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INTERACTIVE DIGITAL TOOL FOR ORDER-SPLITTING ONE PURCHASE ORDER AMONG A NUMBER OF SUPPLIERS[7]

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Abstract: *Each vendor might have significant differences in transport costs, product portfolio, the prices, minimal order quantity, capacity, etc. Managers compare these parameters and decide either to order the whole lot from one vendor or to split it between different vendors. Moreover, in some cases splitting the orders is unavoidable, particularly when any of the vendors have enough capacity to cover the full quoted quantity. This paper represents a digital tool that could be used by procurement staff to split a set of products among a number of vendors. It includes an interactive spreadsheet where the managers check and uncheck the products from a particular vendor, compare the prices and see the final result - the total cost for the orders. The spreadsheet is enriched with additional indicators to alarm if the minimum order quantity for the vendor is not covered, if the capacity of the vendor is exceeded, or if the total ordered quantity is not enough to cover the needs of the company. This spreadsheet tool could be directly used as a model for splitting the orders in the supply chain management office of a company. It also can be used as an interactive task for students to explain this complex part of a procurement process. Human resource managers could use this tool in the recruitment process for testing new employees in supply chain management offices*.

Keywords: *Supply Chain Management, supplier evaluation, vendor comparison, spreadsheet model*
JEL Codes: *M10, M20*

INTRODUCTION

Procurement process is complex. It includes among other processes: vendor evaluation, allocating orders among the approved suppliers, while keeping the total costs at the minimal level and to comply with the constraints. The company's supply strategy might be focused on one main supplier, decreasing the complexity of allocating the orders. But there are situations when splitting the orders is inevitable, i.e. the order quantity is higher than the capacity of the supplier, risk diversification, local suppliers support policy, etc. Moreover there are companies that do not apply the main supplier policy. Sun, Y., Cong Guo, S., Li, X (2022) present their model for two echelon distribution systems, where they pool the lead-time risks by splitting replenishment orders among multiple suppliers. This task could be solved automatically by optimization software. This task is non-linear: the transportation cost for the vendor applies only when we place any order for this vendor. As the number of products and suppliers grows the optimization task becomes too complex for the instruments like Excel Solver or OpenSolver integrated into the popular spreadsheet applications. Some scientists (Sun, Y. et al, 2022) apply mixed integer nonlinear programming models using Matlab to solve this problem. As mentioned in (Sheludko, 2022) officers might prefer lightweight and low cost tools that could give them a basic understanding and help them to make better decisions. In that case the procurement officers need an understandable and low cost tool that could model allocating orders and order-splitting processes. This paper represents such a tool. It allows the manager to model the results of the eventual decision: use supplier A or supplier B, or use them both. The model calculates the total cost for the scenarios. The tool makes basic logical tests for the allocated orders and alarm if there are any excesses, i.e. if the quantity ordered is less then the minimum order requirement, or if the quantity ordered exceeds the supplier's capacity.

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EXPOSITION

The tool consists of: visual cards combined into one plot; the costs calculating logic; material requirement calculating logic; alarming system. As an example it has been implemented using free-to-use Google Spreadsheet software, but it could be transferred to its free and open source (FOSS) alternatives. Next, the main elements of the model are represented below:

The cards

There are 3 types of cards used by the tool:

- Vendor card
- Product card
- Order card

An example of a vendor card is shown on Fig.1. Here it includes the minimal information on the supplier, that can be useful while making a decision for the procurement process.

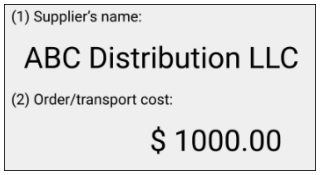

Fig. 1. The vendor card

Here we include following fields:

1. The supplier's name: the formal name of the organisation.
2. The order cost: the fixed cost for initiating the order from the particular supplier. This cost covers the transportation costs as well as other costs associated with operational costs for the procurement process. This cost should be counted only if there is a purchase order for at least one product from the supplier.

The current model ignores other properties of a vendor, such as lead time, defect rate etc. It could be added by the officer if needed. The product card is shown on Fig. 2. It includes some critical information on the product included in the ordering process - the company's material requirement for the screw drivers is 5000 pc.

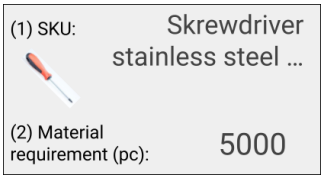

Fig. 2. The product card

The minimal content on the order card includes following fields:

1. Stock keeping unit (SKU) name
2. Material requirement quantity.

Additionally the card might include: current stock level, special requirements, the notes for the purchase officer, etc. The third type of cards is the order card. It includes the information about the specifics on the particular product ordered from a particular supplier. An example of an order card is shown on Fig.3:

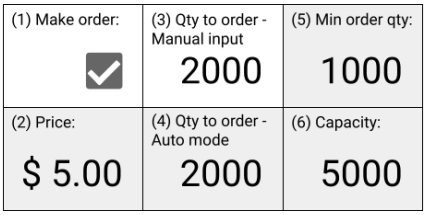

Fig. 3. Order card

1. Make order: boolean value showing either the order for this product from the particular vendor will be made.
2. Price: unit price for the product from the particular vendor.
3. Quantity to order (manual input): the quantity the manager is willing to order. This value overrides any values calculated in the "Quantity to order (automatic mode)" field.
4. Quantity to order (automatic mode): the quantity to order calculated automatically - either to fill the material requirements or the value limited by the vendor's capacity level.
5. Minimal order quantity: the constraint for the minimal lot value declared by the vendor.
6. Capacity: the constraint for the maximal lot value, defined by the production capacity of the vendor.

The order card might include other information as well, i.e. the quality rating, etc.

Plotting the cards

After the officer selects the products and the potential suppliers, the cards are composed into the table plot: product cards go to rows; vendor cards go to columns; order cards go to the centre (values fields). Figure 4 shows the comparison of two suppliers on one product from multiple suppliers plot. Despite the transportation cost for vendor 1 is $1000 lower than the transportation cost for vendor 2, the manager can make the conclusion that the difference in the price for 5000 pc will influence the total cost much more than $1000. In this particular case it would be recommended for the supply officer to use the supplier 2.

	Supplier's name: ABC Distribution LLC Order/transport cost: $ 1000.00			Supplier's name: XYZ Trading Order/transport cost: $ 2000.00		
SKU: Skrewdriver stainless steel ...	Make order: ☐	Qty to order: (Manual input)	Min order qty: 1000	Make order: ☑	Qty to order: (Manual input)	Min order qty: 1000
Material requirement (pc): 5000	Price: $ 5.00	Qty to order: (Auto mode)	Capacity: 5000	Price: $ 4.00	Qty to order: (Auto mode) 5000	Capacity:

Fig. 4. One product from multiple suppliers plot

On Figure 5 the plot is expanded with multiple products. The officer compares the offers for one product from two vendors, he would also consider if there is an order for another product already planned from this vendor. In this way the company would not pay additional transportation costs. The field descriptions are hidden to lower the information noise.

	ABC Distribution LLC $ 1000			XYZ Trading $ 2000			Yet Another Corp. $ 1500		
Skrewdriver stainless steel ...	☐		1000	☑		1000	☐		0
5000	$ 5.00		5000	$ 4.00	5000				0
100 pc din 931 hexagon head bolt ...	☐		1000	☑		1000	☐		1000
10000	$ 5.00		5000	$ 8.00	5000		$ 5.00		5000
Metal hammer with rubber handle ...	☐		1000	☑		1000	☐		1000
2000	$ 13.00		5000	$ 15.00	2000		$ 13.00		5000

Fig. 5. Multiple products from multiple suppliers plot

The cost calculating zone and the material requirements zone

The model includes calculating logic for the material and transportation costs. It can be seen on Figure 6 (the bottom row). The tool calculates the total costs for the currently allocated orders in

the bottom right corner of the plot. The model follows the fulfilment of the material requirements. The model shows if there is any necessity to purchase more from the product.

The alarm system

The tool makes basic logical tests for the allocated orders, showing if there are any inconsistencies in the ordering process by changing the formatting of the text and background:

1. The quantity ordered is less then the minimum order requirement;
2. The quantity ordered exceeds the supplier's capacity;
3. The total ordered quantity is less than the material requirement quantity;
4. The total ordered quantity is greater than the material requirement quantity.

The rules for order allocating process

The spreadsheet cells follow some basic rules according to the model:

1. The transportation cost for a particular supplier must be applied only if there is at least one order from this particular supplier.
2. If the user puts a tick to any product - it must be interpreted as a will to purchase some quantity of this article from this supplier.
3. If the user inputs a quantity to the order quantity field - the model must accept this quantity.
4. If the user puts a tick, but does not input any quantity inside the manual quantity field - the model must apply some logic to show the "default quantity":
    a. If the capacity of the supplier covers the material requirement - it must propose to order the whole material requirement quantity;
    b. If the capacity of the supplier is lower than the material requirement - it must propose the maximum quantity the supplier can offer.

The spreadsheet implementation

The author has made a digital model (see Figure 6) for this plot in Google Spreadsheet platform so anyone could see and try it. It follows the structure described above. Using the link users can make their own copy of the model to their Google Drive account.:

https://docs.google.com/spreadsheets/d/1OSQZk6Zi9APyX-FFfSZfgp97ttFA3IUMN4BP3KbGS8s/copy

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T
1		Supplier 1			Supplier 2			Supplier 3			Supplier 4			Supplier 5				Ordered		Require
2			1000	лв		2000	лв		1500	лв		3000	лв		400	лв				
3	Product 1	☐		1000	☑		1000	☐		1000	☐		0	☐		0				
4	5000	5		5000	4	5000	5000	4		5000	0		0	0		0		5000	/	5000
5	Product 2	☐		1000	☑		1000	☐		1000	☐		0	☑		1000				
6	10000	5		5000	8	5000	5000	7		5000	0		0	5	5000	5000		10000	/	10000
7	Product 3	☐		1000	☑		1000	☐		1000	☐		1000	☐		1000				
8	2000	13		5000	15	2000	5000	15		5000	12		5000	13		5000		2000	/	2000
9	Product 4	☐		1000	☑		1000	☐		1000	☐		1000	☐		1000				
10	5000	32		5000	36	5000	5000	35		5000	31		5000	32		5000		5000	/	5000
11	Product 5	☐		0	☑		1000	☐		0	☐		0	☐		0				
12	3000	0		0	15	3000	5000	0		0	12		5000	0		0		3000	/	3000
13																				
14	Material		0			31500			0			0			25000					
15	Transport		0			2000			0			0			400					
16	Total		0			31700			0			0			25400					342400

Fig. 6. Spreadsheet representing the order-splitting model

Order-allocating process using the presented tool

The task for the officer is to allocate the orders in a way that the material requirements would be covered, the orders would meet the minimal order quantity and the capacity vendor policies, and after meeting all the criterias to optimise this allocation to find the minimal total cost. The officer puts the suppliers and the products in the spreadsheet. Using the ticks he allocates the orders among

the suppliers. After the orders for all products are allocated, he looks over the total costs cell. The officer changes the allocation or changes manually the order quantity. After that he compares the cost level against the initial level. After the officer is satisfied with the total costs, the final order must be made.

CONCLUSION

The presented model can be used for comparing different scenarios for allocating orders and order-splitting processes in a visual manner. It can be implemented using free-to-use applications. The spreadsheet implementation of the model can be copied by researchers and managers to modify it and use it for their cases. The model can be used as well to present the order-allocation and order-splitting processes to the students as an interactive control panel. It can be also used to build interactive tasks for students, and as a task in the recruitment process.

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