BATTERY TRANSPORT OPTIMIZATION BY A VEHICLE MANUFACTURER IN THAILAND

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ABSTRACT

This study is about battery transportation by a Vehicle Manufacturer that was found to have inefficient space utilization in the truck container. This problem negatively affected the company's profit and opportunity. Therefore, the use of GRASP (Greedy Randomized Adaptive Search Procedure) is proposed to minimize the problem substantially. In this research, a Vehicle Manufacturer focuses on its battery exports, which are transported by commercial vehicles. Data was collected by interviewing personnel, observing actual operations, and analyzing historical data. The result showed that a container truck utilized only 68% of its space. This impacted two areas: a high number of transportation trips, and high transportation cost. The conceptual framework of the research is to find the causes of the battery transportation problem as well as to implement GRASP methodology as a solution. GRASP methodology is a heuristics approach to allocating the right space. This methodology is widely applied in vessel container businesses, and can be useful in related fields such as truck containers. The objective of this research is to build a significant tool to enhance space utilization for loading batteries. The result indicates that the proposed solution can be accomplished and solve space utilization. According to this research, the company should implement a tower rack to stack batteries on pallets, and change the truck size from six wheels to ten wheels. These changes will provide cost saving, customer satisfaction, and collaboration, which increases the focus firm's competitiveness in the industry.

บทคัดย่อ

งานวิจัยนี้เพื่อศึกษาบริษัทผู้ผลิตรถยนต์ ที่ประสบปัญหาการขนส่งชิ้นส่วนแบตเตอรี่ที่นำมาประกอบในรถยนต์ส่งออก โดยปัญหาที่เกิดขึ้นคือการจัดการพื้นที่ในตู้คอนเทนเนอร์ได้อย่างไม่เต็มประสิทธิภาพ ซึ่งข้อมูลที่ได้นั้นคือจากการสัมภาษณ์, การปฏิบัติงานจริงในการขนส่งแบตเตอรี่ และการใช้ประวัติข้อมูลจากปี 2558 จึงทำให้ทราบถึงปัญหาว่าปัจจุบันบริษัทฯ ใช้กำลังการขนส่งของรถบรรทุกได้เพียง 68% ซึ่งส่งผล

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ให้เกิดการเพิ่มจำนวนรอบการขนส่ง ตลอดจนค่าขนส่งที่สูงขึ้นตามลำดับ ดังนั้นจึงเป็นกรณีศึกษาตัวอย่างในการหาวิธีที่จะแก้ไขปัญหาดังกล่าวโดยศึกษาทั้งจากการขนส่งแบตเตอรี่ในอุตสาหกรรมเดียวกันและทฤษฎีการจัดการพื้นที่ในตู้คอนเทนเนอร์แล้วนั้น จึงสรุปได้ว่า GRASP คือวิธีการที่สามารถจัดการพื้นที่ได้อย่างเหมาะสมและเกิดประสิทธิภาพอย่างสูงสุด ดังนั้นจึงเป็นวิธีการที่สามารถนำมาประยุกต์ใช้ในการจัดการพื้นที่ในตู้คอนเทนเนอร์ให้สัมพันธ์กับกำลังการขนส่งของรถบรรทุก ประกอบกับการสร้าง tower rack และ เปลี่ยนประเภทรถบรรทุกจาก 6 ล้อเป็น 10 ล้อ ทั้งนี้ตัวชี้วัดประสิทธิภาพในงานวิจัยนี้ คือ จำนวนแบตเตอรี่ในการส่ง ความสัมพันธ์ของประเภทรถบรรทุกกับประสิทธิภาพในการขนส่ง และ ค่าขนส่งแบตเตอรี่ เพื่อประเมินถึงความสามารถในการลดค่าขนส่ง ความพึงพอใจจากลูกค้า และความร่วมมือที่ทำให้เพิ่มความสามารถในการแข่งขันในอุตสาหกรรม

INTRODUCTION

Nowadays, automotive manufacturers are rationalizing their supply base, defining new supply requirements, and increasing their outsourcing as a strategic alternative. In response, the automotive supply industry is experiencing consolidation and restructuring by creating tier suppliers along with third party logistics service providers. This provides challenges and opportunities for an automotive company in terms of cost and time. In regards to automotive supply chains, road transportation is a significant area which creates cost to the company. Thus, automotive manufacturers select outsourcing to achieve cost savings. Therefore, vehicle-fill is a key level in optimizing the use of transport by using all available vehicle load weight and space. This needs consideration of balance weight limitation, operator’s experience, type of road transportation, and different product types, so as to enhance utilization value and competitiveness in the long run.

Statement of the Problems

This Vehicle Manufacturer is a global automotive company which was established in Thailand in 1966. This research is focused on battery transportation: batteries are an essential part in every vehicle. Nowadays, batteries for domestic vehicles are purchased from four well-known brand companies in the market such as 3K, GS, Panasonic, and FB. Otherwise, batteries for export vehicles are purchased from FB only. As to transportation, this Vehicle Manufacturer has a contract with a private transport company whic provides transporting and warehousing. The trucks used in transportation are owned by the transport company. This Vehicle Manufacturer acts as the operation controller of both the battery supplier and the transport company, aside from paying for the transport cost. In battery transportation, there are obvious problems such as container space utilization, and loading/unloading the trucks. These problems usually bring high transportation costs.

This research begins with a review of batteries for export vehicles. Export volume had dramatically increased by 25%, from 81,143 units to 101,191 units, from 2004 to 2005. This is a case study of high volume purchase, with subsequent high cost saving after the implementation of the solution.

LITERATURE REVIEW

Vehicle Fills in Transport Optimization

Overall supply chain optimization is an elusive yet attainable goal for an organization, but different characteristics and operations drive a different business direction in supply chains. Currently, lack of specification and unit load design criteria are limiting transport efficiency in terms of vehicle utilization. ECR Europe (2007) explained key improvement areas to solve this problem. "Vehicle fill" is a key improvement for truck loading because it is a critical factor in realizing transport utilization in available loading weight and volume (cubic capacity). The available weight per vehicle is a factor of maximum vehicle weight and empty vehicle weight. The available cube per vehicle is defined by physical dimensions with fixed equipment and transport items to fit in the space available. Transport items such as pallets and racks are usually maximizing mechanisms in vehicle loading and they also minimize risks of product damage. To achieve vehicle fill, the items need density fulfillment, weight, and volume balance that match with vehicle capacity represented by efficient lead time, quality, and cost.

Greedy Randomized Adaptive Search Procedure (GRASP)

Festa and Resende (2002) introduced the generic model of GRASP by an iterative multi-start algorithm. Each of the iterations consists of two phases. First is a greedy randomized construction phase. Second is a local search phase which starts from the feasible solution built during the greedy adaptive randomized construction phase. GRASP methodology has attractive characteristics. First, it is a simple structure and it can be easily implemented. Second, it is linked with the construction of a greedy algorithm, which can be a basic version for adjustment. And third, it is able to optimize a problem in wide range of combinations.

Alonson, Valdes, Tamarit, and Parreno (2015) implemented the GRASP algorithm to develop pallet building and truck loading in an inter-depot transportation problem. The main purpose is minimizing the number of trucks, which then reduces transportation cost. In this literature, there is a problem classified by two interrelated phases. First is a pallet building phase, because an outstanding problem on multi pallet loading response was found to be its impact on the loading operation. Second is a truck loading phase, which is restricting the maximum weight of loading on axle support. Therefore, the solution is to design the placement of products onto the pallet and loading the pallets in the truck by restricted constraint to ensure that they do not exceed the dimension of the pallet and the truck.

To use GRASP, the researcher followed two steps: a constructive phase and an improvement phase. In the constructive phase, the emphasis is on the pallet problem by adding a related constraint to build a potential pallet in loading. The constraints in pallet composition are orientation, support priority, and stackability. After implementing GRASP for the container loading problem, it produced a good result in empty space filled twice. It is not guaranteed to have cargo stability and not relevant to have a packing sequence.

RESEARCH METHODOLOGY

Data Collection

For data collection, the researcher used three methods. The first was to interview personnel in the logistics department. Second was observation of the actual operation at the plant, especially the battery loading process. Third, historical data was used for the battery transportation cost in the whole of 2015. The collected data was used to support analysis and implementation.

Data Analysis

Referring to the Vehicle Manufacturer’s data, it showed problems in three main areas. The first problem is in space utilization because of the poor initiative by staff in loading, and little interest to improve, even though production volume has sharply increased compared with the past. Additionally, a visible problem is pallet loading that cannot be stacked because it needs quality protection and the container height has limitation. These make transport space utilization to be less important than the actual truck loading capacity. The second problem is that the truck loading capacity is under regulation from the Inland Transportation Department. As a result, loading correctly is highly considered in matching product type, pallet, weight of product and pallet, truck weight limit, and loading space in the truck. The third problem is the high transportation cost that this Vehicle Manufacturer is experiencing.

Findings and Selecting Alternative Solutions

The problems of container utilization and truck load capacity are concentrated on a heuristics approach. It provides flexibility by applying a similar concept from

GRASP to fully utilize truck loading, as a significant tool focusing on stacking ability. The concept to be supported is pallet loading into the container which will solve the space utilization problem. The GRASP concepts requires two implementation phases.

Phase 1, the Constructive phase, is “building”, which concerns the pallet loading problem , in which the batteries in transport are usually placed on pallets and packed in plastic from the supplier factory (to protect the product quality during transportation). Therefore, this research considers providing an additional tool for loading capacity.

Phase 2, the Improvement phase, is “improving”, which is a continuation from the first phase concept, a related improvement concern. The researcher continued to consider other truck loading problems to maximize transportation. For transportation cost, there are three strategies to drive down transportation cost: process, people, and collaboration.

Implementation and Evaluation

The research was implemented by a pilot study in May 2016 as a trial period and to simulate cost saving from June to December 2016. To calculate the result, it uses Excel spreadsheet to compare the volume and weight for opportunity loss, and for contributing a maximized profit to the company. To achieve the experiment, it was important to construct the following steps for the process and make calculations in Excel spreadsheet.

1. Prepare product and pallet dimension
2. Identify truck size and container dimension for loading
3. Prepare historical data of transportation cost before starting the testing
4. Define tower rack dimension and capacity to maximize stack ability
5. Illustrate loading the products into the container by reaching the highest volume and weight constraint of truck loading
6. Arrange the product within the container, based on staff experience
7. Explain the improvement by analyzing the volume and cost in battery transportation

Improvement Indicators

In order to evaluate its validity after implementing the selected solution, there are three key improvement indicators.

1. Volume Utilization

The efficiency measured by increasing the number of batteries and pallets stackable.

2. Truck Load Capacity

To determine the truck type, match it with the loaded volume and material handling.

3. Transportation Cost

It is calculated as cost reduction by price per price (PPP) in battery transportation.

PRESENTATION AND CRITICAL DISCUSSION OF RESULTS

This presents the implementation of the GRASP methodology. It is separated into two phases: constructive and improvement phases. The results from implementation are also explained, following the key indicators.

Data Implementation

Data was collected from the Vehicle Manufacturer by interviewing and observing, and was applied in finding a solution for the three problems. The major four data types are container and truck information, loading carrier information, product and pallet information, and price structure information. The data is explained by dimension, description and function.

Data Analysis

The study uses GRASP as a significant heuristics approach to maximize space utilization. It is trialled by two phases. Phase 1, the Constructive phase, is done by building an iterative process that is separated into two steps. The first step is building an additional tool called "tower rack" to enhance the battery pallet stack ability. The second step is to allocate the tower rack and battery into the truck container. In the implementation of the tower rack and enhancing the truck space utilization, the trial operation showed that Vehicle Manufacturer is faced with a weight limit by adding the tower rack into the truck. The particular tower rack is made of metal, so its weight reduces the weight capacity of the truck. Phrase 2 leads to a continuation to provide an improvement solution by matching the tower rack with the right truck. This phrase is a change, from six-wheel trucks to be ten-wheel trucks.

Data Evaluation

1. Volume Utilization

Volume utilization provides a potential result from the trial process of loading the battery pallets into the tower rack on the truck. In the loading process the manual loading of each pallet was done by the loading staff with experience in using forklifts. The result is a comparison of loading the batteries into the truck by using the current method and the new method with tower rack. By the traditional battery loading, 13 pallets or 195 units of batteries were loaded into the truck. It only used one level and it had a lot of empty spaces in each transport trip. The new method increases to 30 pallets or 450 units of batteries loaded into the truck.

This method allowed the use of three levels and five tower racks. This resulted in an increased of batteries loaded in each transport trip by 130%.

2. Truck Load Capacity

The truck load capacity is related to the increased space utilization by adding battery pallets and a tower rack into the truck. This improvement is to balance the actual loaded weight on the container truck with the actual truck capacity. Moreover, the investment of a tower rack is added in this process to develop simultaneously. Particularly, this Vehicle Manufacturer is concerned with the cost trade-off from changing truck type to match with their production volume. From changing six wheeled truck to be ten wheeled truck. The result is explained by the two data which are trucking cost and trucking capacity. First is trucking cost. It describes a reduction in the number of truck usages and the number of round trips before and after changing the truck. The result shows that this Vehicle Manufacturer can achieve a cost saving of 639,000 baht per month. Second is trucking capacity. It shows the detail for each truck weight limit and the weight balance after placing the tower rack in the transportation. The result shows that the Vehicle Manufacturer can fully utilize the ten wheeled truck capacity by 96%. Therefore, this Vehicle Manufacturer can gain benefit from this additional capacity, by 42%. The number of batteries transported can be definitely increased following the new truck size.

3. Transportation Cost

Implementing the new battery tower rack is a response to enhance the battery volume loaded. This solution requires the Vehicle Manufacturer to change its truck from six wheeled to ten wheeled. All these implementations are favorable in regards to transportation cost. The increase in battery volume transported can significantly reduce the transportation cost per piece. After implementation, the result shows that the Vehicle Manufacturer can reduce its price per piece cost by 14.10%. It shows that the total battery transportation cost before implementation is 3,216,276 baht and the total battery transportation cost is reduced to 2,763,684 baht. The Vehicle Manufacturer can achieve an estimated cost reduction of 452,592 baht from the period May to December 2016.

CONCLUSION

The key focus areas of this study are to provide optimization battery transportation for a Vehicle Manufacturer in Thailand. The research purpose is to identify the inefficient areas and provide an improvement solution. The problem focused on transporting batteries for export. Because these batteries are solely purchased from FB supplier, it creates risk in terms of substitutes for unexpected situation and transport cost balancing. The Vehicle Manufacturer reviewed two outstanding problem areas in battery transportation. The first problem is in container space utilization where the number of batteries transported is low. The batteries are loaded in only one level on the container floor and delivered only 13 pallets or 195 units per trip. The second problem is the truck loading capacity related to the inefficient space utilization where the truck capacity is not fully utilized. The truck's capacity usage is only 68% per trip, resulting in a high number of transportation trips. These problems are directly impacting the transportation cost that the Vehicle Manufacturer has to bear.

After identifying the outstanding areas for improvement, the researcher searched for an appropriate methodology for a solution. The methodology found is based on Greedy Randomized Adaptive Search Procedure (GRASP) to optimize the battery transportation of Vehicle Manufacturer. Regarding the key benefits in conducting this research, the first objective is to study how the company can utilize container space and maximize its truck load capacity. After implementing the battery tower rack on the truck to support an increased load weight, the outcome is positive. This is shown by the 130% increase in the number of batteries loaded, and the truck capacity increase of 42%. The second objective is to examine how the company can reduce its battery transportation cost. The solution provided is the full utilization of the container space and the truck capacity. This is shown by the efficient 14.10% cost reduction of battery price per piece.

Limitations and Recommendations for Future Research

There were two limitations in the trial period. First, the battery sample size is three battery pallets loaded into only one tower rack, so, researcher did not see a fully loaded tower rack and battery pallets in the container truck. Second, battery loading time by the loading staff has to take a longer lead time in the loading process. The number of picks in the rounds adds up and the stacking of batteries in each tower rack level takes time.

This research began by investigating the loss area of this Vehicle Manufacturer. Battery transportation was the first priority that needs analysis. The battery transportation observed is not a common practice in the industry because product characteristics are different for each manufacturer. The researcher selected GRASP methodology after reviewing the published academic literature. The methodology is commonly applied in vessel container problems but after the experiment, it showed that GRASP can be applicable in similar area as it provided opportunity for other researchers to apply GRASP in related problem areas, especially space utilization and value added. However, there are some areas that are not covered in this research which are operating time and manpower. These could be covered in future research.

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