THE ENHANCED MODEL OF HYPERLEDGER COMPOSER SUPPLY CHAIN (HCSC) FOR THE PRODUCT ENVIRONMENTAL IN SUPPLY CHAIN NETWORKS

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I hereby declare that the work in this thesis is based on my original work except for quotations and citations which have been duly acknowledged. I also declare that it has not been previously or concurrently submitted for any other degree at Universiti Malaysia Pahang or any other institutions.

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ABSTRAK

Teknologi Blockchain telah mendapat perhatian yang semakin meluas sejak beberapa tahun ini. Akhir-akhir ini, banyak model berasaskan Blockchain telah dicadangkan untuk menambah baik isu ketelusan yang lemah dalam rantaian bekalan. Walau bagaimanapun, disebabkan oleh pembangunan dan kerumitan operasi rantaian bekalan dalam beberapa tahun kebelakangan ini, ketelusan yang lemah masih menjadi salah satu cabaran utama yang merendahkan prestasi rantaian bekalan. Model Blockchain yang sedia ada mempunyai Batasan yang utama dalam sifat ukuran keterlihatan biasa (VMP): perkongsian maklumat, kebolehkesanan dan keterlihatan inventori seperti kekurangan mengenal pasti sifat persekitaran produk untuk mengenal pasti produk hijau. Masih terdapat keadaan untuk membuang masa dalam sistem kebolehkesanan semasa. Model yang sedia ad aini hanya berkongsi maklumat inventori asas iaitu tahap inventori, ramalan permintaan. Model HCSC ialah salah satu model berasaskan Blockchain yang penting menangani perkongsian maklumat dan kebolehkesanan, walau bagaimanapun, terdapat kekurangan mengenal pasti sifat persekitaran produk untuk mengenal pasti produk hijau. Kekurangan masa untuk pengesanan kelompok produk suhu penyimpanan dan produk tamat tempoh. Kurang keterlihatan inventori dengan kos inventori yang lebih rendah dengan memodelkan stok keselamatan dan titik pesanan semula. Kajian ini mencadangkan model Stok Pesanan Produk Rantaian Bekalan Hyperledger (HCSC-POS) berdasarkan model HCSC yang dianggap untuk berkongsi produk kelestarian alam sekitar dalam rangkaian Blockchain untuk mengenal pasti produk hijau agar dapat mengawal kesan alam sekitar daripada pengeluaran dan meningkatkan kemampanan alam sekitar. Model yang dicadangkan dapat meningkatkan kebolehkesanan proses pengesanan kelompok bagi suhu produk penyimpanan suhu dan produk tamat tempoh, dan memanggil semula pesanan yang rosak dengan pantas untuk mengurangkan penggunaan masa dalam penarikan semula produk. Tambahan pula, keterlihatan inventori dengan kos inventori yang lebih rendah dengan memodelkan stok keselamatan dan titik pesanan semula. Pembangunan model yang dicadangkan terdiri daripada tiga langkah utama: 1-Memperluaskan model data HCSC, 2- Membangunkan peningkatan dalam rangka kerja Komposer Hyperledger Blockchain, dan 3-Menguji peningkatan yang dicadangkan dalam persekitaran masa jalan pelaksanaan Hyperledger Composer. Untuk menilai model yang dicadangkan, senario ujian eksperimen dijalankan untuk menilai kebolehkesanan dan peningkatan keterlihatan inventori dari segi keberkesanan dan kecekapan masa menggunakan data industri sebenar daripada industri pembuatan. Keputusan menunjukkan kebolehcapaian dan ketersediaan produk memberi kesan kelestarian alam sekitar dengan label "produk mesra alam" dalam rangkaian blockchain. Model ini meningkatkan kebolehkesanan kelompok dengan penggunaan masa yang lebih sedikit dengan purata 89.47% lebih baik daripada model sedia ada lain dalam respons masa. Dalam keterlihatan inventori, kecekapan model HCSC-POS dalam pengurangan kos inventori adalah 60.48 % lebih baik daripada model lain. Keputusan menunjukkan beberapa kelebihan daya saing industri rantaian bekalan dari segi kemampanan alam sekitar, kebolehkesanan kelompok yang cepat, dan peningkatan keterlihatan inventori dengan kos inventori yang lebih rendah dengan memodelkan stok keselamatan dan titik pesanan semula. Keterlihatan hujung ke hujung ini membantu dalam proses membuat keputusan perniagaan yang tepat dan meningkatkan prestasi rantaian bekalan

ABSTRACT

Blockchain technology has received growing attention over the years. Recently, many blockchain-based models have been proposed to improve the issues of poor visibility in supply chains. However, due to the expansions and complexity in the operations of supply chains in the last few years, poor visibility is still one of the major challenges that lower the performance of supply chains. Besides, the existing blockchain models have key limitations in the common visibility measurements properties (VMP): information sharing, traceability, and inventory visibility such as a lack of identifying products based on environmental attributes to identify the green products. Still, there is a need to eliminate the time consumption in the current traceability systems. Current models share basic inventory information including inventory level and demand forecasts. Model HCSC is one of the important blockchain-based models that addressed information sharing and traceability; however, it lacks a feature of identifying product environmental attributes to know the green products, lacks a fast batch tracking of product storage temperature and expired products, and lacks visibility of inventory with less inventory cost by modelling safety stock and reorder points. Thus, this study proposes a Hyperledger composer supply chain products orders Stock (HCSC-POS) model based on the HCSC model to share product environmental sustainability attributes to the blockchain network in the identification of green products to control the environmental impact of production and improve the environmental sustainability. The proposed model enhances traceability by fast batch tracking of the product storage temperature and expired products for fast identification and recalling defective orders to reduce time consumption in product recalls. Additionally, it enhances the visibility of inventory with less cost by modelling safety stock and reorder points. The development of the proposed model consists of three main steps: 1-Extending the HCSC data model, 2- Developing the enhancements of the Blockchain Hyperledger Composer framework, and 3-Testing the proposed enhancements in the Hyperledger Composer execution runtime environment. To evaluate the proposed model, experimental test scenarios were conducted to evaluate traceability and inventory visibility enhancements in terms of time effectiveness and efficiency using real industry data from the manufacturing industry. The results show accessibility and availability of product environmental sustainability attributes with “environmentally friendly product” labels in the blockchain network. The model enhances the traceability of batches with less consumption time of about 89.47% better than other existing models in time responsiveness. In the inventory visibility, model HCSC-POS efficiency in terms of inventory costs showed about 60.48% reduction which was better than other models. These results offer the supply chain industry a competitive advantage in terms of environmental sustainability, fast batch traceability, and increased inventory visibility with less inventory cost by modelling safety stock and reorder points. This end-to-end visibility helps in the accurate business decision-making process and improves supply chain performance.

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LIST OF ABBREVIATIONS

BCT	Blockchain Technology
SC	Supply Chain
HCSC-POS	Hyperledger Composer Supply Chain – Product, Order, Stock
HCSC	Hyperledger Composer Supply Chain
SCM	Supply Chain Management
IBM	The International Business Machines Corporation
VMP	Visibility measurement properties: information sharing, traceability, and inventory visibility
CSCMP	Council of SC Management Professionals
WEF	World Economic Forum
SCP	Supply Chain Performance
SCOR	Supply Chain Operations Reference
SCV	Supply Chain Visibility
DSC	Digital Supply Chain
P2P	Peer-to-peer communication network
RFID	Radio-frequency identification
BNA	Business Network Archive
POC	Proof of concept
RIM	Reference Integrity Metric
IV	Inventory Visibility
ACL	Access Control File
PO	Purchase Order
EPA	The United States Environmental Protection Agency

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