance drivers (i.e. in the customer, safety, staff efficiency and process perspectives in the MTR's case). Ultimately, causal paths from all measures on a scorecard should be linked to financial objectives.

The organisational performance model is hypothesised by combining all five IMS constructs into one independent variable, which is used to test the effect of IMS implementation on organisational performance. The staff perceptions on the results of the MTR BSC performance become five constructs,

namely, process performance, safety performance, staff efficiency, customer satisfaction and financial performance are dependent variables as illustrated in Figure 4.

2.2 Hypotheses of IMS Implementation and Five Organisational Performance Constructs

The Operations Division balanced scorecard has become a holistic indication of the organisational performance of the railway operations. Hence, the five hypotheses among five constructs (five perspectives of the scorecard) demonstrate the impact of the IMS implementation to each construct of the organisational performance. They are:

Hypothesis P1: IMS implementation has a positive effect on process performance
Hypothesis P2: IMS implementation has a positive effect on safety performance
Hypothesis P3: IMS implementation has a positive effect on staff efficiency
Hypothesis P4: IMS implementation has a positive effect on customer satisfaction
Hypothesis P5: IMS implementation has a positive effect on finance performance

2.3 Hypotheses among the Five Organisational Performance Constructs

The process in the IMS model involves the integration of various system requirements, such as the safety requirements of the operating railway and the environmental requirements as well as those requirements that concern with the core business to achieve business results. Hence, the following hypothesis is proposed:

Hypothesis PA1: Process performance has a positive impact on safety performance

A comprehensive study jointly conducted by the American Quality Foundation and the accounting and consultant firm, Ernst & Young (1991) studied the TQM efforts of more than 500 firms in US, Canada, Germany and Japan. They found that among other issues, Process improvement methods have significant impact on customer satisfaction. Thus the following hypothesis is proposed:

Hypothesis PA2: Process performance has a positive impact on customer satisfaction

One of the very important features of the IMS design is the establishment of a team-based structure, which aligns all team efforts towards common goals. Providing clear goals and a structured process to achieve them will improve staff work satisfaction and commitment which in turn, will improve staff efficiency and hence, contribute to the business result of the organisation. Anderson et al. (1995) suggest that employee satisfaction has significant effect on customer satisfaction; it is the foundation for an organisation to achieve organisation excellence. Fitzgerald et al. (1991) find that employees' perceptions and attitudes are positively related to customer satisfaction. The research conducted by Anderson and Gerbing (1998) also suggests that satisfied employees will improve efficiency and will also make extra efforts to ensure the success of their firm. Therefore, the following three hypotheses are proposed:

Hypothesis PA3: Staff efficiency has a positive impact on process performance
Hypothesis PA4: Staff efficiency has a positive impact on customer satisfaction
Hypothesis PA5: Staff efficiency has a positive impact on financial performance

Numerous studies have shown that a high level of customer satisfaction is strongly related to firm's financial performance (Neely, et al., 2000). Rust and Zahorik (1993) suggest that customer satisfaction has a positive effect on customer retention and profit. They portray customer satisfaction as an important indicator of a firm's financial health. Zairi et al. (1994) suggest that customer satisfaction can lead to an increase in firm's market share and profits. Based on these empirical finding, the following hypothesis is proposed:

Hypothesis PA6: Customer satisfaction has a positive impact on financial performance

Brown (1988) indicates that safety is the most important issue in the railway operations. A good safety performance not only reduces incidents and hence service interruption it also improves competitiveness. A punctual and reliable service has become a single most competitive advantage over other transportation modes such as buses. Therefore, two additional hypotheses are proposed as follows:

Hypothesis PA7: Safety performance has a positive impact on financial performance
Hypothesis PA8: Safety performance has a positive impact on customer performance

2.4 Formulation of the Theoretical Model

Based on the above 13 hypotheses, a theoretical model of IMS implementation and overall organisational performance is developed, and is displayed in Figure 6 below:

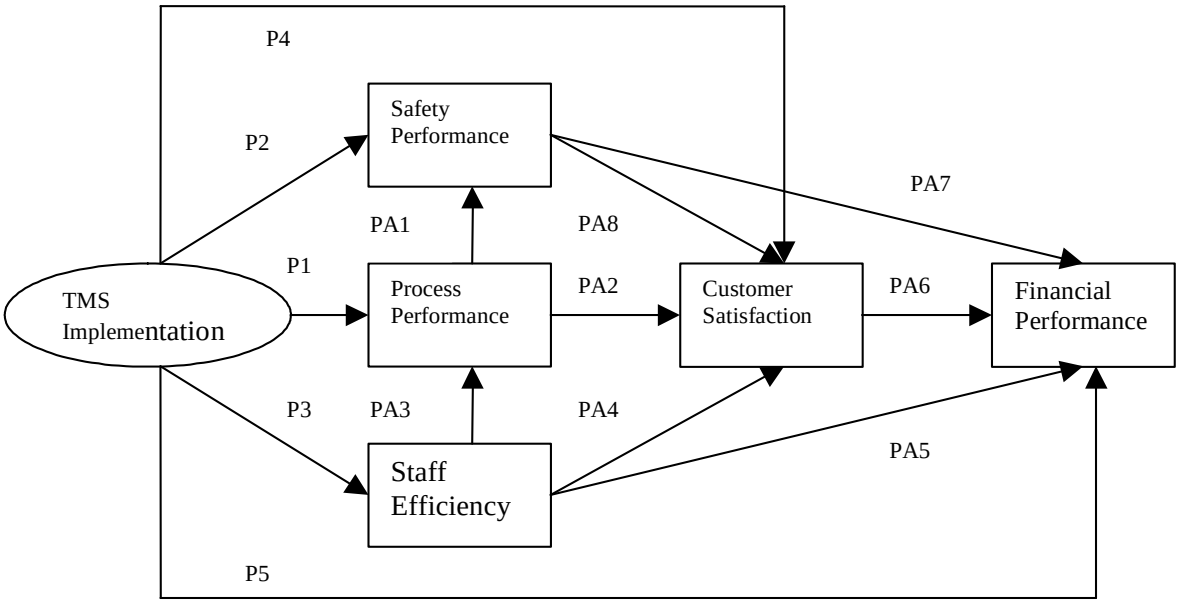


Figure 6 Theoretical Model of IMS Implementation and Overall Organisational Performance

By fitting the Structural Equation Models employing AMOS Version 3.6 (Arbuckle, 1997), the relationships among the IMS, process performance, staff efficiency, safety performance, customer satisfaction and financial performance are revealed as follows:

Table 2: Relationships among the IMS and the Five Organisational Performance Constructs

Effect	Staff Efficiency	Process Performance	Safety Performance	Customer Satisfaction	Financial Performance
IMS Implementation	Significantly Positive	Significantly Positive	Significantly Positive	Not Significant	Not Significant
Staff Efficiency	-	Significantly Positive	N.A.	Significantly Positive	Significantly Positive
Process Performance	N.A.	-	Significantly Positive	Significantly Positive	N.A.
Safety Performance	N.A.	N.A.	-	Significantly Positive	Significantly Positive
Customer Satisfaction	N.A.	N.A.	N.A.	-	Significantly Positive

Note:

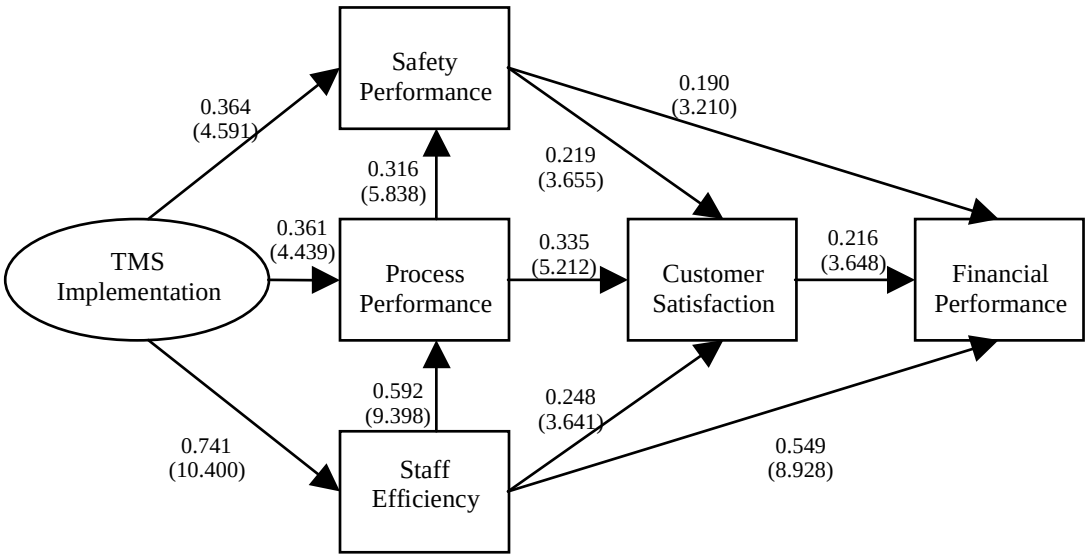
1. 'Significantly Positive' represents that the corresponding C.R. in a path is greater than 1.645.
2. 'Not significant' represents that the corresponding C.R. in a path is less than 1.645.
3. 'N.A.' represents that the corresponding path has not been considered.

The two insignificant paths indicate that IMS implementation does not directly affect both customer satisfaction and financial performance, but indirectly affect the customer satisfaction and financial performance through staff efficiency, process and safety performances (Figure 7). Deleting these two insignificant paths and refitting the model, the following results have been identified (columns 1 and 2 show the results of the proposed model whist 3 and 4 illustrate the revised one):

Table 3: Estimates and CRs of the IMS Implementation and Its Impact to Overall Organisational Performance

Path		Proposed Model		Revised Model	
		Estimate 1	CR 2	Estimate 3	CR 4
Staff Efficiency	← IMS Implementation	0.741	10.400	0.741	10.399
Process Performance	← IMS Implementation	0.361	4.439	0.361	4.439
Process Performance	← Staff Efficiency	0.592	9.398	0.592	9.398
Safety Performance	← Process Performance	0.316	5.838	0.316	5.838
Safety Performance	← IMS Implementation	0.364	4.591	0.364	4.591
Customer Satisfaction	← Process Performance	0.342	5.226	0.335	5.212
Customer Satisfaction	← Safety Performance	0.226	3.626	0.219	3.655
Customer Satisfaction	← Staff Efficiency	0.248	3.419	0.248	3.641
Financial Performance	← Staff Efficiency	0.548	7.961	0.549	8.928
Financial Performance	← Customer Satisfaction	0.216	3.634	0.216	3.648
Financial Performance	← Safety Performance	0.186	2.964	0.190	3.210
Financial Performance	← IMS Implementation	0.012	0.138	Deleted	-
Customer Satisfaction	← IMS Implementation	-0.023	-0.270	Deleted	-

In AMOS, relative chi-square is adopted to evaluate the global fit. According to Carmines and Mclver (1981), the relative chi-square should be in the range of 2:1 and 3:1 for an acceptable model. However, Kline (1998) states that a relative chi-square of 3 or less is acceptable. AMOS lists relative chi-squire as CMIN/DF (minimum sample discrepancy/degree of freedom). In this study, the relative chi-square is 1.929 (CMIN = 82.976; DF = 43; CMIN/DF =1.929). The relative chi-square of this study confirms that the data fits the theoretical model of IMS implementation and overall organisational performance. The testing results and the final theoretical Model of IMS implementation and overall organisational performance are illustrated in Figure 7 below:



Note: 1. Upper figures estimate of path coefficients
2. The figures in the brackets are CRs

Figure 7 Final Theoretical Model of IMS Implementation and Overall Organisational Performance

2.5 Interpretation of Testing Results

From the results of testing the model of IMS implementation and overall performance, which is based on the survey results of 261 staff members of the Operation Division, it can be concluded that IMS implementation has positive effects on staff efficiency, process performance and safety performance. However, the IMS implementation does not have direct impact on customer satisfaction and financial performance but acts indirectly through staff, process and safety performances to achieve them. Among the 13 hypotheses, 11 have been confirmed in this study, including all hypotheses of the cause and effect relationships of the balance scorecard, which is believed to be the first validation empirically.

3. Further Study - The Longitudinal Analysis

3.1 Introduction

In order to prove that the research results are valid in practice, a longitudinal study is conducted with the view of providing answers the following two research questions:

1. Does the model support the MTR's future challenges of substantial network expansion?
2. Does the model applicable in other railway companies in other country?

To answer the question 1, 18 years performance indices of the MTR operations are collected for trending analysis and a review of the service performance ratios in 2015 to see whether these performance ratios are being sustained beyond the Customer Service Pledge set by the Hong Kong Government. The international benchmarking results of key business performance indicators also adopted to demonstrate that the MTR's overall Performance was on the leading position among 35 similar railway corporations in the world. To answer the question2, business results of MTR's subsidiaries in Mainland of China, UK, Sweden and Australia are analysed.

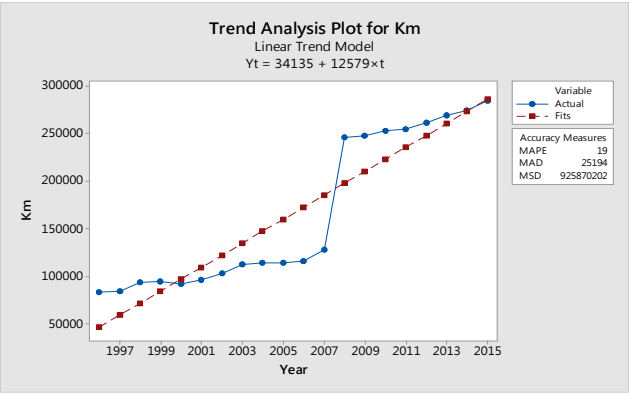
3.2 Trending Analysis of 18-year Performance

The 18 years performance indices of the MTR operations are igrouped into the following 4 Categories:

1. Global Business Results
2. Financial Performance
3. Railway Reliability Performance
4. Staff Safety Performance

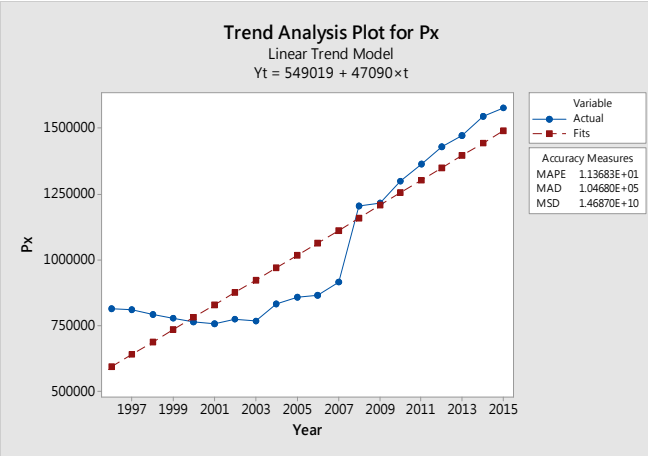
3.2.1 Global Business Results

The business growth of MTR over the 18 years (from 1997 -2015) was analyzed. The business trend is presented in terms of increase of network, number of passengers, number of staff, railway revenue as well as total revenue. All indicators show a healthy growth of the MTR business as illustration in the following graphs.



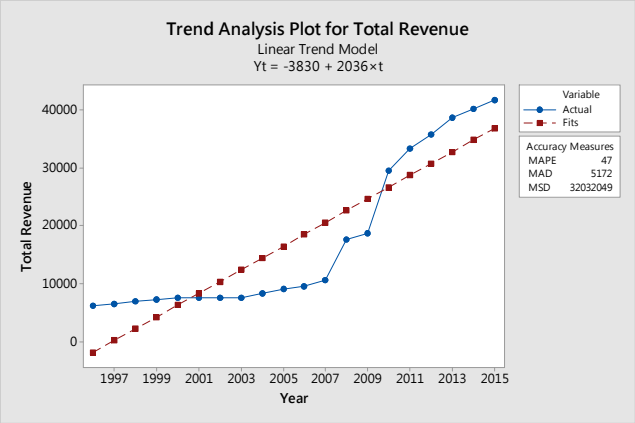
The graph on the left shows the extension of the network over the past 10 years. The big jump in 2007 was a result of amalgamation between MTR and KCR. The IMS model has successfully migrated to manage the new Corporation of nearly double the size.

Figure 5 Expansion of MTR Railway Network



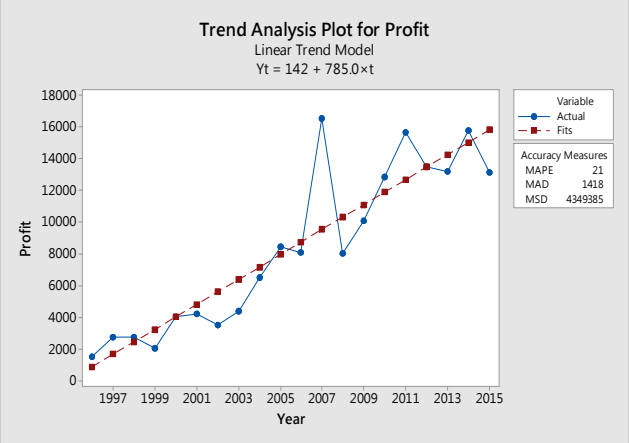
The number of passengers has been increased substantially after amalgamation of two Corporation, MTR and KCR. The new Corporation provides a better, larger and integrated railway network that attracts more passengers.

Figure 6 Increase of Passenger Numbers



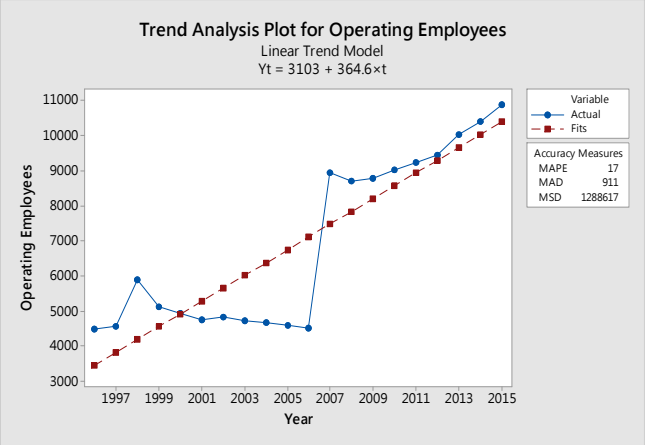
The railway revenue was growled in proportion to the increased railway network that attracts more passengers. Behind the scene, this also demonstrates the IMS was working properly that supports the larger organization.

Figure 7 Increase in Railway Revenue



The profit has been gradually increased showing the Corporation was managed well. Costs were under well control. The spike in 2007 was due to investment revaluation gain of $8,011 upon amalgamation (MTR Annual Report 2015).

Figure 8 Increase in Total Revenue

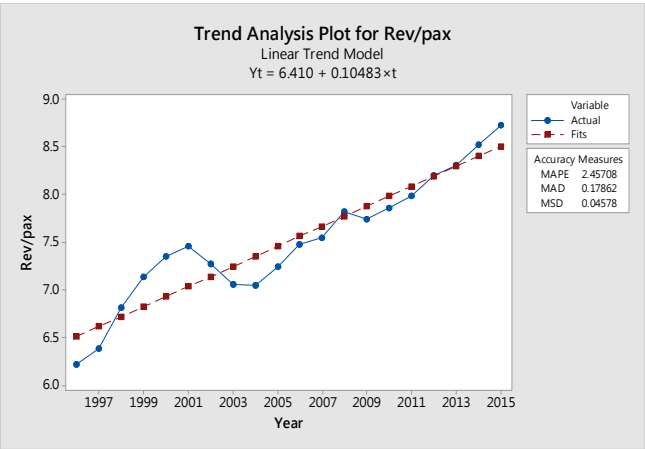


Staff numbers were under control and gradually reduced during upon implementation of the IMS in 1988. The figure surge in 2007 was due to amalgamation with KCRC. The gradually increase after amalgamation was due to increase of new lines in the railway network.

Figure 9 Staff Numbers were Under Control

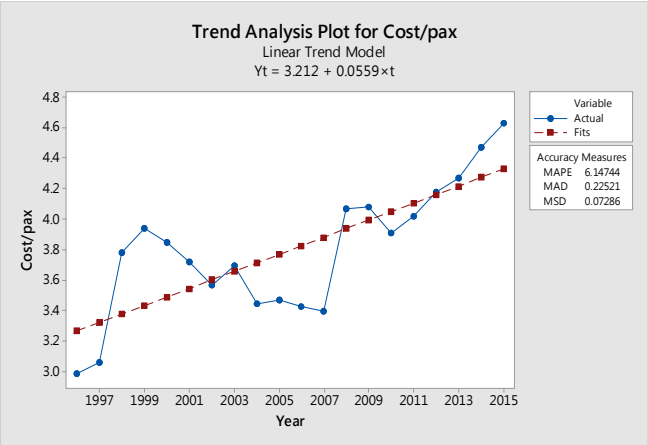
3.2.2 Finance Performance

The financial Ratios in terms of Revenue per passenger, Profit per passenger and Cost per passenger are analyzed below:



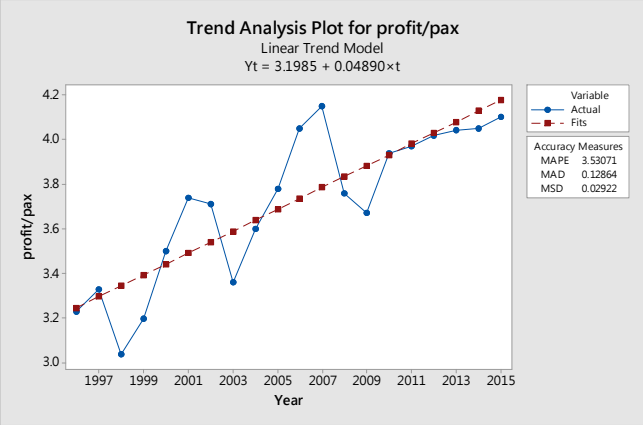
The value of revenue per passenger was also increasing. This was due to multiple factors, a more convenience network attract more passenger, The gradually increase of fare and more passengers attracted by the more reliable services.

Figure 10 Ratio of Revenue per Passenger



The cost per passenger since the IMS implemented in 1998 has been on the downward trend which signified the costs were well managed. The surge in 2007 was due to amalgamation with KCR. The continuous increase from 2010 mainly caused by increase of depreciation resulting from opening of new lines.

Figure 11 Ratio of Cost per Passenger

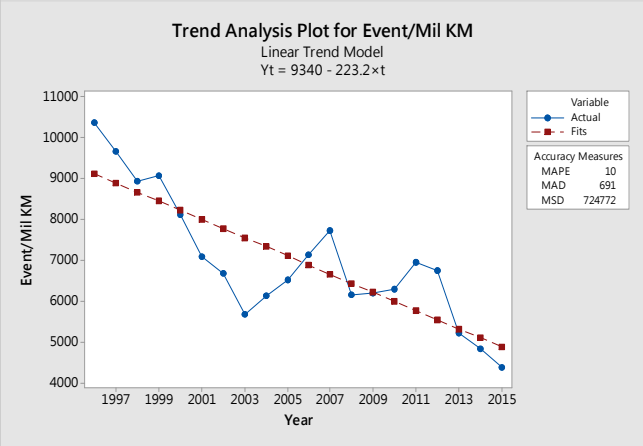


The profit per passenger was on the upward trend. Apart from the increase of passengers, one of the reasons was due to operational efficiency, for which, the IMS plays its role being an effective management system.

Figure 12 Ratio of Profit per Passenger

3.2.3 Railway Reliability Performance

The railway reliability was continuously improving as shown in the following diagram:

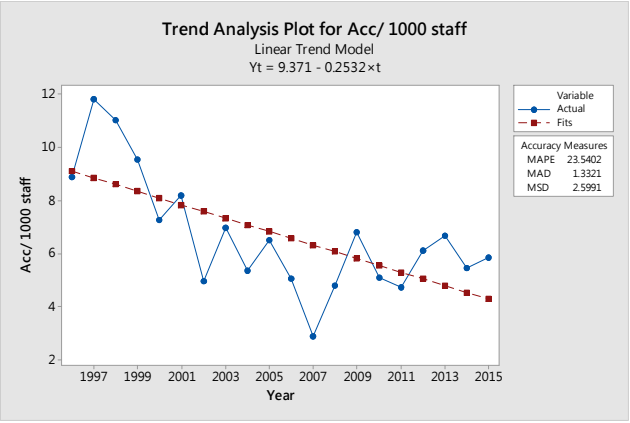


The incident event per million kilometers was on a downward trend which means the reliability of the railway system was continuously improving. The railway maintenance by using the IMS was being effective though the network has been extended substantially over the years

Figure 13 Railway incidents per million kilomers

3.2.4 Staff Saftety Performance

The rarion of staff accidentper 1,000 staff has been substaintially reduced since launch the MIS in 2008 as shown in the following graph:



The staff accident per 1,000 staff was also on the downward trend which proved that the occupational health and safety system which has been integrated into MIS was also effective.

Figure 14 Emloyee accident Ratio

The 10 global performance indicators as shown above have demonstrated that the MIS was flexible and effective to meet the need of continuous business growth of the MTR. MIS is the backbone to sustaining MTR as an excellent company

3.3 Supporting Operating Service Performance

MTR's network is one of the most intensively used in the world, and its reliability, safety and efficiency are held in high regard as illustrated in the 10 trend graph above. The outstanding performance was supported by excellent service performance (MTR Annual Report 2015) as illustrated in Table 4 and 5 below..

Table 4: Actual Service Performance VS Customer Service Pledge Criteria

Service performance item	Performance Requirement	Customer Service Pledge Target	Actual Performance
Train service delivery			
– Kwun Tong Line, Tsuen Wan Line, Island Line, Tseung Kwan O Line, Tung Chung Line, Disneyland Resort Line and Airport Express	98.5%	99.5%	99.9%
– East Rail Line (including Ma On Shan Line)	98.5%	99.5%	99.9%
– West Rail Line	98.5%	99.5%	99.9%
– Light Rail	98.5%	99.5%	99.9%
Passenger journeys on-time			
– Kwun Tong Line, Tsuen Wan Line, Island Line, Tseung Kwan O Line, Tung Chung Line and Disneyland Resort Line	98.5%	99.5%	99.9%
– Airport Express	98.5%	99.0%	99.9%
– East Rail Line (including Ma On Shan Line)	98.5%	99.0%	99.9%
– West Rail Line	98.5%	99.0%	99.9%
Train punctuality			
– Kwun Tong Line, Tsuen Wan Line, Island Line, Tseung Kwan O Line, Tung Chung Line and Disneyland Resort Line	98.0%	99.0%	99.8%
– Airport Express	98.0%	99.0%	99.9%
– East Rail Line (including Ma On Shan Line)	98.0%	99.0%	99.9%
– West Rail Line	98.0%	99.0%	99.9%
– Light Rail	98.0%	99.0%	99.9%
Train reliability: train car-km per train failure causing delays ≥ 5 minutes			
– Kwun Tong Line, Tsuen Wan Line, Island Line, Tseung Kwan O Line, Tung Chung Line, Disneyland Resort Line and Airport Express	N/A	650,000	2,861,014
– East Rail Line (including Ma On Shan Line) and West Rail Line	N/A	650,000	7,386,248
Ticket reliability: smart ticket transactions per ticket failure			
– Kwun Tong Line, Tsuen Wan Line, Island Line, Tseung Kwan O Line, Tung Chung Line, Disneyland Resort Line, Airport Express, East Rail Line (including Ma On Shan Line) and West Rail Line	N/A	8,000	20,254
Add value machine reliability			
– Kwun Tong Line, Tsuen Wan Line, Island Line, Tseung Kwan O Line, Tung Chung Line, Disneyland Resort Line and Airport Express	98.0%	99.0%	99.7%
– East Rail Line (including Ma On Shan Line)	98.0%	99.0%	99.8%
– West Rail Line	98.0%	99.0%	99.9%
– Light Rail	N/A	99.0%	99.6%
Ticket machine reliability			
– Kwun Tong Line, Tsuen Wan Line, Island Line, Tseung Kwan O Line, Tung Chung Line, Disneyland Resort Line and Airport Express	97.0%	99.0%	99.7%
– East Rail Line (including Ma On Shan Line)	97.0%	99.0%	99.7%
– West Rail Line	97.0%	99.0%	99.7%
– Light Rail	N/A	99.0%	99.9%

Table 5: Actual Service Performance VS Customer Service Pledge Criteria, Cont.

Service performance item	Performance Requirement	Customer Service Pledge Target	Actual Performance
Ticket gate reliability			
– Kwun Tong Line, Tsuen Wan Line, Island Line, Tseung Kwan O Line, Tung Chung Line, Disneyland Resort Line and Airport Express	97.0%	99.0%	99.9%
– East Rail Line (including Ma On Shan Line)	97.0%	99.0%	99.9%
– West Rail Line	97.0%	99.0%	99.9%
Light Rail platform Octopus processor reliability	N/A	99.0%	99.9%
Escalator reliability			
– Kwun Tong Line, Tsuen Wan Line, Island Line, Tseung Kwan O Line, Tung Chung Line, Disneyland Resort Line and Airport Express	98.0%	99.0%	99.9%
– East Rail Line (including Ma On Shan Line)	98.0%	99.0%	99.9%
– West Rail Line	98.0%	99.0%	99.9%
Passenger lift reliability			
– Kwun Tong Line, Tsuen Wan Line, Island Line, Tseung Kwan O Line, Tung Chung Line, Disneyland Resort Line and Airport Express	98.5%	99.5%	99.8%
– East Rail Line (including Ma On Shan Line)	98.5%	99.5%	99.8%
– West Rail Line	98.5%	99.5%	99.9%
Temperature and ventilation			
– Trains, except Light Rail: to maintain a cool, pleasant and comfortable train environment generally at or below 26°C	N/A	97.5%	99.9%
– Light Rail: on-train air-conditioning failures per month	N/A	<3	0
– Stations: to maintain a cool, pleasant and comfortable environment generally at or below 27°C for platforms and 29°C for station concourses, except on very hot days	N/A	91.0%	99.9%
Cleanliness			
– Train compartment: cleaned daily	N/A	99.0%	99.9%
– Train exterior: washed every 2 days (on average)	N/A	99.0%	100.0%
Northwest Transit Service Area Bus Service			
– Service Delivery	N/A	99.0%	99.7%
– Cleanliness: washed daily	N/A	99.0%	100.0%
Passenger enquiry response time within 6 working days	N/A	99.0%	100.0%

The train service delivery and passenger journeys on-time in the heavy rail network were maintained at 99.9%, a world-class performance that exceeds the targets set out in the Operating Agreement and MTR's own more demanding Customer Service Pledges. Of more than 1.9 million train trips on MTR's heavy rail network and more than 1 million train trips on MTR's light rail network during the year, only seven delays on the heavy rail network and one delay on the light rail network lasting 31 minutes or more were attributable to factors within MTR's control. The service performance in 2015 was one of MTR's best since the Rail Merger with KCRC back in 2007, despite passenger numbers from 2008 to 2015 increasing by a significant 30.5%.

3.4 International Benchmarking Results

MTR initiated the Community of Metros (CoMET) benchmarking group, which now comprises 32 large and medium-sized metro systems from 30 cities. The groups are jointly owned and steered by their members, and are facilitated by the Railway and Transport Strategy Centre (RTSC) at Imperial College London.

The Community of Metros (CoMET) programme collects data from large metro system operators around the world in order to compare performance and improve standards across the industry. The 2015 benchmarking exercise assessed data for 2014 for metro systems from 16 cities including Beijing, Berlin, Delhi, Guangzhou, Hong Kong, London, Mexico City, Madrid, Moscow, New York, Paris, Santiago,

Singapore, Shanghai, São Paolo and Taipei. Performance was measured across five categories, including growth and learning, customers, internal processes, safety and security, financial performance and environmental performance (MTR Sustainability Report, 2015).

3.4.1 Passenger Safety Performance

MTR's passenger safety record in 2014 reflects no fatalities, which are recorded within the KPI for deaths from accidents in the CoMET benchmarking results for that year. This KPI includes deaths due to accidents on metro property or trains operated, owned or maintained by the metro, or due to metro operations, if death occurs within 30 days of an event.

3.4.2 Financial performance

In 2014, MTR continued to outperform all other CoMET participants on the indicator for total commercial revenue per operating cost, which reflects the success of MTR's sustainable financial models. This year, MTR has started to report on a new indicator, fare revenue per passenger km, which shows that over the past six years we have generated average levels of revenue from passenger fares compared with other metro operators. At the same time, in 2014 MTR sustained an improving trend on two measures of normalised operating cost, i.e. operating cost per revenue car km and per passenger journey.

3.4.3 Environment Performance

In 2014, MTR started to report on a new indicator, CO2 per passenger km. Since we exercise minimal influence over the source of electricity that MTR consumes, MTR's efforts to mitigate climate change focus on improving energy efficiency. The CoMET benchmarking results show that MTR was sustaining an improving trend for energy consumption per passenger km, and MTR's performance was better than average when compared with other metro systems around the world.

3.4.4 Customer Service Performance

Comparing punctuality and reliability of MTR's train services with other metro systems, MTR's passengers in Hong Kong enjoy good service by international standards but there was still room for moderate improvement. Despite the problems MTR is currently experiencing with crowding during peak hours, the data on capacity utilisation shows that MTR operates its services in an efficient way, doing MTR's best to transport MTR's passengers over the existing network.

The following graphs show the MTR performance vs the best performance in system reliability, operation efficiency and staff efficiency respectively:

(1) System Performance

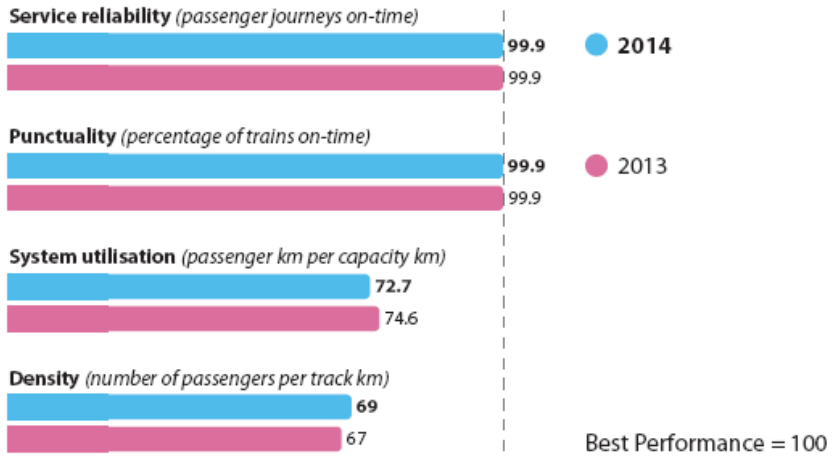


Figure 16 MTR Performance vs. Best Performance Stockholm Metro, Sweden

As shown in Figure 20, MTR maintained its strong position, particularly in service reliability, against international benchmarks.

(2) Cost Efficiency and Staff Efficiency

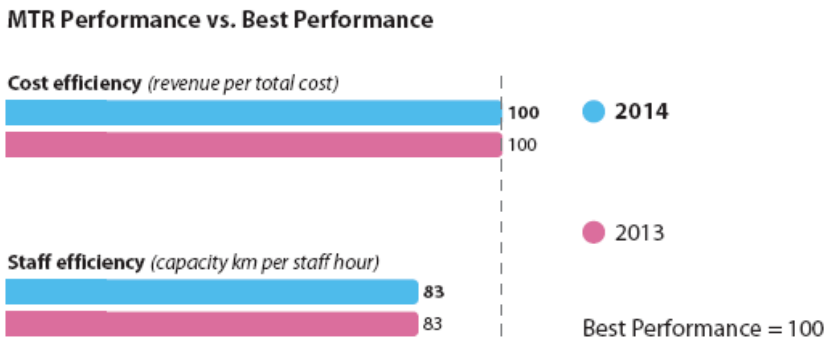


Figure 17 Benchmarking on Cost Efficiency and Staff Efficiency

The results showed that MTR was outperformed in cost efficiency, but there are rooms for improvement in staff efficiency.

The results of the trending analysis results of 18 years performance indices of the MTR operations, the review of the service performance ratios and the international benchmarking have answered the research question 1: the IMS model supports the MTR's substantial network expansion over the past 18 years and there is no doubt, it will support MTR's grow in the future.

3.5 Business Results of MTR Subsidiaries

MTR is recognised as one of the world's leading railway operators, with a successful track record of operating reliable and safe rail transport. Since its opened first railway line in 1979, the railway network increased in size, scale, geographical coverage and diversity. MTR's growth strategy is making good progress, with significant expansion of its network in Hong Kong and its portfolio of rail-related operations in the Mainland of China and operated rail concessions in the UK, Sweden and Australia. MTR's subsidiaries are list as follows:

The Mainland of China railway businesses include:

1. Beijing Metro Line 4 (BJL4)
2. Daxing Line of BJL4
3. Beijing Metro Line 14
4. Shenzhen Metro Longhua Line
5. Hangzhou Metro Line 1 (HZL1)
6. HZL1 Extension

Overseas Include:

1. London Overground, United Kingdom
2. Stockholm Metro, Sweden
3. Metro Trains Melbourne, Australia
4. Crossrail, United Kingdom
5. MTR Express, Sweden

As MTR's subsidiaries, MTR's good railway operating practives were being adopted in all susidaries list above, and IMS was being one of these good practices being asdopted. The total number of passengers carried by all these subsidiaries was approximately 1,598 million in 2015, compared to approximately 1,458 million in 2014, representing an increase of 9.6%. Revenue from these subsidiaries was HK$12,418 million. This represents a slight decrease of 0.4% over 2014 and mainly reflects the net result of adverse exchange rate movements offset by incremental contributions from new start-up operations. The IMS deployed in these companies has contributed to these companies as management system to support their growth regardless the difference in countries and culture. These results answered the research question 2: the model is applicable in other railway companies in Mainland China, UK, Sweden and Australia.

3.6 Conclusions

The key benefit of the IMS, by demonstrated by empirical evidence, is a more strengthened and effective leadership and communication structure, enhancing operational efficiency and cost-effectiveness. It also encompasses greater staff involvement and participation, and fosters more effective teamwork by reducing bureaucracy and promoting empowerment.The implementation of IMS in MTR has fulfilled MTR's need for breakthrough improvement to cope with the enormous network expansion in the past 18 years.

The experience of system implementation so far has indicated that IMS is agile and provides effective support to management for reacting quickly and decisively to the challenges of managing business such as amalgamation with KCRC in 2007 and also to cope with economic fluctuations during this period. The IMS have been extended to the other joint venture companies since 2000, with a view to paving the way for the Corporation to meet the immense challenges to the future to come.

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Dr. Y.K. Chan has over 30 years working experience in engineering and management positions in both Manufacturing and Service industries. He has rich consultancy experience in the field of strategy operations management, quality management, team and motivation, leadership and strategic management.

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