Analisis Limbah Konstruksi pada Pekerjaan Struktur Bangunan Gedung dengan Pendekatan Modifikasi Value Stream Mapping (Studi Kasus: Proyek Gedung Rumah Sakit X) = Analysis of Construction Waste on Structure Work in High Building with Extended Value Stream Mapping (Case Study: X Hospital Building Project)

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Abstrak

Industri konstruksi merupakan pengonsumsi bahan baku material terbesar di antara industri lain. Sedangkan, pelaksanaannya masih tertinggal dalam hal efisiensi, sehingga masih banyak terjadi pemborosan pada pekerjaan konstruksi. Tujuan dari penelitian ini yakni mengidentifikasi pemborosan pekerjaan dan limbah lingkungan yang muncul pada proses produksi kolom struktur bangunan gedung rumah sakit menggunakan metode Value Stream Mapping yang sudah dimodifikasi, menganalisis penyebab terjadinya pemborosan dan timbulan limbah menggunakan Value Stream Analysis Tools dan Fishbone Diagram, serta memberikan rekomendasi tindakan pencegahan dan perbaikan untuk mengurangi pemborosan dan limbah yang dihasilkan.

Untuk mengidentifikasi pemborosan pekerjaan, penulis mengambil data pengamatan di lapangan berdasarkan indikator Value Stream Mapping, tepatnya pada pekerjaan kolom struktur, yakni proses perakitan besi, pemasangan besi, bekisting, pengecoran, dan bongkar bekisting serta memberikan lembar kuesioner mengenai peringkat keterjadian pemborosan kepada pihak proyek terkait. Penelitian dilakukan dengan lima tahap, yaitu identifikasi pemborosan dan limbah pada proses produksi menggunakan Value Stream Mapping, penentuan jenis pemborosan terbesar dan alat Value Stream Analysis menggunakan kuesioner pembobotan metode Borda, menganalisis pemborosan yang terjadi menggunakan Process Activity Mapping, menentukan penyebab terjadinya pemborosan dan limbah menggunakan Fishbone Diagram, serta memberikan rekomendasi tindakan perbaikan.

Penelitian ini memperoleh hasil persentase pekerjaan yang memberikan nilai tambah bagi produk (VA) sebesar 15,24%, pekerjaan yang tidak memberikan nilai tambah (NVA) sebesar 13,21%, dan pekerjaan yang tidak memberikan nilai tambah namun diperlukan (NVAN) sebesar 71,55% pada satu siklus produksi kolom. Adanya pemborosan juga ditunjukkan dengan indikator index kontributif kerja (CWI), persentase waktu persiapan (STP), persentase durasi operasional (UTP), dan persentase aktivitas yang menambah nilai (VAP) pada masing-masing proses. Pemborosan bahan bakar juga teridentifikasi sebesar 53,45% dari durasi penggunaan mesin concrete pump.

Berdasarkan kuesioner dan analisis Process Activity Mapping, aktivitas yang teridentifikasi sebagai pemborosan yang terjadi di lapangan yaitu Delay/Waiting sebanyak 19,15% dan Transportation sebanyak 12,77% dari keseluruhan aktivitas. Sedangkan limbah yang dihasilkan selama proses berupa logam sebesar 31,12 kg/m3, kayu sebesar 22,377 kg/m3, dan beton sebesar 0,23 m3. Selain limbah, diperoleh juga konsumsi energi listrik setiap proses dengan total 20.370,4 Watthour.

Penyebab utama terjadinya Delay/Waiting yakni ketidakseimbangan beban produksi antar proses, pekerja banyak menganggur, dan waktu persiapan alat. Sedangkan Transportation disebabkan oleh keterbatasan kapasitas Tower Crane, kurangnya koordinasi antar pekerja, material menumpuk, dan jarak stasiun kerja yang berjauhan. Limbah material yang dihasilkan selama proses disebabkan oleh ketiadaan metode kerja yang memperhatikan efisiensi penggunaan material, budaya pekerja boros, kurangnya pengawasan pekerja, dan pekerjaan yang dipercepat untuk mengejar target (crashing).

Rekomendasi pencegahan dan perbaikan berdasarkan metode lean, green, dan sustainable construction pada Delay/Waiting adalah mengimplementasikan analisis Setup Time Reduction atau pengurangan durasi persiapan, melakukan standarisasi kerja yang telah dianalisis VA, NVA, dan NVAN dan diimplementasikan oleh pekerja, dan meningkatkan pengawasan pekerja di lapangan. Untuk Transportation, rekomendasi pencegahan yang dapat dilakukan ialah menumbuhkan budaya kaizen dan kaikaku pada pekerja untuk menemukan inovasi pemindahan material yang lebih cepat dan minim tenaga manusia, melakukan analisis Site Layout untuk mendekatkan jarak penyimpanan dengan lokasi pekerjaan, dan mengimplementasikan 5R atau Visual Work Place agar material tidak menumpuk di area proyek. Sedangkan limbah material yang dihasilkan mendapat rekomendasi berikut: melakukan standarisasi kerja dan sosialisasi terhadap metode kerja yang ekonomis dan efisien terhadap material, merancang petunjuk gambar kerja berbasis keberlanjutan pada tahap desain, melakukan pengumpulan, pengklasifikasian, dan pendauran ulang limbah konstruksi yang dihasilkan, dan bekerja sama serta mengevaluasi pemasok dan subkontraktor terhadap limbah yang dihasilkan selama proses produksi.
.....The construction industry is the largest raw materials consumer among other industries. Nevertheless, its implementation is still left behind in terms of efficiency, there is still plenty of waste in construction work. The objectives of this study are to identify performance and environmental waste that appears along the production processes of hospital building’s structure columns using the modified Value Stream Mapping method, to analyze the roots of performance and environmental waste using Value Stream Analysis Tools and Fishbone Diagram, and to provide preventive and corrective recommendations to reduce waste.

To identify performance waste, the author took observational data in the field based on the Value Stream Mapping indicator, specifically on structural column work, namely the process of iron fabrication, installation, formwork, casting, and formwork disassembly, and provided a questionnaire regarding the ranking of the occurrence of waste to the related project parties. The research was carried out in five stages, namely identification of performance waste and environmental waste in the production process using Value Stream Mapping, determining the largest type of waste and the Value Stream Analysis Tools using a weighting questionnaire using the Borda method, analyzing the waste that occurs using Process Activity Mapping, determining the causes of waste and waste using Fishbone Diagram, and provide recommendations for preventive and corrective action.

This study shows the percentage of jobs that grant added value to the product (VA) of 15.24%, jobs that do not grant added value (NVA) of 13.21%, and jobs that do not grant added value but are necessary (NVAN) of 71.55% in one column production cycle. The existence of waste is also proved by indicators such as the Work Contributive Index (CWI), Set-Up Time Percentage (STP), Up Time Percentage (UTP), and Value

Adding Percentage (VAP) to each process. Fuel wastage was also identified at 53.45% of the duration of using the concrete pump machine.

Based on the questionnaire and Process Activity Mapping analysis, the activities that are identified as waste that occurred in the field were Delay/Waiting as much as 19.15% and Transportation as much as 12.77% of all activities. While the environmental waste during the process was in the form of 31.12 kg/m3 metal, 22.377 kg/m3 wood, and 0.23 m3 concrete. In addition, the electricity consumption was also obtained for each process with a total of 20,370.4 Watthours.

Delayed time happens because there is an unbalanced production load between processes, unoccupied workers, and relatively-long tool preparation time. While the Transportation waste is caused by the limited capacity of Tower Crane, the lack of coordination between workers, excessive raw materials, and the far apart distance between their workstations. The absence of work methods that focuses on the efficiency of material use, wasteful habits among workers, supervision deficiency, and project acceleration to catch up with targets (Crashing) are the main reasons why environmental waste has resulted.

Based on lean, green, and sustainable construction methods, preventive and corrective recommendations for Delay/Waiting are by implementing Setup Time Reduction analysis or reducing preparation time, creating a standardized work frame that has been analyzed by VA, NVA, and NVAN that will be implemented by workers, and rising supervision. Preventive recommendations that can be carried out for Transportation waste are by cultivating a culture of Kaizen and Kaikaku for workers to find innovations to move materials faster and with less manpower, performing a Site Layout analysis to bring storage distance closer to the work location, and implementing 5R or Visual Workplace so that materials do not accumulate in the certain project area. While the material waste produced received the following recommendations, such as carrying out standardization of work and socialization of work methods that are economical and efficient for materials, designing a shop drawing based on sustainability from the design stage, collecting, classifying, and recycling environmental waste, and working together as well as evaluating suppliers and subcontractors for waste generated during the production process.