Prioritising the safety management elements
A hierarchical analysis for manufacturing enterprises

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Abstract
Purpose – The purpose of this paper is to present a hierarchy decision model for assessing the priority of safety management elements in manufacturing enterprises with reference to three major industries (i.e. textile and clothing, electronics, and printing and publishing) in Hong Kong. The identification of core decision criteria and safety management elements were addressed with respect to the effective implementation of safety management systems (SMS) in manufacturing enterprises.

Design/methodology/approach – Empirical data were acquired via a conduct of personal interviews with evaluators (i.e. safety personnel, experts and professionals) in industry. Using the analytic hierarchy process (AHP) methodology, a list of seven decision criteria and 13 safety management elements were identified and their relative importance were evaluated.

Findings – It was found that the top three criteria for SMS implementation were “client requirement” “insurance company requirement” and “employee requirement”. Both “safety organisation” and “safety policy” were the most important safe management elements. Besides, evaluators put greater concerns on “safe person” elements than “safe place” elements. Incorporating the AHP findings, a self-regulatory approach to implementing safety management elements was proposed.

Research limitations/implications – The hierarchy decision model would enable manufacturing enterprises to focus their resources on the critical elements at a time, to improve the effectiveness of SMS implementation. Future study could validate the applicability of the model and the self-regulatory approach in large enterprises and small to medium-sized enterprises, separately and collectively.

Practical implications – Using the AHP methodology, safety personnel could evaluate the relative importance of decision criteria and safety management elements with respect to the corporate goals, resources and constraints of their respective organisations.

Originality/value – The hierarchy decision model presented would enable manufacturing enterprises to determine the relative importance of decision criteria and safety management elements and to establish viable strategies for SMS implementation.

Keywords Analytical hierarchy process, Decision making, Health and safety, Manufacturing industries, Hong Kong

Paper type Research paper

1. Introduction
Nowadays, safety and health protection has become a major positive factor in favour of economic growth and productivity (Abdul Raouf, 2004; Hawkins and Booth, 1998; ILO,
Industry concerns have been put on identification and assessment of potential risks, and the elimination of unacceptable risks. Many recent studies (e.g. Chan et al., 2004; Pun and Hui, 2002; Yu and Hunt, 2004) advocated that safety and health functions should be integrated into the activities to increase the chances of reaching safety goals in organisations. A safety management system (SMS) contains a number of elements including safety policy, job hazard analysis, and safety and health awareness, etc. This provides guidance for enterprises to manage risks and improve the safety and health performance. SMS facilitates occupational safety and health management by providing systematic approaches for continual identification, evaluation and control of hazards and risks (BSI, 1999; ILO, 2001; Rondinelli and Berry, 2000). Since, 1999 the Hong Kong Special Administrative Region (HKSAR) Government has enacted the Factories and Industrial Undertakings (Safety Management) Regulation (ФIUSMR), which requires contractors and proprietors of designated undertakings to implement a list of 14 safety management elements so as to improve the safety and health performance and increase the productivity of their organisations (OSHC, 1999а,b). The importance of these elements is affected by:

- requirements from stakeholders;
- management’s perception;
- effects on production; and
- business strategies.

It is critical to determine the priority of resources allocated to individual elements during SMS implementation (Wee and Quazi, 2005), especially for small and medium-sized enterprises (SME) with limited resources and comparatively slower adaptation of new management concepts (Chan et al., 2004; Davig et al., 2003; Harms-Ringdahl et al., 2000; Motwani et al., 1998; OSHC, 1997; Vassie et al., 2000; Yang et al., 2006).

Hong Kong’s manufacturing sector grew rapidly during the 1970s and is currently the fifth largest employer in Hong Kong. Both original equipment manufacturing and original design manufacturing are the major operations of the industries (HKCSD, 2005; HKID, 2000). In order to enhance their competitiveness, local manufacturers have expanded or relocated their production facilities into Mainland China and other low-cost economies in the region. Hong Kong has become the control centre for these manufacturers to manage their operations and joint ventures in Mainland China (HKID, 2000; Yang and Lee, 2002). In terms of gross output and number of persons employed, textiles and clothing, electronics, and printing and publishing are the three major manufacturing industries in Hong Kong.

According to the statistics of the Hong Kong Labour Department (HKLD, 2005), manufacturing industries accounted for some 17 per cent of the total number of industrial accidents in Hong Kong in 2004. Most of the accidents in the manufacturing industries come from textiles and clothing industry, followed by printing and publishing, electronics industries and metal. The accident rate per thousand employees has been around 20 since 1994. Owing to a significant decrease of manufacturing employments and the relocation of manufacturing production to Mainland China, there was a decline in the number of accidents over the past ten years. Nevertheless, the stability of accident rate from 1994 to 2004 indicated no significant improvement in...
safety and health performance of the industries throughout the period. There is a pressing need to investigate the current industry situation in safety and health management, and identify decision criteria for determining the implementation priority of safety management elements for manufacturing industries in Hong Kong. This paper presents a hierarchy decision model for assessing the priority of safety management elements. Using the analytic hierarchy process (AHP) methodology, the model addresses the identification of relative importance of decision criteria and safety management elements with respect to the effective SMS implementation in manufacturing enterprises. The priorities of these criteria and elements are discussed and a self-regulatory approach to implementing safety management elements is proposed.

2. Safety management specifications
According to the European Process Safety Centre (1994), the core safety management elements include policy, organisation, management practices and procedures, monitoring and auditing, and management review. Top management of an organisation should establish the safety policy and the objectives that show its commitment and accountability on safety and health issues (Chan et al., 2004). An adequate safety organisation should be established for allocating responsibilities and resources, to facilitate the achievement of safety policy. Safety management practices and procedures should then be implemented in organisation's activities to achieve safety objectives. Performances should be monitored after their implementation, and the overall system performance should be audited. Besides, corrective actions should be suggested in the management review if irregularities were identified (Pun and Hui, 2002; Yu and Hunt, 2004; Yang et al., 2006). There are four common SMS guidelines and specifications, namely HS(G)65, BS 8800, OHSAS 18001 and ILO/OHS-MS. These four guidelines and specifications stress the safety policy, planning, implementation and performance evaluation (HSE, 1995; BSI, 1996, 1999; ILO, 2001), while the major difference falls on the order of element presentation (Hawkins and Booth, 1998).

3. The FIUSMR’s SMS and safety management elements
In 1995, the Hong Kong Government conducted a comprehensive review of industrial safety. The review concluded that factories and industrial undertakings should embrace self-regulation and safety management to achieve high standards of safety and health at work (HKLD, 2001). In 1999, the Factories and Industrial Undertakings (Safety Management) Regulation was enacted. It became mandatory that industrial proprietors and contractors covered by this regulation need to establish and implement their SMS in Hong Kong. The Government has promoted the SMS with a list of fourteen safety management elements to industries through launching pilot scheme, publishing an Occupational Safety Charter and organising seminars and promotion visits. These elements cover the critical aspects for achieving effective safety management (HKLD, 2002), and can be classified into four categories with respect to their nature and coverage (Table I).

Among these elements, both “safety policy” and “safety organisation” are the anchoring elements for SMS implementation, as reflected by the safety management specifications and recent researches (Shaluf et al., 2002; Walker and Tait, 2004; Yu and Hunt, 2004). Safety policy shows the senior management commitment on the safety and health issues, setting clear direction for the enterprise and the employees to follow.
<table>
<thead>
<tr>
<th>Category</th>
<th>Definition</th>
<th>Safety management elements</th>
<th>Implications</th>
</tr>
</thead>
<tbody>
<tr>
<td>SMS fundamentals</td>
<td>Basis of the SMS</td>
<td>1. Safety policy 2. Safety organisation</td>
<td>A policy to state the commitment of the proprietor to safety and health at work</td>
</tr>
<tr>
<td>Safe person elements</td>
<td>Emphasise on individuals and their protection</td>
<td>8. Inspection programme 9. Job hazard analysis 10. Accident control and hazard elimination</td>
<td>Training to equip personnel with knowledge to work safely and without risk to health</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Rules to provide instruction for achieving safety management objectives</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>A programme to identify hazardous exposure or the risk of such exposure to the workers and to provide suitable personal protective equipment as a last resort where engineering control methods are not feasible</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Promotion, development and maintenance of safety and health awareness in a workplace</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>A programme to protect workers from occupational health hazards</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>A programme of inspection to identify hazardous conditions and for the rectification of any such conditions at regular intervals or as appropriate</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Evaluation of job related hazards or potential hazards and development of safety procedures</td>
</tr>
<tr>
<td>Safe place elements</td>
<td>Emphasise on hazards and their removal at source</td>
<td></td>
<td>A programme for accident control and elimination of hazards before exposing workers to any adverse work environment</td>
</tr>
<tr>
<td>Others</td>
<td>Elements that are not belonging to any of the above categories</td>
<td>11. Accident/incident investigation 12. Emergency preparedness 13. Safety committees 14. Evaluation, selection and control of sub-contractors</td>
<td>Investigation of accidents or incidents to find out the cause of any accident or incident and to develop prompt arrangements to prevent recurrence</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Preparedness to develop, communicate and execute plans prescribing the effective management of emergency situations</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Committees to provide recommendation of measures to improve safe and health at work</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Evaluation, selection and control to ensure that sub-contractors are fully aware of their safety obligations and are in fact meeting them</td>
</tr>
</tbody>
</table>

Table I. The 14 safety management elements
Safety organisation defines clearly the safety and health responsibilities of staff at various levels, and the allocation of manpower resources that are necessary for implementing safety and health commitment. According to Gallagher (1997), safety management strategies can be classified into two main categories. That is, safe person approach focuses on individuals, while safe place approach emphasises on hazards and their removal at source. The safe person elements stressing individuals or the control of their behaviour include “safety training” “in-house safety rules” “personal protection programme” “safety and health awareness” and “occupational health assurance programme”. Whereas the safe place elements focus on the control of hazards and their removal, and include “inspection programme” “job hazard analysis” and “accident control and hazard elimination”.

In order to facilitate industrial proprietors and contractors to implement the SMS, the HKSAR Government had proposed the FIUSMR’s model with similar structure as that of the HS(G)65. Both “planning” and “developing” constitute the development phase of the SMS. Planning involves initial status analysis, periodic status analysis and risk assessment, and developing refers to the development of safety policy and effective safety plan. The implementation phase includes organising and implementing, and maintenance phase includes measuring and auditing (HKLD, 2001). Depending on the number of workers of the undertaking, either safety review or safety audit should be conducted at regular intervals. Reports should be produced for each review and audit and recommendations should be planned and implemented as soon as possible.

4. Conduct of an AHP study

In order to investigate the relative priorities of the safety management elements for manufacturing industries, the authors initiated a recent study in Hong Kong using the AHP methodology. The methodology as devised by Saaty is a powerful management tool in structuring fuzzy and complex problems (Saaty, 2000). It involves the decomposition of a complex problem into a multi-level hierarchical structure of characteristics and criteria with the last hierarchical level constituting the decision alternatives (Sevdel, 2006). AHP can accommodate both objective and subjective judgements of the evaluators involved in order to make trade-off and to determine priorities among them (Saad, 2001; Udo, 2000).

This was an exploratory study targeted at a selected group of industry evaluators (including safety personnel, experts and professionals) in industry. The study was to determine the priority of decision criteria and elements for SMS implementation in manufacturing enterprises with respect to the FIUSMR’s model and related requirements. The goal of SMS implementation was decomposed into seven criteria identified from literature. These criteria were:

1. customer requirement (Pun and Hui, 2002);
2. insurance company requirement (Harms-Ringdahl et al., 2000);
3. employee requirement (Saksvik and Nytro 1996);
4. cost-effectiveness (Ashmore, 1995; Beheshti, 2004);
5. effect on production rate (Cagno, 2001);
6. competence and expertise requirement (Harms-Ringdahl et al., 2000); and
7. employee safety and health (Vassie et al., 2000).
Figure 1 shows a three-level decision hierarchy incorporating these criteria and their sub-criteria.

By way of quota sampling, a group of eight industry evaluators were interviewed for evaluating these criteria and elements. Two evaluators were safety professionals, one being the President of Professional Association of Occupational Safety and Health and the other was a Senior Safety Management Consultant of the Hong Kong Occupational Safety and Health Council. Six evaluators were invited from organisations in three major industries namely:

1. textiles and clothing;
2. electronics; and
3. printing and publishing in Hong Kong.

These evaluators were responsible for and/or have substantial experience in managing safety matters for their respective organisations and/or client organisations (Table II). Those manufacturing enterprises selected for interviews had established their SMS in one form or other.

All interviews involved personal visits. It was assumed that respondent would be familiar with the major terms of the questionnaire. During the interview, specific terminology of decision criteria and safety management elements was explained to evaluators if necessary. Special care was taken to avoid the pitfall of leading questions when requesting evaluators to do the rating. The length of the interviews had been limited to end within 30-40 min. In the first stage, evaluators were requested to compare the seven-decision criteria pairwisely using a nine-point scale of intensity (Table III). For example, if an evaluator decided that “customer requirement” was moderately important than “employee requirement” then the former would be rated as “3” and the latter would be rated as “1/3” (Saaty, 2000). As a result, a matrix of rating was obtained after the competition of all comparisons. The matrix was then used for calculating the relative importance (or weight) of each decision criterion as shown in level 2 of Figure 1.
In the second stage, evaluators were requested to use absolute measurement to rate the safety management elements, i.e., to rate them against each decision criterion by the criterion’s own intensity set as shown in level 3 of Figure 1 (Saaty, 2000). The intensities within each set represent different weights as shown in Table IV. These weights were calculated by setting the intensities to have an equal distinction from one other (Liberatore et al., 1992; Tam and Tummala, 2001). The major reason for using this absolute measurement rather than pairwise comparison at this stage is to avoid inconsistent judgment by evaluators. As humans are only able to compare only seven to nine things accurately at a time, therefore, the number of factors to be evaluated by

<table>
<thead>
<tr>
<th>Industry evaluators</th>
<th>Organisation</th>
<th>Position</th>
<th>Experiences on safety and health management</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Company I (textile and clothing)</td>
<td>General Manager</td>
<td>More than 10 years</td>
</tr>
<tr>
<td>B</td>
<td>Company II (textile and clothing)</td>
<td>Production Manager</td>
<td>More than 10 years</td>
</tr>
<tr>
<td>C</td>
<td>Company III (electronics)</td>
<td>Production Manager</td>
<td>More than 10 years</td>
</tr>
<tr>
<td>D</td>
<td>Company IV (electronics)</td>
<td>Senior EHS Engineer</td>
<td>More than 5 years</td>
</tr>
<tr>
<td>E</td>
<td>Company V (printing and publishing)</td>
<td>Safety Manager</td>
<td>More than 10 years</td>
</tr>
<tr>
<td>F</td>
<td>Company VI (printing and publishing)</td>
<td>Safety Personnel</td>
<td>More than 5 years</td>
</tr>
<tr>
<td>G</td>
<td>Professional Association of Occupational Safety and Health</td>
<td>President</td>
<td>More than 20 years</td>
</tr>
<tr>
<td>H</td>
<td>Hong Kong Occupational Safety and Health Council</td>
<td>Safety Management Consultant</td>
<td>More than 20 years</td>
</tr>
</tbody>
</table>

Table II.
Background of safety professionals invited

<table>
<thead>
<tr>
<th>Intensity</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Equal importance</td>
</tr>
<tr>
<td>3</td>
<td>Moderate importance of one over another</td>
</tr>
<tr>
<td>5</td>
<td>Essential or strong importance</td>
</tr>
<tr>
<td>7</td>
<td>Demonstrated importance</td>
</tr>
<tr>
<td>9</td>
<td>Extreme importance</td>
</tr>
<tr>
<td>2,4,6,8</td>
<td>Intensities values between the two adjacent judgments</td>
</tr>
</tbody>
</table>

Table III.
Intensities of relative importance for pairwise comparison

<table>
<thead>
<tr>
<th>Rating</th>
<th>Weight obtained from relative comparison (local weight)</th>
<th>Weight divided by the highest value (ideal weight)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Always</td>
<td>0.513</td>
<td>1.000</td>
</tr>
<tr>
<td>Usually</td>
<td>0.261</td>
<td>0.509</td>
</tr>
<tr>
<td>Sometimes</td>
<td>0.129</td>
<td>0.251</td>
</tr>
<tr>
<td>Rarely</td>
<td>0.063</td>
<td>0.123</td>
</tr>
<tr>
<td>Never</td>
<td>0.033</td>
<td>0.064</td>
</tr>
</tbody>
</table>

Table IV.
Weights of intensities used in the AHP study
pairwise comparison should be limited to not more than nine (Saaty, 1980). Absolute measurement is, therefore, an appropriate means for rating the 13 safety management elements. The result of absolute measurement was then multiplied with the weights of the decision criteria as obtained in the first stage, and the consequent sum was the weight of the safety management element.

As group decision-making was used for the study, individual judgment resulted from the second stage were combined to produce the group judgment results, i.e. the overall weights of safety management elements. Geometric means of all individual judgments were then computed with the following formula to produce the group judgment (Saaty, 1989):

\[ A = \sqrt[N]{a_1 \times a_2 \times \cdots \times a_N} \]

where \( A \), combined judgment; \( N \), number of individual judgement; and \( a_1, a_2, \ldots, a_N \) is the individual judgement.

Weights of individual elements were then compared and became their respective priorities. Inconsistency ratios were calculated to verify the consistency of the comparison process. The computations and analysis of interview findings were made using computer software, Expert Choice™ (Expert Choice, 2002).

5. Analysis of results

5.1 Evaluation of decision criteria

The evaluators were requested to make pairwise comparisons of decision criteria. Local normalised weights of criteria and the inconsistency ratio of pairwise comparisons for each industry are given in Table V. It was found that factors vary among industries when motivating enterprises to attend safety and health performance. The rankings of decision criteria were identical for textiles and clothing industry and printing and publishing industry (Kendall’s \( W = 1.000; \chi^2 = 12.000; p = 0.062 \)). The top three criteria were “client requirement” “insurance company requirement” and “employee requirement”. For electronics industry, the most critical criterion was “employee safety and health” followed by “client requirement” and “cost-effectiveness”. The criteria ranking of this industry is different from that of the other two industries (Kendall’s \( W = 0.571; \chi^2 = 6.857; p = 0.334 \)). The criterion of “competence and expertise requirement” had the lowest or second lowest rank in all

<table>
<thead>
<tr>
<th>Decision criteria of SMS implementation</th>
<th>Textiles and clothing industry</th>
<th>Electronics industry</th>
<th>Printing and publishing industry</th>
</tr>
</thead>
<tbody>
<tr>
<td>Client requirement</td>
<td>0.276 (1)</td>
<td>0.228 (2)(^a)</td>
<td>0.230 (1)</td>
</tr>
<tr>
<td>Insurance company requirement</td>
<td>0.201 (2)</td>
<td>0.118 (4)</td>
<td>0.178 (2)</td>
</tr>
<tr>
<td>Employee requirement</td>
<td>0.130 (3)</td>
<td>0.045 (7)</td>
<td>0.166 (3)</td>
</tr>
<tr>
<td>Effect on production rate</td>
<td>0.126 (4)</td>
<td>0.116 (5)</td>
<td>0.112 (4)</td>
</tr>
<tr>
<td>Cost-effectiveness</td>
<td>0.091 (6)</td>
<td>0.175 (3)</td>
<td>0.107 (6)</td>
</tr>
<tr>
<td>Competence and expertise requirement</td>
<td>0.083 (7)</td>
<td>0.089 (6)</td>
<td>0.098 (7)</td>
</tr>
<tr>
<td>Employee safety and health</td>
<td>0.094 (5)</td>
<td>0.228 (1)(^a)</td>
<td>0.108 (5)</td>
</tr>
<tr>
<td>Inconsistency ratio</td>
<td>0.06</td>
<td>0.08</td>
<td>0.02</td>
</tr>
</tbody>
</table>

Notes: \(^a\)Priority of elements is reflected by the difference in later decimal places of the weights; figures in brackets represent the ranking of decision criteria.

Table V. Weights of decision criteria and inconsistency ratios obtained
three industries. Results showed that responses in the pairwise comparisons were consistent, as their inconsistency ratios were less than 0.10 (Saaty, 2000).

5.2 Assessment of safety management elements

The evaluators assessed the relative importance of a list of safety management elements against each of the seven criteria. It should be noted that the element of “evaluation, selection and control of sub-contractors” in FIUSMR was excluded from the study, as the measures suggested for this element were more specific for construction industries rather than manufacturing industries. The overall implementation priorities of individual elements then were determined by combining the element evaluation results against criteria. Those elements with greater implementation extent and better performance could have higher priority of implementation. Table VI shows the computed priorities of implementation of individual elements for three major manufacturing industries in Hong Kong, respectively. The Kendall’s coefficient of concordance shows that the degree of agreement of priorities for three industries is not high (Kendall’s $W = 0.554; \chi^2 = 19.956; p = 0.068$). The analysis of main findings, addressing the identification of core elements and safe person versus safe place elements, is elaborated in Table VI.

5.2.1 Determination of SMS fundamentals

Both “safety policy” and “safety organisation” had high ranks in textiles and clothing industry, because these two elements had higher weights than the others with respect to “client requirement” in the AHP evaluation. “Client requirement” was the top decision criterion which accounted for nearly 30 per cent of the total weight of implementation priority of elements for the industry. This was attributable to the fact that many customers from the USA and Europe would require suppliers to comply with their expectations about social responsibility, and they were increasingly concerned about the suppliers’ performance on the safety and health issues. As implementations of “safety organisation” and “safety policy” demonstrate an enterprise’s commitment to safeguarding workers’ safety that would have a positive impact on enterprise’s competitiveness in the marketplace. Nevertheless, a different finding recorded in electronics industry and printing and publishing industry where both “safety policy” and “safety organisation” did not receive high ranks. “Client requirements” for “safety policy” and “safety organisation” were not as frequent as that of textiles and clothing industry. A majority of Hong Kong’s electronics products were exported to the Mainland China, and printing products are largely for local consumptions. Results reflected that clients from these regions focus more on product quality than the safety and health performance of the suppliers.

5.2.2 Safe person elements vs safe place elements

“Safety training” “in-house safety rules” and “personal protection programme” had high ranks (i.e. the 1st to 5th) in three manufacturing industries. These results indicated that evaluators stressed performance measures on individual safety (i.e. safe person approach) including safety training, the use of safety rules and personal protective equipment. For maintaining their health and safety, employees requested the “safe person” elements more frequently than the “safe place” elements that focused on the control of hazards.

In this study, “job hazard analysis” “accident control and hazard elimination” and “inspection programme” were grouped as the “safe place” elements. They were not highly ranked, except the latter ranked fourth in the electronics industry. The results
<table>
<thead>
<tr>
<th>Rank</th>
<th>Element</th>
<th>Weight</th>
<th>Element</th>
<th>Weight</th>
<th>Element</th>
<th>Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Safety organization</td>
<td>0.475</td>
<td>Safety training</td>
<td>0.478</td>
<td>Personal protection programme</td>
<td>0.356</td>
</tr>
<tr>
<td>2</td>
<td>Safety policy</td>
<td>0.470</td>
<td>Personal protection programme</td>
<td>0.440</td>
<td>Emergency preparedness</td>
<td>0.327</td>
</tr>
<tr>
<td>3</td>
<td>Safety training</td>
<td>0.427</td>
<td>In-house safety rules</td>
<td>0.417</td>
<td>Safety training</td>
<td>0.323</td>
</tr>
<tr>
<td>4</td>
<td>In-house safety rules</td>
<td>0.427</td>
<td>Inspection programme</td>
<td>0.408</td>
<td>In-house safety rules</td>
<td>0.311</td>
</tr>
<tr>
<td>5</td>
<td>Personal protection programme</td>
<td>0.386</td>
<td>Emergency preparedness</td>
<td>0.379</td>
<td>Safety committee</td>
<td>0.302</td>
</tr>
<tr>
<td>6</td>
<td>Accident/incident investigation</td>
<td>0.386</td>
<td>Accident control and hazard elimination</td>
<td>0.353</td>
<td>Safety policy</td>
<td>0.300</td>
</tr>
<tr>
<td>7</td>
<td>Safety and health awareness</td>
<td>0.384</td>
<td>Safety policy</td>
<td>0.340</td>
<td>Safety and health awareness</td>
<td>0.297</td>
</tr>
<tr>
<td>8</td>
<td>Emergency preparedness</td>
<td>0.382</td>
<td>Accident/incident investigation</td>
<td>0.306</td>
<td>Occupational health assurance programme</td>
<td>0.280</td>
</tr>
<tr>
<td>9</td>
<td>Inspection programme</td>
<td>0.366</td>
<td>Job hazard analysis</td>
<td>0.300</td>
<td>Accident/incident investigation</td>
<td>0.261</td>
</tr>
<tr>
<td>10</td>
<td>Occupational health assurance programme</td>
<td>0.366</td>
<td>Occupational health assurance programme</td>
<td>0.266</td>
<td>Job hazard analysis</td>
<td>0.260</td>
</tr>
<tr>
<td>11</td>
<td>Safety committee</td>
<td>0.345</td>
<td>Safety and health awareness</td>
<td>0.244</td>
<td>Safety organization</td>
<td>0.259</td>
</tr>
<tr>
<td>12</td>
<td>Job hazard analysis</td>
<td>0.321</td>
<td>Safety committee</td>
<td>0.229</td>
<td>Inspection programme</td>
<td>0.249</td>
</tr>
<tr>
<td>13</td>
<td>Accident control and hazard elimination</td>
<td>0.315</td>
<td>Safety organization</td>
<td>0.219</td>
<td>Accident control and hazard elimination</td>
<td>0.247</td>
</tr>
</tbody>
</table>
showed that evaluators put lesser emphasis on the importance of hazards control and removal. There was a weaker link to SMS implementation with “safe place” characteristics as evidenced in the study. The element priorities indicated that many industry evaluators stressed safety management elements on individual concerns rather than those on hazardous sources and their removal. It should be noted that these findings reflected a diverted focus as compared to the findings of some recent studies. For instance, Bahr (1997) suggested that typical hazard reduction procedures would design out hazards prior to using special procedures and training for mitigating the hazard consequences. Gallagher (1997) also contended that “safe place” approach would be more effective in improving safety and health performance.

5.3 Advocates of a self-regulatory approach
Results showed that “safety policy” and “safety organisation” were the fundamentals for SMS implementation. Proprietor should formulate a safety policy that is relevant to the nature of the enterprise’s activities, to demonstrate the enterprise’s commitment, objectives and approach towards safety and health performance. After establishing the safety policy, safety organisation and safety committees, safety personnel could implement other safety management elements based on the implementation priority. Development of the SMS and its elements should be reviewed at regular intervals for evaluating their efficiency, effectiveness and reliability. A self-regulatory approach to implementing safety management elements is shown in Figure 2.

Nevertheless, lack of resources and relevant expertise was identified as one of the difficulties encountered by enterprises in fulfilling the requirements of the FIUSMR. Proprietors and safety personnel’s understanding on self-regulatory approach would be a critical factor for determining the effectiveness of SMS implementation. Misperception of this approach would result in a situation that manufacturing enterprises implemented SMS based entirely on the code of practice under the FIUSMR, rather than the safety and health needs of the enterprise. Inspecting and auditing safety performance should stress the flexibility and creativity of SMS

![Figure 2.](image-url)

A self-regulatory approach to implementing safety management elements

Keys:
- Sequence
- Feedback information
implementation. Safety inspectors and auditors should therefore not focus only on checking SMS documentation. The HKSAR Government should also provide appropriate SMS training to inspectors and auditors in order to ensure them having proper understanding on the self-regulatory approach to implementing safety management elements.

6. Conclusion
The HKSAR Government has been transforming its industrial safety strategy from the legislation enforcement approach to a safety management approach for tackling safety and health issues at work. The FIUSMR was enacted to facilitate this transformation. The findings of this study serve as a reference for facilitating management and decision makers in managing safety and health issues and making safety management decisions in their organisations. The FIUSMR's model of SMS implementation and the accompanied self-regulatory approach provides guidance for manufacturing enterprises to establish their SMS for managing and improving safety and health performance. The ultimate goal is to implement as far as possible the applicable safety management elements in order to maximise the effectiveness in improving safety and health performance. However, it is impractical to implement all or most elements concurrently, especially for the SMEs with limited resources. Therefore, the priority of implementation should be determined for manufacturing enterprises refocusing its resources on individual elements at a time.

Using the AHP methodology, safety personnel could evaluate the relative importance of individual decision criteria and safety management elements with respect to the corporate goals, resources and constraints of their respective organisations. It was found that among the top criteria were “client requirement” “insurance company requirement” and “employee requirement” for textile and clothing and printing and publishing industries. For electronics industry, the most critical criterion was “employee safety and health” “client requirement” and “cost-effectiveness”. Both “safety policy” and “safety organisation” were two most important elements for SMS implementation. Interestingly, industry evaluators also stressed safety management elements on individual concerns (e.g. safety training, safety rules and personal protection programme) rather than those on hazardous sources and their removal (e.g. job hazard analysis and accident control and hazard elimination programme).

The hierarchy decision model presented in this paper was established for prioritising safety management elements for manufacturing industries. It enables manufacturing enterprises to determine decision criteria and safety management elements in the design, establishment and implementation of their SMS. Manufacturing enterprises can determine the importance of the criteria and rate each element with intensities. As elements are rated independently in absolute measurement, the decision model enables decision maker to introduce new elements or delete old elements without affecting the weights of existing elements in the prioritisation. Future research could validate the applicability of the hierarchy decision model in large enterprises and SMEs, separately and collectively. In order to reveal sector-specific characteristics, comparative evaluations of decision criteria and safety management elements should be conducted across various manufacturing industry sectors. Case studies are suggested to investigate the detailed SMS processes and their implementation.
determinants in manufacturing enterprises. Organisational safety culture and the
safety performance measurement issues are also areas for further study. Moreover, the
future research findings can be enhanced through improvements in the acquisition of
timely and properly processed data, the methodologies and techniques used to elicit
empirical information and subjective judgements.

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Further reading


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