A Structured Management System Integration Methodology: Development and Implementation

Y K Chan, F K C Tao, L C Koo and K Y Chau

Abstract

This paper describes the needs for a management system integration concept and the development of a structure system integration methodology to facilitate a full integration. The paper reviews various system integration approaches in the literature and developss a structured analysis methodology for system integration. The paper cites the case of developing a Total Integrated Management System (TIMS) in the Operations Engineering Department (OED) of the MTR Corporation to propound the use of such methodology.

Keywords: TTMS, TQM, IDEF

摘　要

論文探討綜合管理體系的需要，並建立一套體系綜合的系統方法，以便各種不同的管理體系能夠全面整合。論文參閱了大量文獻各種管理體系之整合方式而建立此體系綜合系統方法。論文並引用香港地鐵公司營運工程部應用個案加以說明。

【關鍵字】綜合管理體系；TQM；IDEF

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Chan, Y. K., Tao, F. K. C. , Koo, L. C., and Chau, Gavin (2004) "A Structured Management System Integration Methodology: Development and Implementation" *Asia International Open University Journal, June Issue, pp. 1-19*

1. Introduction

The subject of an Integrated Management System in terms of quality, environmental and occupational health and safety management has become of increasing interest to researchers and business as alike since 1996 (Castle, 1996; Hayday, 1996; Massey, 1996; Aboulnaga, 1998; Jacobs, 1998; Moore, 1998; Hoyle, 1998; Hall, 1998, Thelen, 1997; Jonker and Klaver, 1998; Wilkinson and Dale, 1999 and Karapetrovic and Willborn, 1998). Such literature has discussed pathways to integration, benefits of integration as well as obstacles to integration. Much of what has been written has been based on individual case studies and focused on alignment between the quality, environmental and health and safety management standards (Renfrew and Muir, 1998; Karapetrovic and Willborn, 1998; Lawrence et al., 1998; Thelen, 1997; and Pun and Chin, 1995). There are only a few reports related to the successful integration of OHSS, EMS and QMS, though Wilkinson and Dale (1998) reveal that there is an increasing interest in an integrated systems approach to ISO 9001, ISO 14000 and OHSAS 18000. Many companies have attempted to establish an integrated system in their organisation, but only a few of them have been successful (Mangelsdorf, 1999). Many of their management systems are either partially integrated or still in the process of being completely integrated towards a single effective business management system (Karapetetrovic and Willborn, 1998). To achieve an integrated management system that positively drives business performance while remaining flexible enough for future integration is difficult, mainly due to the complication of integration process and difficulties in aligning IMS with the organisation's strategy (Beechner and Koch, 1997). As highlighted by Jonker and Klaver (1998), *"integration difficulties arise mainly because there is a lack of proper methodology; a methodological body of knowledge which will facilitate integration not only at the start, but also when newly emerging quality system have to be integrated into existing ones"*. This paper discusses the development of a new system integration methodology to address these difficulties.

2. System Integration Approaches

There is an increasing trend that organisations adopt an integrated management system to avoid implementing different individual management systems separately for enhancing organisation efficiency (Tranmer, 1996). The need for an integrated management system has arisen since 1996, in particular as a result of launching ISO 14000 standards (1996) on environmental management system (EMS) and BS 8800 standards (1995) on occupational health and safety management system (OH&SMS) in addition to a quality management system (QMS). According to Sissell (1996), the chemical sector has been taking the lead, as this sector needs to tackle these

three issues simultaneously. As this subject was an emerging topic, few papers had been published and discussed in the literature at the time when the MTR decided to integrate its five management systems in 1998.

An IMS seeks to combine similar aspects of different management system requirements in order to simplify management procedures, minimise paperwork and reduce costs. As explained by Hoyle (1998), "integrated" means "combined" so in this sense it is putting all the internal management practices into one system, not as separate components. Massey (1996) reveals that it is common practice for organisations to use ISO 9000 quality manual as the backbone, as it is the most comprehensive one covering the twenty elements of a complete manufacturing process; the other management system requirements such as the 16 elements in the environmental management system and similar requirements from the safety management system are added. Strickly speaking, this is not the system integration, it only puting all requirements in the same category. The need to use the system approach into system integration has created a number of useful models (Renfrew and Muir, 1998; Castle, 1996; Karapetrovic and Willborn, 1998; Lawrence, et al., 1998) from which various levels of integration can be achieved. The following three levels summarise the extent of integration of various studies:

1. Integrating QMS with EMS only (Refrew and Muir, 1998; Aboulnaga, 1998, and Karapetrovic and Willborn 1988);
2. Integrating QMS, EMS and OH&SMS (Center for Chemical Process Safety, 1996);
3. Integrating QMS or EMS and TQM (Lawrence, et al., 1998 and Thelen, 1997). Or QMS and other management initiatives such as total productive maintenance, world–class manufacturing and business process re-engineering (Castle, 1996).

Wilkinson and Dale (1999) furhter categorise the system integration into four levels (first column of Table1). They suggest that the fourth level which integrates all systems into an overall system is the "true IMS". But they have not included the integration with TQM model. The TMS developed for the MTR 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. The integration requirement set by the TMS is more extensive as it requires the system to be able to integrate the current five management systems (QMS, OH&SMS, Railway Safety Management System, Asset Management System and TQM) into a single management system which focuses on the core business processes. Table 1 compares the level of integration suggest by Wilkinson and Dale (1999) and the equivalent four levels of integration suggested by the author:

	Level of Integration Suggested by Wilkinson and Dale (1999)	Level of Integration Suggested by the Author
Level 1	Fully integrated, company-wide Quality Management System (QMS) to ISO 9000.	Integrating QMS with EMS only.
Level 2	Combining linkages shared by the various standards.	Integrating QMS, EMS and OH&SMS.
Level 3	Linking QMS and Environmental Management System (EMS) with other certification such as Investors in People.	Integrating QMS, EMS and OH&SMS or QMS and other management initiatives.
Level 4	Integrating certificated and uncertificated systems with the overall management system.	Integrating QMS, EMS, OH&SMS, TQM with organisation's own core business processes.

Table 1 Comparison of Latitudinal Integration Levels

Synthesising numerous studies, the author catergorises the issue of integration into two types: Longitudinal Integration and Latitudinal Integration. The author suggests that the Latitudinal Integration refers to the extent of the integration among various management systems as demonstrated in Figure 1 below:

Level of Longitudinal Integration	ISO 9000	ISO 14000	OH&S18000	TQM and Other Management Initiatives	Organisation's Own Core Business Process
Level 1					
Level 2					
Level 3					
Level 4					

Figure 1 Latitudinal Integration

The Longitudinal Integration refers to the depth of the integration within the organisation. In this regard, Jonker and Klaver (1998) suggest a concept of four-level integration:

Policy - the integration requires management to decide on its integration policy and whether or not integration is required;

Conceptual - adopting a conceptual model such as the EFQM as a basic model for the integration, which should be operational by employing a method such as a questionnaire for self-assessment and by ensuring that the principles of feedback and improvement are addressed;

System - a system based on the standards be required; but for the integration, both the similarities and differences have to be addressed; and

Normative – integration of instructions and manuals be achieved by merging instructions and procedures.

Building on Jonker and Klaver's concept, the author recommends, for TMS implementation, that the four-level integration concept be more appropriately amalgamated into three levels without level 2 (i.e. using EFQM as a basic model for the integration). The TMS integrates the Business Excellence Model into the the core business process rather then using the Business Excellence model as a basic model for the integration (Item 2 above). The author terms this three-level integration the Longitudinal Integration (Figure 2) as detailed below:

1. Policy integration – amalgamate quality, environmental, and occupational safety and health policies with business polices to form a holistic set of polices. These can be housed in the first level document, the Policy Manual.
2. System integration – integrate all identified management systems and management models with core business processes to spearhead corporate goal.
3. Process integration - integrate quality, environmental, occupational safety and health as well as business processes requirements into both process-based procedures and work instruction to support staff in performing their tasks to the prescribed standards.

The extent of the Longitudinal Integration at three levels: policy integration, system integration and process integration is illustrated in Figure 2:

Level of Longitudinal Integration	Policy Integration	System Integration	Process Integration	Work Integration
Level 1				
Level 2				
Level 3				

Figure 2 Longitudinal Integration

Through the three-level integration, a policy manual, a management system manual, web-based procedures and multi-media work instructions are developed, forming the four-tier documentation structure of the TMS. Based on this structure, the TMS can be implemented at all levels of the organisation.

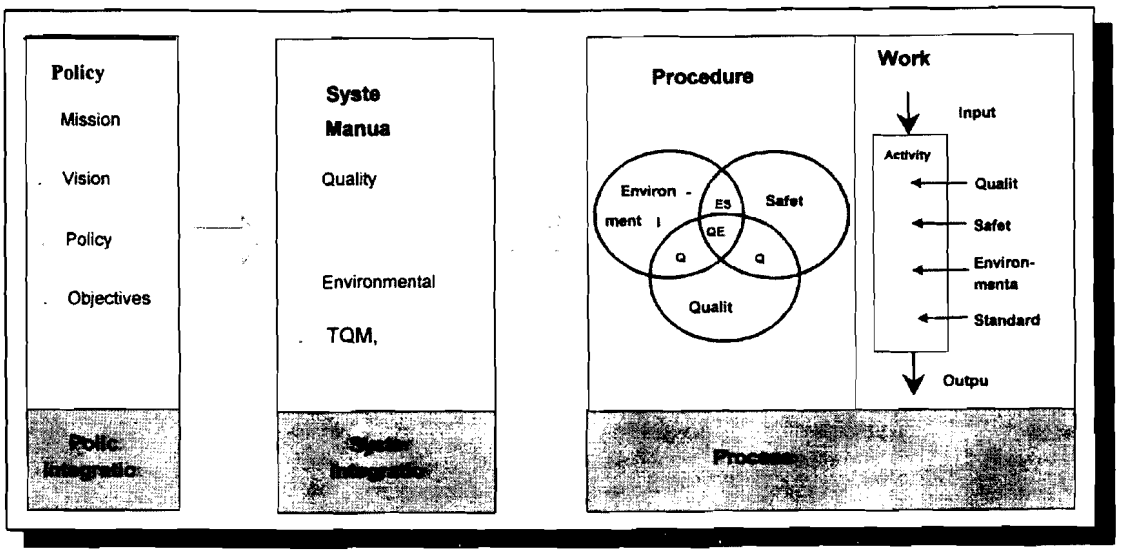

Figure 3 Three-level Integration Approach

The major difference between Jonker and Klaver (1998)'s concept with that of the author is the basic model for the integration. They suggest using the EFQM as a basic model while the author adopts the own organisation's core business process as basics for the integration. The author believes that by integrating the five management systems (including the business excellence model) with the core business process, many system requirements can be aligned with the core business process towards the corporate goal. The new system can be very flexible to be enhanced to cope with any new system requirements (such as the Revised Version of ISO 9000 in 2000) in the future. The Table 2 illustrates the differences between Jonker and Klaver (1998)'s concept of four-level integration and the author's three-level longitudinal integration method:

Level	Jonker and Klaver's Four–level Integration	Level	The Author's Three–level Longitudinal Integration
Level 1	Policy integration – Management to decide on integration policy	**Level 1**	Policy integration – Policies are aligned to form a holistic set of policies
Level 2	Conceptual integration - Use MBNQA as a conceptual model for integration – self-assessment questionnaire is to be used	-	The TMS defines the integration of five systems with core business processes
Level 3	System integration – Building a system based on a model to meet requirements of all management systems	**Level 2**	System integration – Integration of all management standards and TQM with core business processes (Level 4 of Table 7.1)
Level 4	Normative integration – Manual, procedures and instructions	**Level 3**	Process integration - Integration of procedures and instructions

Table 2 Comparison of Longitudinal Integration Levels

A "fully" integrated management system (IMS) covers both the Latitudinal Integration (level 4) and the Longitudinal Integration (Level 3). This full IMS forms a cornerstone of the Total Management System. This is in line with the integrated management system concept propounded by Seghezzi (2000) later in 2000, who believes that the integration requires the development of a generic management system in which all the partial systems, such as ISO 9001 and ISO 14001, can be included. He recognises that this is not easy, because these systems have different structures and content, but he believes that models based on cross-functional processes, which include model of TQM, and process model such as those in ISO 9004:2000, form a good base for integration. Seghezzi (2000) therefore recognises the need for common structure and content, but the standards have not yet provided it.

Though there are a number of successful cases in low level (levels1, 2 and 3 of Wilkinson and Dale (1999)'s level of integration) integration (Thelen, 1997; Carter, 1999; Wilkinson and Dale, 1999 and Pun et al., 1999), a "full integration" is rare (Seghezzi, 2000). According to the survey conducted by Douglas and Glen (2000) on integrated management systems in the UK's small and medium enterprises, 71% of organisations in this study have achieved levels one and two integration as suggested by Wilkinson and Dale (1999), i.e. an integrated company-wide QMS to ISO 9000, and an integration based on combining linkages shared by the various standards. None of these organisations have achieved a "true" IMS. To achieve an integrated management system that

positively drives business performance while remaining flexible enough for future integration is difficult, mainly due to the complication of integration process and difficulties in aligning IMS with the organisation's strategy (Beechner and Koch, 1997). Echo with the same view, Jonker and Klaver (1998). suggest that to avoid wasting time and energy, the complex integration process should be guided by a methodological framework.

3. System Integration Methodologies

Regardless of the needs for system integration by industries, ISO technical advisory group, ISO/ TAG, 12 recommends that ISO 9000 and ISO 14000 series should not be merged but made more compatible. This means the common elements of the standards can be implemented in a shared manner, in whole or in part, by the organisations without unnecessary duplication or the imposition of conflicting requirements (British Standards Institution, 1998). This approach has been adopted in a number of case studies (Beechner and Koch, 1997; Moore, 1998; Karapetrovic and Willborn, 1988; Center for Chemical Process Safety, 1996). Most companies only combine QMS with EMS by consolidating multiple steps of common elements into a single step so it addresses elements of both systems.

A comparative matrix is a commonly used tool to identify common elements between QMS and EMS. Manuals based on ISO 9000 structure with integration of QMS and EMS requirements are thus produced to guide the implementation of the integrated system. However, when considering integrating further the OH&SMS and TQM into a single system, the situation is much more complicated. Some research has adopted the system thinking on the integration process (Castle, 1996, and Karapetrovic and Willborn, 1998). Karapetrovic and Willborn advocate a "system in systems" approach to demonstrate the relationship between the elements of the standards that make up the QMS, EMS, OH&SMS etc. and how they fit into the overall management and business systems. Renfrew and Muir (1998) see the move towards IMS as necessary step towards QMS, EMS and OH&SMS integration.

To achieve a full integration as discussed in Section 2, the author considers that combining systems by using cross-functional matrices is only seen as first step. The next step is to use the matrix to produce integrated procedures that meet the requirements of each standard, but this does not necessarily mean that the IMS will reflect the organisation's actual processes. A further step is required where the core, supporting and assurance processes are identified and the focus is on strategy. All these steps end up with a requirement of a structural approach for system integration.

The popular matrix method of integration as suggested by the Centre for Chemical Process Safety of the American Institute of Chemical Engineers (1996) is not able to cope with the full integration (level 4 of the latitudinal integration and level 3 of the longitundinal integration). A full integration leads to a fundamental change in the way of working and the integration process is a complex process. Integrating five management systems with the core business processes requires multi-level analysis. This cannot be easily done without a step-by-step analysis of each process. Due to this difficulty, a structured analytical method should be employed to provide an unambiguous road map for a total integration. As stated by Stracker (1997), there is a wide range of methods for diagramming processes, such as flow charts, data flow diagrams, process mapping and information matrix, but few of these are both rigorously defined and non-proprietary. Even if they have become part of costly computer packages, these methods cannot exhibit the variety required for organisational re-design (Castle, 1995). The TMS wants a well-established, standardised technique with a history of success and good prospects for continued use for future possible system modification.

The Structure Analysis and Design Technique (SADT) has been placed in the public domain in the late 1960s as IDEF0 (Integrated Definition zero) by the US Department of Defense as a standard for process definition (Stracker, 1997). Since then it has been adopted by many organisations seeking a simple but rigorous way of describing their process. IDEF0 is based on graphic and text descriptions of functions, information and data. It is widely understood and well documented (Hill, 1995). IDEF0 originally defined by the "Architects Manual" includes guidance for modelling, together with rules for model syntax, diagram and model validation, document control procedures and interview techniques (Schoiz-Reiter, 1996). According to the O'Sullivan (1994) classification, IDEF0 is both a functional technique (representing what process elements are performed and their information flows) and an organisational technique (representing where and by whom process elements are performed), with some elements of an information technique (representing the structure of the information used).

According to Yadav et al. (1998), IDEF0 is also one of the few formal processes modelling techniques to have been the focus of empirical research. His research, comparing IDEF0 with other process modeling techniques such as data-flow diagrams, has revealed that IDEF0 has a wide range of applications in many areas with 15 IDEF standards, from IDEF0 to IDEF14 developed (O'Sullivan, 1997). The application of IDEF0 for management system integration is the first attempt adopted by the author to establish an integrated management system and as a tool to streamline operations procedures.

4. *System Integration for the OED*

4.1 Objectives of the OED System Integration

The author's objective of system integration for the OED as a pilot scheme for developing a TMS for whole Operations Division is to provide a totally integrated management structure in the form of a Management System Manual (MSM) which focuses on core business processes. This document replaces the former Quality Manual and serves as a high-level introduction and roadmap which demonstrates how the TMS supports each key business area in the organisation and each element of the integrated system infrastructure. The Management System Manual serves a number of purposes, including:

1. Stating the strategic directions that support the first-level documentation – Policy Manual;
2. Demonstrating compliance with best-practice models such as ISO 9001, ISO 14000, Safety Management System, TQM Model, etc.;
3. Presenting an overview of the TMS to both internal and external customers to demonstrate the Department's commitment to business excellence;
4. Directing the training and reinforcing awareness and compliance by contractors and suppliers; and
5. Enhancing staff's understanding of TMS.

It is important that the OED purpose and objectives are derived from corporate purpose and objectives, and are supported by the strategic framework documented in the MSM. The latter spells out how the departmental purpose can be effectively achieved.

4.2 Basic Categories of Business Processes

Before performing the integration process, the OED business processes have to be identified to form the basis of the Management System Manual (MSM). Business processes refer to the various processes, which transform inputs into outputs and increase product or service attributes. Business processes fall into the following three basic categories (Tranmer, 1996):

1. Core Business Process
2. Supporting Process
3. Assurance Process

The core business process is a series of strategic elements which spell out the means of achieving the corporate objectives of an enterprise (Massey, 1996). Through these means, an enterprise can produce products or provide services that are required by customers. The supporting process

is established to guarantee the effective implementation of the core business process, such as business planning, human resources management and development, etc. The assurance process refers to the work of ensuring that an enterprise will achieve its objectives. This process, however, is easily neglected in an ordinary management system. The ISO 9000 series of standards bear relatively detailed requirements on the guarantee process, including management review, process audit and document management system, etc. According to the above principles, the OED business processes can be classified into the following 8 areas:

Core Business Process	• Asset Maintenance and Process Management • Management of Capital and Revenue Work
Supporting Process	• Management Responsibility and Organisation • Business Planning • Human Resources Management and Development
Assurance Process	• Document and Information Management • Performance and Results • Audit and Continuous Improvement

Table 3 OED Business Process

These eight areas become eight sections of the OED Management System Manual (MSM). All requirements of the quality and safety management systems as well as the Malcolm Baldrige National Quality Award criteria are integrated under these eight sections (Figure 4). Using the IDEF0, the contents of the MSM covering these eight sections are produced as will be discussed in Section 4.3 and illustrated. The MSM is so structured that it paves the way to integrate the environmental management system in the near future.

Asset Management Model	*ISO 9001 Requirements*	*Safety Management System Requirements*	*Malcolm Baldrige National Quality Award 1997 Criteria*
Conceptual	Management Responsibility	Information	Leadership
Definition/Specification	Quality System	Safe System of Work	Strategic Planning
Tendering	Contract Review	Buildings, Plant, Equipment & Software	Customer and Market Focus
Design and Manufacturing	Design Control	Systems Protective Equipment	
Installation, Commissioning & Decommissioning	Document and Data Control	Human Resources	Information and Analysis
Operation and Maintenance	Purchasing	Communication and Safety Matters	Human Resource Development and Management
Disposal	Process Control •	Contractors and Visitors	Process Management
	•	Design and Project Management	Business Results
	•	Accident Reporting & Investigation	
	•	Safety Performance Monitoring	
		Review and Audit	
		•	
		•	

1. Management Responsibility and Organisation	3. Human Resource Management and Development	6. Process Management and Asset Maintenance
2. Business Planning Revenue	4. Documentation and Information management	7. Performance and Results
	5. Management of Capital and Works	8. Audit and Continuous Improvement

Figure 4 Organisation of the Management System Manual

4.3 A New Methodology for System Integration –The IDEF0

Integrating five systems into a single management system with all the systems documented in an integrated management system manual is by no means an easy task. To attain the highest possible standards in safety, reliability, timeliness and efficiency, it is essential that the integrated system meets all the requirements of the five systems describes how good railway service is to be provided. This Section details how the IDEF0 methodology is developed to derive a Management System Manual (MSM) for the system integration.

The IDEF0 is a strucutred analysis and design method based on graphical and text description fo fuction, information, and data. A key concept of IDEF0 modelling is the definition of a "Context" and the modeller's "Viewpoint" to establish an explicit common understanding of the boundary and aspect of the system being modelled (Scholz-Reiter, 1996). The first step in IDEF modelling is thus concerned with establishing the objectives of the modelling effort from which a context and viewpoint can evolve. Moreover, this is a top-down method which starts from general applications and moves on to more specific issues, from a single page that represents an entire system to more detailed pages that explain how the sub-sections of the system work. It includes both the procedures and language for constructing a model of the decisions, actions, and activities in an organisation (Benjamin et al., 1993). The IDEF0 model consists of three components: (1) a set of hierachically decomposed diagrams; (2) an accompanying text for the diagrams; and (3) a glossary of terms used in the diagrams (Wisnosky, 1987; Scholz-Reiter, 1996).

As explained by Hill (1995), the basic element of an IDEF0 model is called a function block, as shown in Figure 5. In such a model, the individual function blocks are linked together through the inputs, outputs, resources and constraints. The nature of each of these links can be specified: they can be either physical objects or information. When an input is utilised to create an output, a function will be actuated. The performance of the function is carried out using resources and under the constraints.

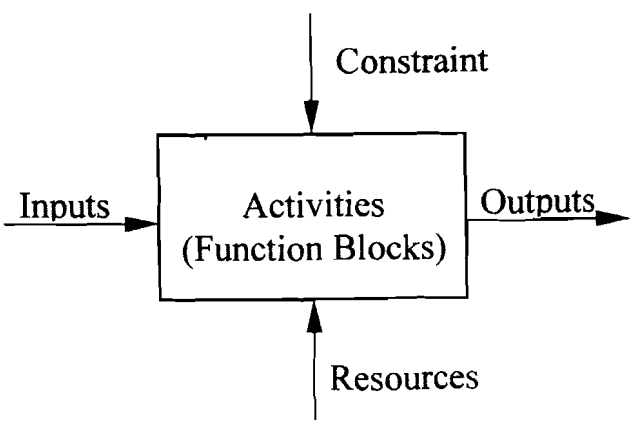

Figure 5 IDEF0 Function Box

The inputs to a function entering the function block from the left are usually (but not necessarily) "consumed" by the function to produce outputs. In case of system integration, inputs mean requirements of various management system standards that have to be met by the activity in the function block. The outputs are the ways and means to meet these requirements. The resources, represented by an arrow entering the function block from below, indicates the resources required for carrying out the transformation process. All resources shown must be used as means to achieve the function. They only become part of the output if they are passed on by the function to support other functions. Finally, the constraints that enter from the top of the block only influence the transformation process but will not be processed themselves.

The powerful approach used in IDEF0 is the stepwise revelation of details through hierarchical decomposition (Scholz-Reiter, 1996). Each activity in a model represents a number of sub-activities, and each arrow represents a number of sub-arrows. According to Hill (1995), a number of rules on decomposition that must be observed if the true and unambiguous nature of the model is to be maintained:

1. *Each activity (or group of sub-activities) is given a node number such as A1. The letter A represents the model and 1 the relative position of the activity in the model. The activity at the top of the hierarchy is normally denoted as A0.*
2. *The node numbers of sub-activities are determined by suffixing the node number of the activity to the sub-activity number, such as A12. The node number A1 is suffixing to the sub-activity number 2.*
3. *Each activity box contains a title box, which clearly illustrates the context for the activity (top right-hand corner), its activity title and its node number.*
4. *Arrows that are not traceable to parent or child diagrams can be tunnelled. Tunnelled arrows appear in parentheses.*
5. *Activities that are further decomposed will have the full node number indicated outside the box on the bottom right-hand corner.*

4.4 Application of IDEF0 in Management System Integration

The OED Management System Manual (MSM) in the MTR, it is an integrated part of the documentation structure of the TMS. It contains detailed description of the requirements of the TMS and shows how the system works and how it controls the achievement of quality and safety. The subject or the viewpoint of the IDEF0 modelling in this case is defined as "Design a MSM" and a node A0 is established (Figure 6). Besides, the MSM has to encompass the requirements of ISO 9001 (1994), the MTR safety management system, the MTR Asset Management System, the MBNQA criteria, and in the near future, the ISO 14001. Thus, these requirements have to be defined as the input of this system (left-hand-side of Figure 6):

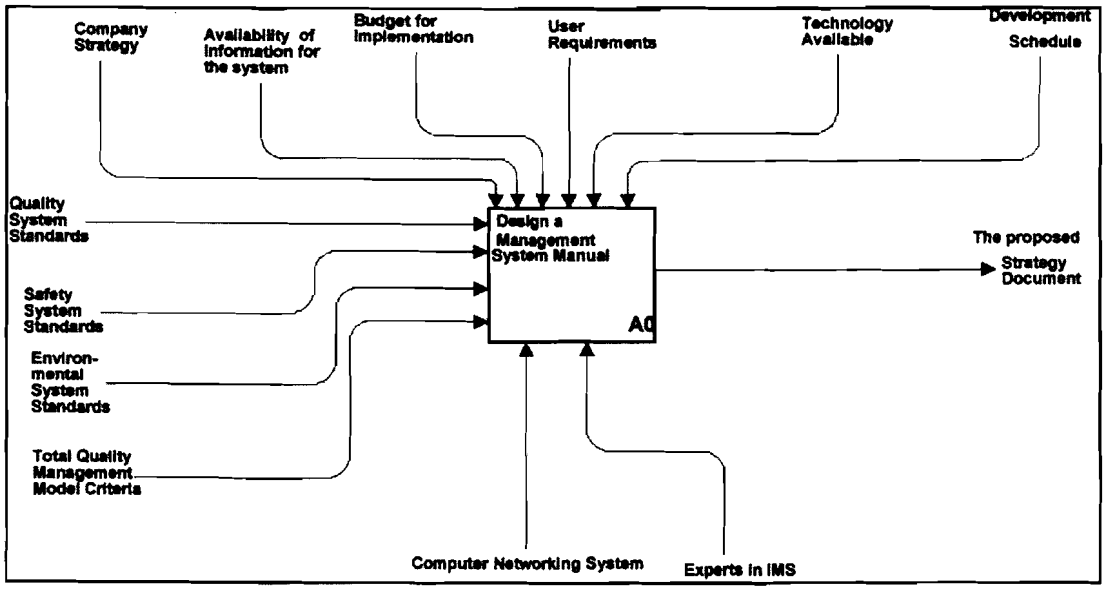

Figure 6 Design of the MSM

It has been designed to expose eight core business activities (see Table 3), which are necessary to support the TMS. For instance, node A1 "Management Responsibility, node A-2 "Strategy and Planning", node A-3 Human Resources Management and Development, etc. The relevant part of the page 2 (i.e. node A1) is shown in Figure 7 below:

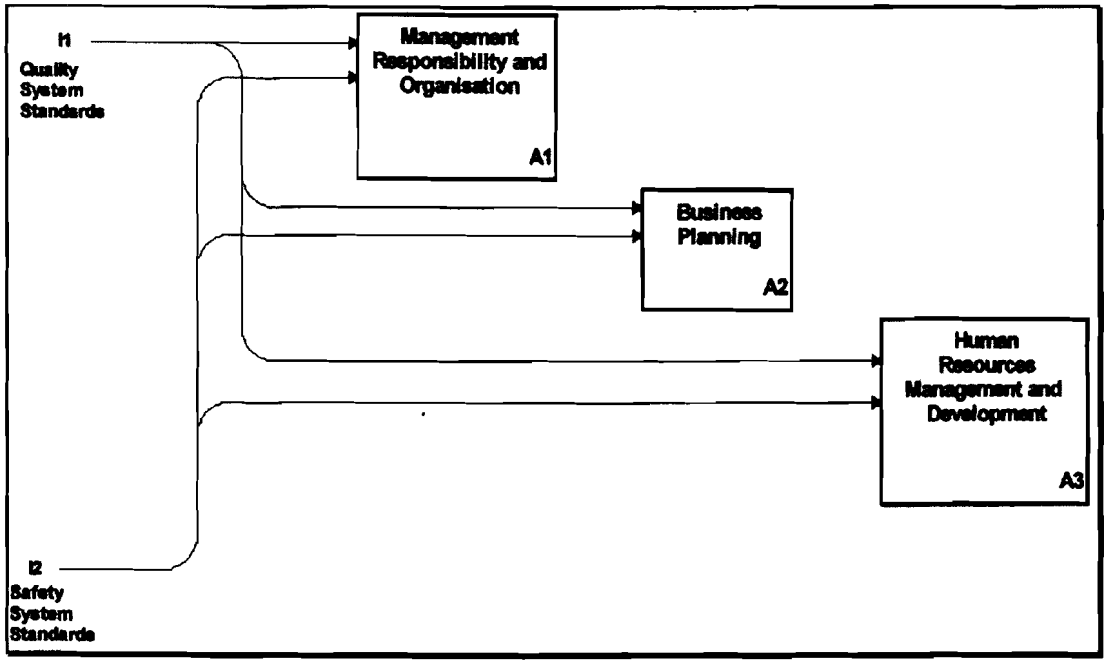

Figure 7 Part of the Decomposed Page from Block A0, Design of the MSM

The next level in the model, as a result of decomposing 'Management Responsibility and Organisation' node A1 is 'Corporate, Division, Department and Functional Policies' node A11 and 'OED Vision, Mission and Culture' node A12, etc. The level of decomposition for related activities is considered necessary to provide a valid view of the information required to support the eight sections of the System Management Manual (Figure 8). To this end, a total of 51 decomposed diagrams have been developed.

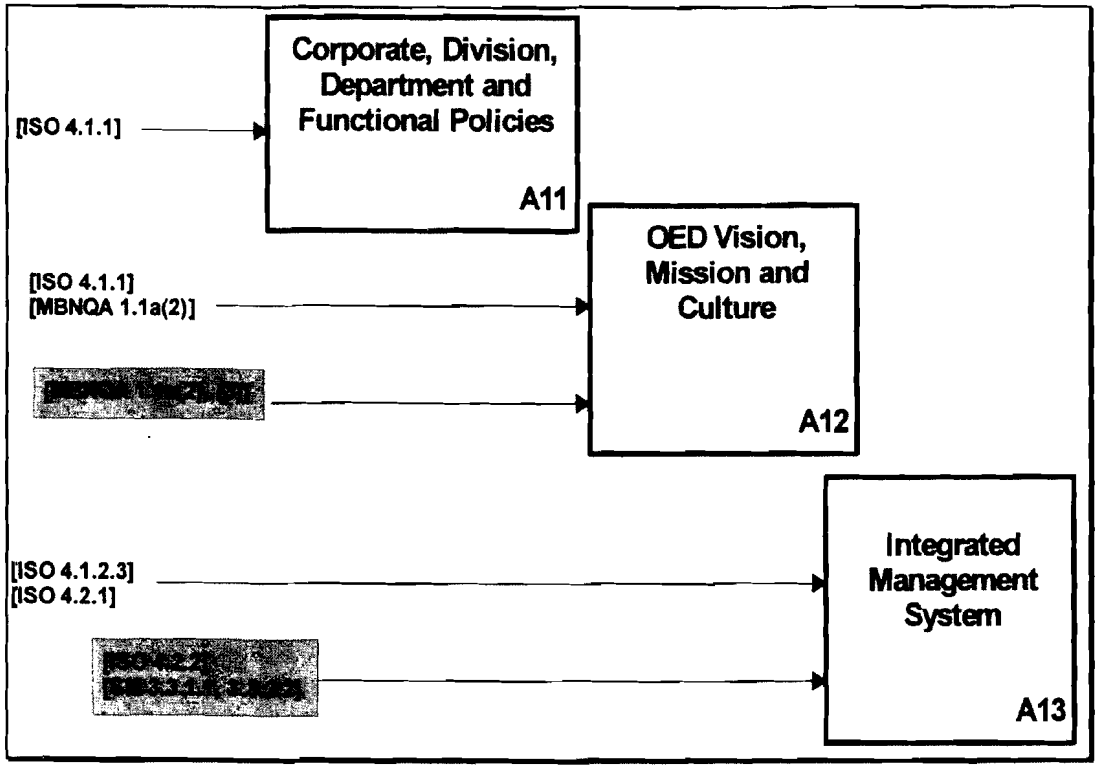

Figure 8 Part of the Decomposed Page from Block A1, Management Responsibility and Organisation

In the last part of design, there is a node tree that can be generated automatically to show the depth of decomposition and give an overview of the system. The node tree then becomes the content list of the Management System Manual (MSM) and the outputs become the relevant clauses of the MSM.

IDEF0 was found to be a powerful description tool that offers a number of features, which make it easy to apply and, more importantly, to understand. For example, it allows a top down step by step refinement, using a graphical representation with few constructs and simple rules and, it is based on the widely accepted concept of a function or activity transforming inputs into outputs

under external constraints. It forces the analyst to examine in details what constraints and enabling activities to present a diverse group of activities in graphic form. The use of a graphical presentation minimises the necessity for elaborative text, makes revision easily and provides clarity in a standard form for the diverse aspects of the system manual.

These advanced features have enabled the MSM for the OED to be extended to produce the MSM for the railway operations covering eight departments. The IDEF0 analysis has proven to be very useful in providing a step-by-step analysis for building the structure of the MSM. It also provides a valuable platform to allow speedy amendment of the Manual in response to changes in the business environment and regulatory requirements.

7.5 Summary

The Latitudinal Integration and Longitudinal Integration provide a structure from which an integration decision can be made. A new integration methodology, IDEF0, serves to provide a framework for effective management system integration. The structure, which integrates all five systems into a single management system, lays a foundation from which any amendments or enhancements to the TMS can be easily accommodated in future. The use of IDEF0 analysis as a methodology for systems integration has proved to be very useful in providing a step-by-step analysis for building the structure of the Management System Manual. It also provides a valuable platform to ensure that procedures are established against the TMS requirements and they are streamlined. The OED integrated documentation structure provides a user-friendly and streamlined documentation system which supports the operational requirements and focuses on critical business areas that lead to management excellence.

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