A PROTOTYPE OF KNOWLEDGE BASED FUZZY ANALYTIC NETWORK PROCESS SYSTEM FOR SUSTAINABLE MANUFACTURING INDICATOR

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Abstrak

Sektor pembuatan lestari merupakan paradigma pembuatan yang masih baharu namun paling kompleks. Kekompleksan ini wujud kerana paradigma ini merangkumi tiga aspek kelestarian yang saling bergantung iaitu ekonomi, alam sekitar dan sosial. Dalam memulakan usaha pembuatan lestari, pembentukan indikator merupakan perkara yang perlu diberi perhatian berbanding perkara lain. Malangnya, indikator sedia ada mempunyai beberapa kelemahan yang mungkin menghad ketepatan penilaian prestasi kelestarian sesebuah organisasi. Sementelah, hanya terdapat sebilangan kecil mekanisme indikator piawai yang mampu untuk menangani keperluan spesifik pelbagai organisasi pembuatan. Sehubungan itu, kajian ini mencadangkan Sistem Proses Rangkaian Analitik Kabur Berasaskan Pengetahuan (KBFANP) yang baharu, dan mampu untuk membantu proses pembuatan keputusan dalam pengurusan pembuatan lestari dengan membangunkan satu mekanisme indikator. Sistem KBFANP ini mengandungi empat fasa utama iaitu Pendahuluan, Pemilihan, Penilaian dan Pengutamaan. Sistem ini menyatukan kelebihan Sistem Berasaskan Pengetahuan, Teori Set Kabur dan Proses Rangkaian Analitik sebagai satu kaedah gabungan indikator piawai yang dapat digunakan dalam semua jenis konteks permasalahan. Satu prototaip Sistem KBFANP telah dibina, diuji dan dianalisis ke atas tiga set data eksperimen dan dua persekitaran pembuatan sebenar. Sistem ini mampu memberi penyelesaian terhadap bahagian yang perlu ditambah baik pada tahap keutamaan yang berbeza-beza. Kajian ini juga menyokong idea pembuatan langsing dan pembuatan hijau sebagai teras dalam pelaksanaan pembuatan lestari. Sistem KBFANP yang dicadangkan boleh bertindak sebagai Sistem Sokongan Keputusan penasihatan yang mampu memberi manfaat kepada ahli akademik dan pengamal industri.

Kata kunci: Indikator pembuatan lestari, Sistem berasaskan pengetahuan, Proses rangkaian analitik kabur

Abstract

Sustainable manufacturing is a relatively new but a very complex manufacturing paradigm. The complexity arises as this paradigm covers three interdependent yet mutually supporting sustainability dimensions of economic, environmental and social. In a further step to embark on the essence of sustainable manufacturing, the development of appropriate indicators needs to be emphasized as compared to other efforts. Regrettably, the existing indicators have several drawbacks that may hamper the accuracy of sustainability performance assessment of an organization. As such, there are only a few standardized indicator mechanisms which can suit specific requirements of various manufacturing organizations. Hence, this study suggests a novel Knowledge-Based Fuzzy Analytic Network Process (KBFANP) system which can assist the decision making process of sustainable manufacturing by developing a new indicator mechanism. The KBFANP system comprises of four major phases, namely Initialization, Selection, Evaluation and Prioritization. The system incorporates the advantages of Knowledge-Based System Fuzzy Set Theory and Analytic Network Process into a single unified approach as a standardized indicator, which is applicable to all types of problem setting. A prototype of KBFANP system was developed, tested and analyzed on three experimental data sets and two real manufacturing settings. The system was able to provide solutions on the areas that need improvement with different levels of priority. This study also supports the notion of lean and green manufacturing as the elementary foundation of sustainable manufacturing implementation. The proposed KBFANP system can act as an advisory Decision Support System which is beneficial to both academia and industrial practitioners.

Keywords: Sustainable manufacturing indicator, Knowledge-based system, Fuzzy analytic network process

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List of Abbreviations

ACO	Ant Colony Optimization
AHP	Analytic Hierarchy Process
AI	Artificial Intelligence
ANN	Artificial Neural Network
ANP	Analytic Network Process
CBR	Case Based Reasoning
CI	Computational Intelligence
DEA	Data Envelopment Analysis
DJSI	Dow Jones Sustainability Index
ELECTRE	ELimination Et Choix Traduisant la REalité - ELimination and Choice Expressing Reality
EMS	Environmental Management System
EPA	Environmental Protection Agency
EPI	Environmental Performance Index
ES	Expert System
FAHP	Fuzzy Analytic Hierarchy Process
FANP	Fuzzy Analytic Network Process
FKBS	Fuzzy Knowledge Based System
FLSP	Fuzzy Least Squares Priority
FLLS	Fuzzy Logarithmic Least Squares
FPP	Fuzzy Preference Programming
FMCDM	Fuzzy Multi Criteria Decision Making
FRGS	Fundamental Research Grant Scheme
FST	Fuzzy Sets Theory
GA	Genetic Algorithm
GhG	Greenhouse gas emission
GMM	Green Manufacturing Management
GRI	Global Reporting Initiative
IEA	International Energy Agency
IS	Intelligent System

ISP	Indicators of Sustainable Production
JIT	Just in Time
KBFANP	Knowledge Based Fuzzy Analytic Network Process
KETTHA	Kementerian Tenaga, Teknologi Hijau Dan Air
KPI	Key Performance Index
KBS	Knowledge Based System
LCA	Life Cycle Assessment
LCSP	Lowell Centre for Sustainable Production
LMM	Lean Manufacturing Management
LP	Linear Programming
MADM	Multi Attribute Decision Making
MCDM	Multi Criteria Decision Making
MODM	Multi Objective Decision Making
MOHE	Ministry of Higher Education
NN	Neural Network
OECD	Organization for Economic Co-operation and Development
OEE	Overall Equipment Effectiveness
PDCA	Plan, Do, Check, Act
PDSA	Plan, Do, Study, Act
QFD	Quality Function Deployment
QMS	Quality Management System
SA	Simulated Annealing
SOP	Standard of Practice
SWOT	Strength, Weakness, Opportunities, Threats
TOPSIS	Technique for Order Preference by Similarity to Ideal Solution
TPS	Toyota Production System
UN	United Nations
UNEP	United Nations Environment Programme
UNESCO	United Nations Educational, Scientific and Cultural Organization
VSM	Value Stream Mapping

CHAPTER ONE
INTRODUCTION

At the exact time when this thesis first sentence is being written, the total number of the current world population is 7,201,815,103 and keeps on growing at the current rate of 1.14% (Worldometers, 2013). Based on the latest United Nation (UN) projection, a continued increase in population in the future is anticipated as shown in Figure 1.1. Although there exist a steady decline in the population growth rate, the global population is still expected to reach between 8.3 and 10.9 billion by the year 2050 (UN, 2013). At a glance, this figure means nothing if we look this as a single variable. However, it means a global catastrophe if we considered it with the trending issues of scarcity of non-renewable natural resources, emerging natural environment health problems of climate change, increasing energy security and potential global famine (OECD, 2008).

Scientists have debated that current global population expansion and resource consumption increment will indeed threatened the world's economy as well as ecosystem (Nature, 2009). Nevertheless, the existing environmental problems, such as rising levels of greenhouse gas (GhG) emissions, global warming, and various types of pollution, are being further provoked by the population expansion matter (Desonie, 2008). In addition, several experts claimed that overpopulation's real casualty is our environment which as a matter of fact is not true in some point of view because human,

The contents of the thesis is for internal user only

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