

Design and engineering analysis of material procurement mobile operation platform

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Abstract. The material procurement mobile operation platform (MPMOP) consists of six modules, including network operation, truck transportation, remote communication, satellite positioning, power supply and environment regulation. The MPMOP is designed to have six major functions, including online procurement, command control, remote communication, satellite positioning, information management and auxiliary decision. The paper implements an engineering analysis on the MPMOP from three aspects, including transportation transfinite, centroid, and power dissipation.

1. Introduction

In the process of material procurement, the geographical position of the customer could be changing and sometimes the material procurement institution is asked to follow them, and then the material procurement institution should be able to fulfill their procurement mission without fixed office and corresponding ancillary facilities. We design a kind of material procurement mobile operation platform (MPMOP), and the MPMOP is designed to be able to carry out the task of material procurement on the move according to the requirement of user. In this paper, we discuss the module of the MPMOP in part 2, the function of the MPMOP in part 3, and make an engineering analysis of the MPMOP in part 4.

2. Module

The MPMOP consists of six modules, including network operation, truck transportation, remote communication, satellite positioning, power supply and environment regulation.

2.1. Network Operation Module

Having the function of network formation, information gathering, data processing and storage, real-time positioning, procurement scheme draft and decision, procurement document draft and printing, procurement information upload and download, the network operation module is the core of MPMOP. The network operation module consists of hardware system and software system. The hardware system includes server, microcomputer, switch, router, K-converter, synchronous/asynchronous modem, and laser printer. The software system provides the function of information management, resource analysis, auxiliary decision, network procurement, and so on.



2.2. Truck Transportation Module

Consisting of chassis and car body, the truck transportation module mainly provides the function of moving and transportation. The application of off-road vehicle chassis let the MPMOP run faster and can adjust itself to different terrain. Having the function of shock absorption, electromagnetic shielding, and heat insulation, the car body includes door, window, annex, chair, ventilator and air-conditioner.

2.3. Remote Communication Module

Consisting of wireless communication system and wire communication system, the remote communication module is mainly used to connect the MPMOP and the command network and the suppliers, and implement the transmission of data, audio and image. The wireless communication system consists of CDMA1X vehicle terminal, CDMA1X wireless network card, GSM wireless terminal, shortwave FH/adaptive terminal, shortwave modem, VHF FH radio set, and handheld walkie-talkie. The wire communication system consists of telephone, digital fax machine, intercom between car body and cab.

2.4. Satellite Positioning Module

Using satellite navigation system, the satellite positioning module mainly provides the function of navigation and positioning, and can plan vehicle running route on the electric map.

2.5. Power Supply Module

Consisting of external power supply input cable, vehicle-mounted electric generating set, vehicle battery, main vehicle generator, power supply box, and power distribution box, the power supply module can provide power support for other modules in four way, including civilian power supply, battery set power supply, generating set power supply, main vehicle generator power supply.

2.6. Environment Regulation Module

Using overhead air-conditioner and adjustable vent, the environment regulation module can provide a comfortable work environment for the MPMOP.

3. Function

The MPMOP is designed to have six major functions, including online procurement, command control, remote communication, satellite positioning, information management and auxiliary decision.

3.1. Online Procurement Function

The MPMOP includes internal resources database and external network. The internal resources database stores information of material procurement organization, material storage base and warehouse. Using wireless network technology, the MPMOP connects with local government procurement center and enterprise suppliers through Internet network, and implement online electronic procurement.

3.2. Command Control Function

The MPMOP can acquire real-time information of material procurement quickly, make decision intelligently, manage efficiently, and implement material procurement at any area, any weather and any time.

3.3. Remote Communication Function

The MPMOP is designed to have remote communication function, including wire communication, wireless communication and satellite communication, and then, the information of demand can be received timely and the instruction can be issued quickly.

3.4. Satellite Positioning Function

The MPMOP needs to move to implement different material procurement mission. It must have the satellite positioning function so that the task allocation of material procurement and the material demand report can be more reasonable.

3.5. Information Management Function

The MPMOP is designed to receive, process, analysis and transmit demand information and resource information of large number, and then, the MPMOP can make regional statistics of resource and analyze their potential.

3.6. Auxiliary Decision Function

The MPMOP is designed to search resource database according to specific requirement and display these information in the electric map dynamically, and then help the commanders and staff make scientific decision quickly.

4. Engineering Analysis

In order to achieve the designed purpose, it is needed to make an engineering analysis on the MPMOP, and verify its ability to achieve the target. In this part, we implement an engineering analysis on the MPMOP from three aspects, including transportation transfinite, centroid, and power dissipation.

4.1. Analysis of Vehicle Transport Transfinite

The purpose of vehicle transport transfinite analysis is to assure that the MPMOP satisfies the requirement of general transportation equipment, including railway transportation and highway transportation. The MPMOP installs side frame and main compartment on the IVECO NJ1056SHX6-T chassis, and makes the shape size as 6710 mm×2115 mm×3160 mm(length × width × height). According to GB1589, the shape size limit of 2 axle truck whose weight is between 3.5 tons and 8 tons is 8000 mm×2500 mm×4000 mm(length × width × height). According to GJB 2948, the shape size limit of material for railway transportation is 3000 mm×3650 mm(width × height). The MPMOP satisfies the requirement of railway transportation and highway transportation.

4.2. Centroid Analysis of the MPMOP

Because of the action of installing side frame and main compartment on IVECO NJ1056SHX6-T chassis, the centroid of the MPMOP must have changed. Centroid analysis is needed to assure the operation platform will drive safely. Take the center of front axle of the chassis as the origin of coordinate, the length of the MPMOP as the X axis, the width as the Y axis, the height as the Z axis, and the quality distribution condition can be seen clearly in Table 1.

4.2.1. Analysis of the Centroid Position. The total weight of the MPMOP is $G=4935$ kg. Take X as the vertical position of the MPMOP, then $X=(G_1 \times X_1 + G_2 \times X_2 + \dots + G_n \times X_n)/G=2525.1$ mm. Take Y as the horizontal position of the MPMOP, then $Y=(G_1 \times Y_1 + G_2 \times Y_2 + \dots + G_n \times Y_n)/G=3.3$ mm. Take Z as the height of the centroid, then $Z=(G_1 \times Z_1 + G_2 \times Z_2 + \dots + G_n \times Z_n)/G=1199.2$ mm.

4.2.2. Analysis of the Axle Load. According to the requirement of the technical parameters of IVECO NJ1056SHX6-T, the load of the front axle must be less than 1550 kg, the load of the rear axle must be less than 3550 kg, the proportion of the load of the front axle to the total weight of the operation platform must be less than 36% and bigger than 20%, only then can the platform drive safely.

Take G_f as the load of the front axle and G_r the load of the rear axle, then $G_f=G \times X/L=4935 \times 2525.1/3600=3461.5$ kg, $G_r=G-G_f=4935-3461.5=1473.5$ kg, and the proportion of the load of the front

axle to the total weight of the platform $G_f/G=1473.5/4935=29.9\%$. Conclusion can be made that the technical parameters of the MPMOP satisfies the requirement of safety and design.

Table 1. Quality Position Distribution Table

Name of Project	Code	Quality (kg)	X (mm)	Y (mm)	Z (mm)
Chassis	G ₁	2045	1050	0	670
Car Body	G ₂	1300	3550	0	1800
Side Frame	G ₃	300	3450	0	840
Operating Personnel	G ₄	300	3850	0	1428
Equipment of Personnel	G ₅	40	3850	0	1428
Generating Set	G ₆	70	5138	0	1340
LCD TV & Installation	G ₇	25	1540	0	2300
Integrated Printer	G ₈	10	2170	-670	1820
Digital Fax Machine	G ₉	15	1730	-670	1815
Overhead Air-conditioner	G ₁₀	68	3725	0	3040
Mounting Frame of Outdoor Machine	G ₁₁	15	1110	-95	2600
Ultra-short Wave Antenna	G ₁₂	15	2820	-500	2977
Satellite TV Receiver	G ₁₃	5	1888	500	2970
Satellite User Receiver Antenna	G ₁₄	5	4898	500	2965
Left Rear Left Electric Cabinet	G ₁₅	80	5093	-698	2190
Right Rear Left Electric Cabinet	G ₁₆	80	5093	698	2190
Front Left Electric Cabinet	G ₁₇	60	1923	-700	1315
Notebook Computer	G ₁₈	10	3258	0	1690
Office Furniture	G ₁₉	150	3605	0	1315
Accessory Box	G ₂₀	40	2500	-850	686
Cable Tray Box	G ₂₁	70	2250	850	686
Toolbox	G ₂₂	30	4780	890	757
UPS Battery	G ₂₃	72	5143	650	1090
Electric Fuel	G ₂₄	80	3540	0	1340
Others	G ₂₅	50	3540	0	1140
Total	G	4935	2525.1	3.3	1199.2

4.2.3. Analysis of the Left and Right Axle Load. According to the technical parameters of the IVECO NJ1056SHX6-T chassis, the proportion of the difference of axle load between the left and the right part to the total weight ($\Delta G/G$) must be less than 3%, only then can the MPMOP drive safely. The horizontal position of the centroid $Y=3.3$ mm, the wheel spacing $B=1683$ mm, the load of the left part $G_L=(B/2-Y) \times G/B=838.2 \times 4935/1683=2457.8$ kg, and the load of the right part $G_R=G-G_L=4935-2457.8=2477.2$ kg. The difference of axle load between the left part and the right part $\Delta G=G_L-G_R=19.4$ kg, and $\Delta G/G=0.39\%$.

4.2.4. Lateral Stability Check Analysis. According to the technical parameters of IVECO NJ1056SHX6-T chassis, the maximum lateral stability angle of the MPMOP $\beta_{\max}$ must be bigger than 35° . Because $\tan \beta_{\max}=B/2Z=1683/(2 \times 1199.2)=0.71$ and $\beta_{\max}=35.1^\circ > 35^\circ$, so the lateral stability satisfies the safety requirement.

4.2.5. Longitudinal Stability Check Analysis. According to the technical parameters of IVECO NJ1056SHX6-T chassis, the attachment coefficient ϕ between tire and road when the MPMOP is uphill and downhill must be bigger than 0.7. When the MPMOP is uphill, $\phi = (L-X)/Z = (3600-2525.1)/1199.2=0.9$. When the MPMOP is downhill, $\phi = X/Z = 2525.1/1199.2=2.11$. L is the wheelbase of the MPMOP and $L=3600\text{mm}$. With the analysis, we can find that the attachment coefficient ϕ between tire and road when the MPMOP is uphill and downhill are both bigger than 0.7, and satisfy the requirement of longitudinal stability.

4.2.6. Wind Load Stability Analysis. The MPMOP is asked to be able to work even when the wind speed is level 8, so we take the maximum wind speed of level 8 20.7m/s as the input wind load when we analyze the wind load stability. The windward area of the side is biggest for the MPMOP and the support force of the tire is the smallest, so, we calculate the windward rollover torque M of the side of the MPMOP. Because the height of the MPMOP is less than 10 m while working, the MPMOP is mainly influenced by surface wind. The wind load W_0 is proportion to the square of the wind speed V_0 , the coefficient of correspondence is 1600, and $V_0=20.7\text{ m/s}$, then $W_0=V_0^2/1600=0.27\text{ KN/m}^2$. The windward rollover torque M consist of car body frame's rollover torque M_1 and chassis's rollover torque M_2 .

The measure of the side area of the car body frame $S_1=L \times W=4.115 \times 2=8.23\text{ m}^2$. In the equation, L is the length of the car body frame, and W is the width of the car body frame. The wind load of the car body frame $F_1=W_0 \times S_1=0.27 \times 8.23=2.22\text{ KN}$. The equivalent point of this force is located at the center of the car body and the height $L_d=1917\text{ mm}$, then the car body frame's rollover torque $M_1=F_1 \times L_d=2.22 \times 1917=4256\text{ Nm}$.

The measure of the side area of the chassis can be achieved by the calculation of the closed contour of the MPMOP, then we get the measure of the side area of the chassis $S_2=4.4\text{ m}^2$, the height of the center of the closed contour $h=745\text{ mm}$, the wind load of the chassis $F_2=W_0 \times S_2=0.27 \times 4.4=1.19\text{ KN}$, the rollover torque of the chassis $M_2=F_2 \times h=1.19 \times 745=887\text{ Nm}$, the total of the rollover torque $M=M_1+M_2=4256+887=5143\text{ Nm}$.

The stability torque of the MPMOP $M_g=G \times (B/2 + Y) \times 9.8/1000=40857\text{ Nm}$. In this equation, G is the total weight of the MPMOP and $G=4935\text{kg}$, B is the wheel spacing and $B=1683\text{ mm}$, Y is the horizontal position of the MPMOP and $Y=3.3\text{ mm}$. Because the rollover torque of the MPMOP $M=5143\text{ Nm}$ is smaller than the stability torque $M_g=40857\text{ Nm}$, the wind load stability of the MPMOP satisfies the requirement of the safety.

4.3. Analysis of the Power Dissipation

The following table shows the power dissipation of equipments of the MPMOP.

Table 2. Power Dissipation Statistical Table

Serial Number	Equipment	Number	Maximum Power Dissipation(W)
1	VHF Radio	1	120
2	Ultra short Wave Modem	1	10
3	Cable Modem	1	10
4	Wired Intercom	1	3
5	Notebook Computer	4	100
6	Satellite Signal User Terminal	1	30
7	Digital Fax Machine	1	20
8	Video Conference System	1	90

9	Information Calendar	1	5
10	Power Distribution Control Cabinet Ventilator	1	30
11	Network System Accessories	1	50
12	PBX	1	10
13	Lighting	4	100
14	Multi-function Printing Machine	1	300
15	Air-conditioner	1	1200
16	Cabin Ventilator	3	30
17	Others	1	115
Total			2883

According to the analysis of power dissipation of equipments of the MPMOP, a diesel generator of 3000W will satisfy the requirement of power consumption of all the equipments of the MPMOP.

5. Conclusion

According to the analysis above, we can make some conclusions as follows:

Conclusion 1: The MPMOP satisfies the requirement of railway transportation and highway transportation.

Conclusion 2: The technical parameters of the MPMOP, including the axle load, the left and right axle load, the lateral stability, the longitudinal stability and the wind load stability, satisfies the requirement of safety.

Conclusion 3: A diesel generator of 3000W will satisfy the requirement of power consumption of all the equipments of the MPMOP.

Conclusion 4: The MPMOP can fulfill its material procurement mission safely and efficiently.

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