

SUSTAINABLE MANUFACTURING PERFORMANCE EVALUATION TOOL
FOR AUTOMOTIVE COMPANIES

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Dedicated with love and gratitude to my beloved mother, late father,
brothers, sisters, and son.

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ABSTRACT

In response to the growing sustainability concerns, manufacturing companies have to formulate a set of measures to evaluate sustainable manufacturing performance, aimed at integration of sustainability aspects. Sustainability is generally evaluated by dimensions of environment, economic, and social, known as the triple bottom line (TBL) of sustainability. However, while the literature on sustainability is rapidly growing, only few studies have attempted to integrate sustainability into manufacturing performance evaluation. There is also no consensus yet on a standard set of sustainable manufacturing performance measures. This study aims to integrate sustainability into manufacturing performance by incorporating manufacturing performance measures with sustainable manufacturing measures. As a result, a set of initial measures for sustainable manufacturing performance evaluation believed to be suitable for automotive companies have been proposed, consisting of three factors divided into nine dimensions and a total of 41 subdimensions. In order to validate the initial measures with industry practices, a survey was conducted on the automotive companies in Malaysia. It was found that all the initial measures are highly important and thus proposed as the key measures of sustainable manufacturing performance evaluation for automotive companies. A sustainable manufacturing performance evaluation tool for automotive companies was then developed using a hybrid Multi Criteria Decision Making (MCDM) technique. Interpretive Structural Modeling (ISM) methodology was applied to determine the structural relationships and inter-relationships amongst all the performance measures and Analytic Network Process (ANP) methodology was employed to determine the important weights of each of the performance measures by summarizing the opinions of the experts. While the tool provides a systematic approach for quantitative assessment of sustainable manufacturing performance, it is not entirely automated. Thus, for that purpose, a software-based tool named SUSMAP was subsequently developed using PHP and MySQL. Two case studies have been conducted to validate the tool. Results from the case studies suggested that the SUSMAP is easy to use and applicable to evaluate sustainable manufacturing performance in automotive companies. The tool can be used by companies for self-assessment as well as benchmarking. It shows the existing performance level on strengths and weaknesses, and where improvements need to be made. It is hoped that the proposed sustainable manufacturing performance measures and the associated SUSMAP tool can aid the automotive companies to achieve successful implementation of sustainable manufacturing so as to compete in a much more sustainable manner.

ABSTRAK

Dalam tindak balas kepada keperihatinan kelestarian yang semakin meningkat, syarikat perkilangan perlu membentuk satu set ukuran untuk menilai prestasi kelestarian perkilangan, yang bertujuan untuk mengintegrasikan aspek kelestarian. Kestarian umumnya dinilai oleh dimensi alam sekitar, ekonomi, dan sosial, yang dikenali sebagai garis bawah berganda tiga (TBL) daripada kelestarian. Walau bagaimanapun, sementara literatur tentang kelestarian berkembang pesat, hanya sedikit kajian yang berusaha untuk mengintegrasikan kelestarian ke dalam penilaian prestasi perkilangan. Masih tidak terdapat persetujuan kepada satu set ukuran prestasi kelestarian perkilangan yang standard. Kajian ini bertujuan untuk mengintegrasikan kelestarian ke dalam prestasi perkilangan dengan menggabungkan ukuran prestasi perkilangan dengan ukuran kelestarian perkilangan. Hasilnya, satu set ukuran awal untuk penilaian prestasi kelestarian perkilangan yang dipercayai sesuai untuk syarikat automotif telah dicadangkan, yang terdiri daripada tiga faktor yang dibahagi menjadi sembilan dimensi dan sejumlah 41 subdimensi. Untuk mengesahkan ukuran awal tersebut dengan amalan industri, satu kajian soal selidik dijalankan di syarikat automotif di Malaysia. Didapati semua ukuran awal adalah sangat penting dan oleh kerana itu dicadangkan sebagai ukuran utama untuk penilaian prestasi kelestarian perkilangan bagi syarikat automotif. Satu alat bagi penilaian prestasi kelestarian perkilangan untuk syarikat automotif telah dibangunkan dengan menggunakan satu teknik hibrid pengambilan keputusan multi kriteria (MCDM). Kaedah permodelan struktur berinterpretif (ISM) telah diaplikasikan untuk menentukan hubungan struktur dan hubungan timbal balik diantara semua ukuran prestasi dan kaedah proses rangkaian analitik (ANP) telah digunakan untuk menentukan pemberat kepentingan untuk setiap ukuran prestasi dengan merumuskan pendapat dari pakar. Walaupun alat ini menyediakan suatu pendekatan sistematik untuk penentuan kuantitatif prestasi kelestarian perkilangan, namun ia tidak sepenuhnya automatik. Oleh itu, satu perisian berdasarkan alat ini yang dinamakan SUSMAP telah dibangunkan dengan menggunakan PHP dan MySQL. Dua kajian kes telah dijalankan untuk mengesahkan alat ini. Keputusan daripada kajian kes ini mencadangkan SUSMAP adalah mudah digunakan dan terpakai untuk menilai prestasi kelestarian perkilangan dalam syarikat automotif. Alat ini boleh digunakan oleh syarikat untuk penilaian diri serta ukur rujuk. Alat ini menunjukkan tahap prestasi yang ada atas kekuatan dan kelemahan, dan dimana pembaharuan perlu dilakukan. Diharapkan ukuran prestasi kelestarian perkilangan yang dicadangkan dan kaitannya dengan alat SUSMAP dapat membantu syarikat automotif untuk mencapai kejayaan dalam pelaksanaan kelestarian perkilangan sehingga mampu bersaing dalam keadaan yang lebih lestari.