Customer Orders Prioritization Method for Shared Stages In Multi-Business Channel Environment

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***Abstract*—Increased globalization has offered many challenges to the companies regarding the competition, healthy customer relationship and managing expanded variety of business channels. These diverse business channels demand a balanced sharing of resources among various channels, while each individual channel offers independent variability and complexity levels. The success of such types of business is based majorly on the order management system that ensures the customer satisfaction and revenue generation. This study proposes a customer order prioritization model for multi business channels that share one or more order fulfillment stages. The dynamic model contains order prioritization tool to assess and prioritize customers' order for shared order fulfillment stages. The existing single attribute based Demand Build Plan model prioritizes customers' orders for a shared stage using proportional method considering the demand volume of all business channel for that time period. The proposed decision making method based on multiple criteria namely "Technique for Order of Preferences by Similarity to Ideal Solution" (TOPSIS), prioritizes customer orders for shared stages considering both operation and strategic levels attributes. The proposed framework can effectively balance the individual business channel as well as overall business goals.**

Keywords*— *multi-business channels, order management, order prioritization tool, success factor, TOPSIS,

I. INTRODUCTION

Industries are transforming into multi-channel businesses to fulfill the diverse demands of customers at one point. This transformation can easily be observed in our surroundings like the supermarket concept where customer can get different items from different supply chains and then can have them packed and dispatched from one point. Likewise this multi-channel supply chain can be observed in clothing industry. The clothing industry is considered one of the most dynamic retailer driven sector with complex multichannel supply chains and is characterized by one of the factors of wide product range with price sensitive customers [1].

Since 1990's, the conventional manufacturing organizations have become obsolete due to the emergence of dynamic market conditions. Therefore, new dimensions of production systems were investigated to enhance the manufacturers' ability to cope with the dynamism and competitiveness towards the customers' demands. One such system is defined as Multi-Channel Manufacturing (MCM). It is an extension of cellular manufacturing. It involves forming cells with a new criterion i-e enhancing the daily production of cells on cost-effective basis. Islier explained it a noteworthy approach that offers fractal manufacturing in which cells are organized as channels and machines are lined up to facilitate streamlined materials flow [2]. Research has been carried out to modify the manufacturing systems to multichannel manufacturing for better customer demands fulfilment. Meller and Deshazo [3] reengineered the Electrical box and enclosures manufacturing system to MCM and claimed that the throughput time went down over 67%, work-in-progress by at least 50%, with increase in production capacity.

Organizations that are operating multiple channels as parallel routes to market have to deal with intense pressure to ensure customer satisfaction due to competitive market. The fframework offers various challenges based on the structural alignment. Thus, the concurrent channel providers should give priority to channel attributes that could be aligned. Many retailers operate concurrent channels in which customers can obtain similar offerings. Many challenges have been cited for multi-channel customer management[4]. To accommodate these challenges and problems different methodologies have been proposed. Hammerschmidt [5] presented a 5C model for tracing the true difference between the customer channels. J.Lee [6] worked on the decision support system and provided optimized operation levels for best possible high-quality suppliers by using Pareto

fronts.. The order management system has become a critical subject for the organizations which share common resources and working for diverse business goals, in order to deal with such complexities within their production lines and managing the customer demands. The current study deals with a multi-channel business with 4 individual channels with their own supply chain networks, producing different products to process their confirmed customer orders. These business channels share some of the common stages due to employee expertise constraint, proximity of work area, etc. Every channel owns an independent order type and fulfilment criteria and all channels share final stage of their order fulfillment process shown in fig 1.

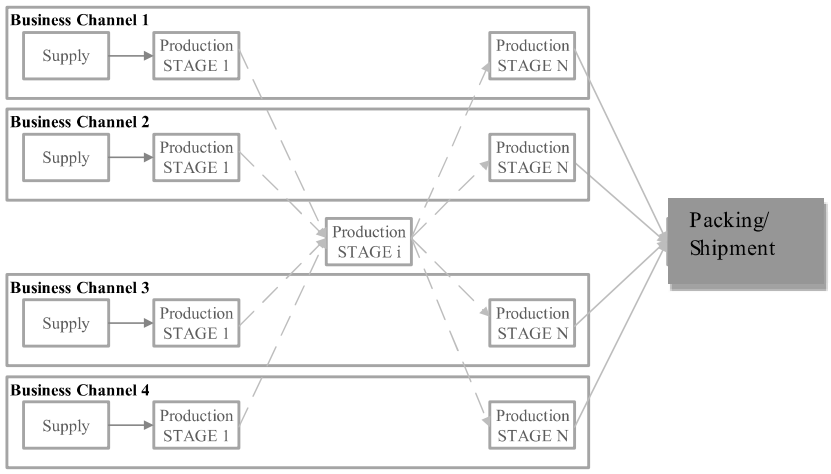

Fig 1: Multi-business channels with shared stages

To manage the order selection systems, different methodologies have been presented with significant impact on performance. One of the widely adapted methodology is applying Technique for Order of Preference by Similarity to Ideal Solution (TOPSIS) for order selection. This approach defines the concept that the supplier selection is based on the closeness from the positive ideal solution and the deviation from negative ideal solution. Hemmati [7] presented a decision support system based on TOPSIS for acceptance and rejection of incoming orders, prioritization and management depending upon their capacity, order due dates and material availability. Kuo, Y., et al. worked on Flow Shop with Multiple Processors and presented a robust solution for the dispatching decisions by integrating TOPSIS with other multi criteria decision making approach, Analytic Hierarchy Process (AHP) and Taguchi orthogonal array for fining the most appropriate dispatching mechanism for every workstation[8]. Somayé Ghandi [9] presented Scatter Search (SS) optimization algorithm is customized for this problem to produce high-quality solutions for Assembly Sequence Planning (ASP). The parameters of this algorithm were tuned by a TOPSIS-Taguchi based tuning method.

In this paper, a model is proposed that prioritizes jobs (customer orders) for a shared stage for all the jobs coming from different business channels. The model considers multiple attributes for order prioritization to meet both operational and strategic level missions. The remaining sections of paper are organized in way that section II defines the framework developed for implementing the technique and the simulation results. Section III defines the results obtained from this works and section IV concludes the whole paper with the future scope in the related field.

II. FRAMEWORK:

The framework for the order management system is proposed on the basis of some assumptions mentioned below.

- All the orders accepted are needed to be produced.
- Received orders are processed at their dedicated channels.

The existing Drawer Build Plan (DBP) is a single attribute based model. It analyzes orders placed in production lines on the basis of demand volume arriving from different business channels.

A. AS-IS Model:DBP

Demands of various types of products (J) arrives from different business channels. These products are built one at a time during the production stage and then move to next stage. The DBP tool distributes the prioritized orders of the DBP that are proportional to the quantity of demand. Fig 2 explains the framework of DBP. An illustrated example for business channel (BC) 1 with demand D_a = 2 and BC 2 with demand D_b = 5 are presented in Table 1 to help understand the DBP concept. The prioritization results obtained from DBP were based only on the demand of product. But this model did not incorporate the other

attributes that could affect the order prioritization process and in turn the overall objectives of the company. Thus, the company needs a tool that can incorporate both strategic and operation level attributes to assist order prioritization decision support system

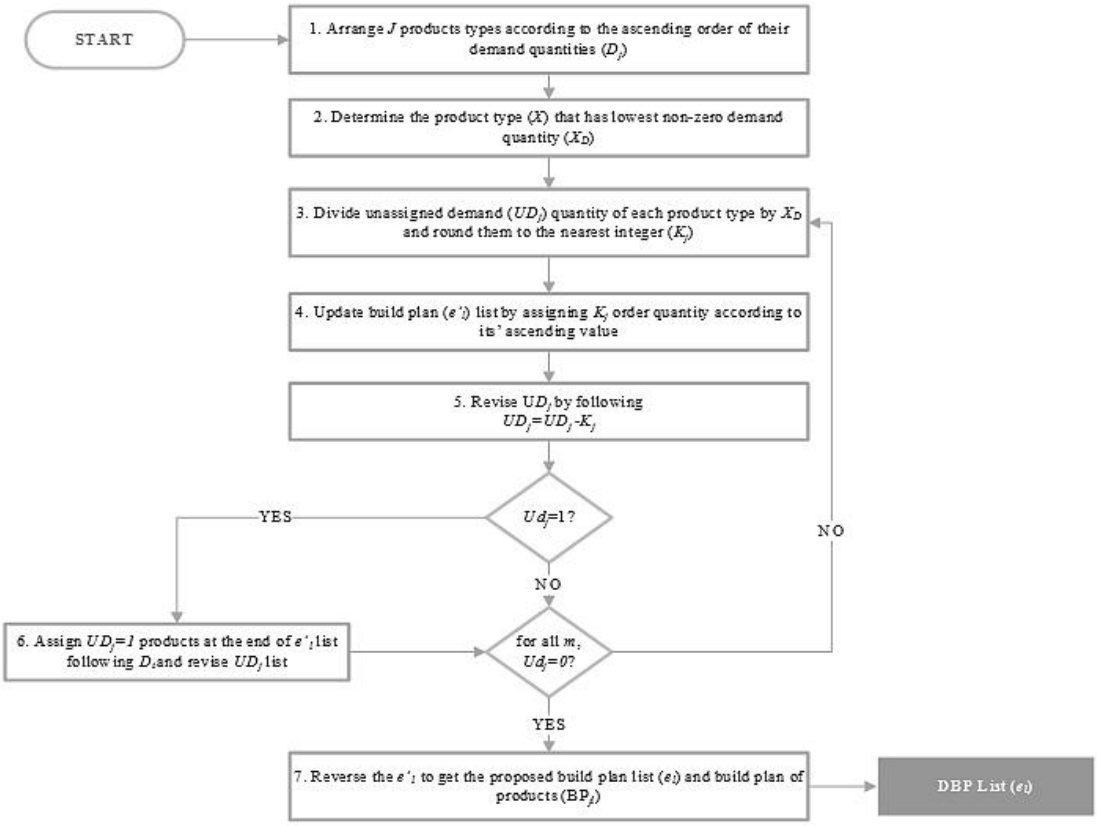

Fig 2: Demand Build Plan Tool

TABLE I. ILLUSTRATION OF DBP TOOL FOR J= a, b

DESIGN	S1 & 2 (D_j)	S3 (K_j)	S4 (e'_l)	S5 (UD_j)	S6 (e'_l, UD_j)		S3 (K_j)	S4 (e'_l)	S5 (UD_j)	S6 (e'_l, UD_j)		S7 (e_l)
BC 1	2	1	a	1	a	0	0	a	0	a	0	b
BC 2	5	3	b,b, b	2	b, b, b	2	1	b,b, b	1	b, b, b	0	b
					a			a		a		a
								b		b		b, b, b
										b		a
Demand Build Plan: b(BC2)-b(BC2)--a(BC1)--b(BC2)--b(BC2)--b(BC2)--a (BC1)												

B. *TO-BE model*

The Order Prioritization Tool (OPT) incorporates both the qualitative and quantitative types of data for customer satisfaction criteria and order prioritization of each channel, based on individual goals, complexity, order delivery schedules and shipment places.The framework developed for the TO-BE model is shown in the fig 3. Fig 4 illustrates the order prioritization process of the OPT. Each business channel has its own list of criteria. A min max approach is applied for a particular business channel based on the number of orders available for it and dynamic weights are calculated for each criterion.

Quantitative type of data is evaluated for all the available orders depending on the range calculated for a specific criterion. Then 9 categories are formed from the dynamic range between the maximum and minimum values for every criterion. Each category is then assigned a weight ranging from 1 to 9, where value 9 is assigned the highest weight and 1 is the lowest weight. In the same way, the weights are assigned to the qualitative type of data based on the expert's opinion. The weights ranging between 1 and 9, where 9 is the highest weight. The calculated dynamic weight category from min max approach is then utilized to assign weights to the criteria of all available orders for a particular business channel in form of a performance matrix. Every criterion has independent importance value to the customer order

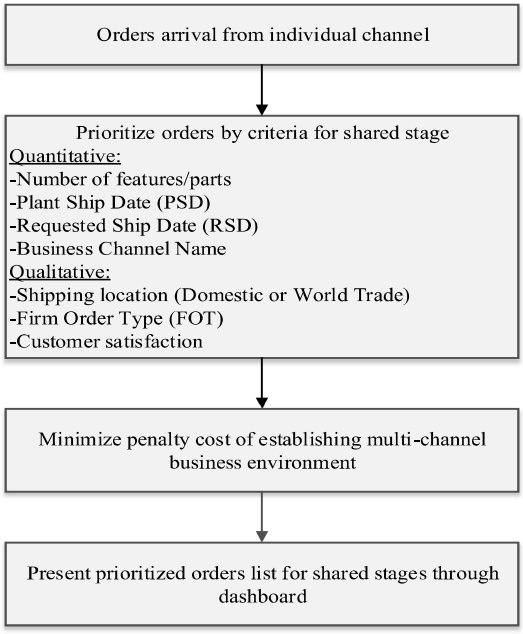

Fig 3: Framework for Order Prioritization Tool

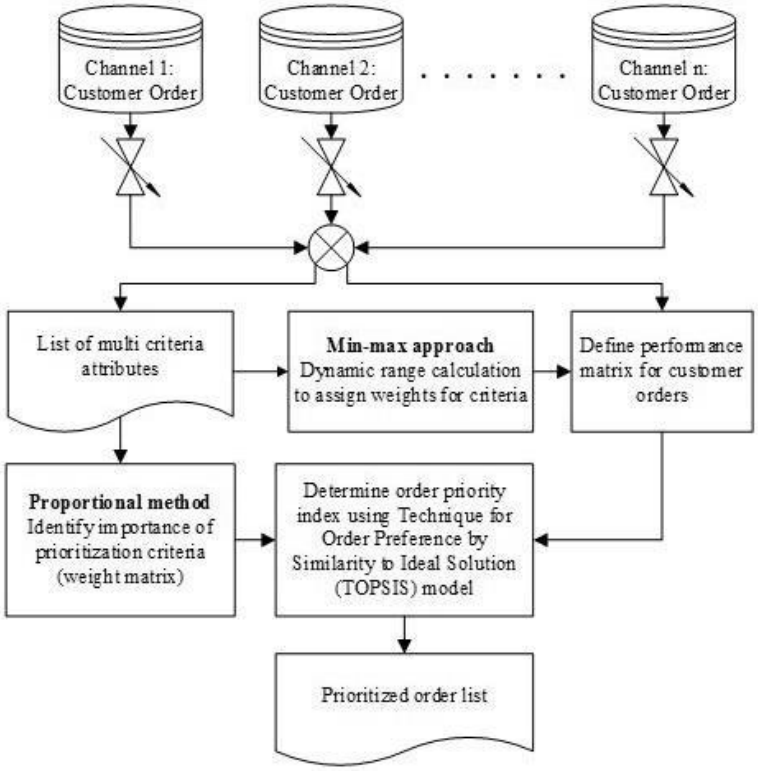

Fig4: Representation Order prioritization tool

Thus, by implying a proportional method, the importance of the prioritization criteria is recognized. The proportional method offers a pairwise comparison approach between two criteria by defining a matrix. The proportional matrix includes the proportions of all pairs, where elements aij +aji =1 and 0< aij <1, and the diagonal elements are zero [10]. The above mentioned proportional matrix and relative weights for the weight matrix are determined using the following two steps:

Step 1:

$$\begin{pmatrix} 0 & a_{12} & \cdots & a_{1n} \\ 1-a_{12} & 0 & \cdots & a_{2n} \\ \vdots & \vdots & \ddots & \vdots \\ 1-a_{1n} & 1-a_{2n} & \cdots & 0 \end{pmatrix} = \begin{pmatrix} 0 & b_{12} & \dots & b_{1n} \\ b_{21} & 0 & \cdots & b_{2n} \\ \vdots & \vdots & \ddots & \vdots \\ b_{n1} & b_{n2} & \cdots & 0 \end{pmatrix}$$

Step 2:

$$w_i = \frac{\sum_{j=1}^{n} b_{ij}}{\left(n \times \left(\frac{n-1}{2}\right)\right)}$$

n = total criteria defined.

b_{ij}= proportional weight of ith criterion in comparison with j^{th} criterion

w_i= i^{th} criterion weight.

On the basis of TOPSIS method, customer order priority indexes are calculated, providing ideal solutions with a positive and negative value on the basis geometric distance for multi-criteria decision making models [11, 12]. The final value obtained here lies between 0 and 1where the two extremes defines the negative and positively values of ideal solution respectively. Following the below mentioned TOPSIS steps, the order priority indexes are calculated:

Step1: Develop a performance matrix.

$$\mathbf{D} = \begin{array}{c} \\ A_1 \\ A_2 \\ \vdots \\ A_m \end{array} \begin{array}{c} \begin{array}{cccc} X_1 & X_2 & \cdots & X_n \end{array} \\ \begin{pmatrix} x_{11} & x_{12} & \cdots & x_{1n} \\ x_{21} & x_{22} & \cdots & x_{2n} \\ \vdots & \vdots & \cdots & \vdots \\ x_{m1} & x_{m2} & \cdots & x_{mn} \end{pmatrix} \end{array}$$

Where:

A_i= available customer orders

X_j= criteria for the customer order

Step 2: Performance matrix normalization.

$$r_{ij} = \frac{x_{ij}}{\sqrt{\sum_{i=1}^{m} x_{ij}^2}}$$

Where:

x_{ij} = j-th criterion value for i-th order

r_{ij}= normalized performance value of customer order A_i pertaining to criterion X_j

Step 3: Multiplying the performance matrix with its associated weights defined in weight matrix.

$$V = \begin{pmatrix} w_1 r_{11} & w_2 r_{12} & \cdots & w_n r_{1n} \\ w_1 r_{21} & w_2 r_{22} & \cdots & w_n r_{2n} \\ \vdots & \vdots & \ddots & \vdots \\ w_1 r_{m1} & w_2 r_{m1} & \cdots & w_n r_{mn} \end{pmatrix} = \begin{pmatrix} v_{11} & v_{12} & \cdots & v_{1n} \\ v_{21} & v_{22} & \cdots & v_{2n} \\ \vdots & \vdots & \ddots & \vdots \\ v_{m1} & v_{m2} & \cdots & vr_{mn} \end{pmatrix}$$

Where:

w_i= criterion X_j weight obtained from weight matrix

v_{ij}= normalized performance weight of order A_i pertaining to criterion X_j

Step 4: Calculate positive and negative ideal solutions using the formula below:

$$V^+ = \{(\max v_{ij} \mid j \in J) \text{ or } (\min v_{ij} \mid j \in J'), = 1, 2, \cdots, m\}$$

$$= \{v_1^+, v_2^+, \cdots, v_n^+\}$$

$$V^- = \{(\min v_{ij} \mid j \in J) \text{ or } (\max v_{ij} \mid j \in J'), = 1, 2, \cdots, m\}$$

$$= \{v_1^-, v_2^-, \cdots, v_n^-\}$$

Where

$$\boldsymbol{J} = \{j = 1, 2, \cdots, n | v_{ij}, \text{ a large response is desired}\}$$

$$\boldsymbol{J'} = \{j = 1, 2, \cdots, n | v_{ij}, \text{ a small response is desired}\}$$

Step 5: Calculation of separation measures

$$\text{Positive separation measure: } S_i^+ = \sqrt{\sum_{j=1}^{n} \left(v_{ij} - v_j^+\right)^2}$$

$$\text{Negative separation measure: } S_i^- = \sqrt{\sum_{j=1}^{n} \left(v_{ij} - v_j^-\right)^2}$$

Step 6: Calculation of relative closeness to ideal solution and then arrange the customer orders in a descending order of the calculated relative closeness values.

$$C_i = \frac{S_i^-}{S_i^+ + S_i^-}$$

v = performance matrix

V^+ , V^- = positive ideal, and negative ideal value set, respectively

S_i^+ S_i^-= separation measures from positive ideal and negative ideal solutions, respectively

C_i= relative closeness value whose range lies in between 0 and 1 ($0 \leq C_i \leq 1$)

The results of all the calculations are explained in the table 2.

TABLE II. ATTRIBUTES WEIGHTED MATRIX

NUMBER OF FEATURES	X_{ij}	CUSTOMER SATISFACTION	U_{ij}	SHIPPING DESTINATION	U_{ij}
# features > 88% of # features range	9	CUST_P > 5 and CUST_R > 5	9	World trade	9
# features < round(Min + (Max-Min)*0.88+ 0.49)	8	(CUST_P > 5 and CUST_R > 3) or (CUST_P > 3 and CUST_R > 5)	8	Domestic	5
# features < round(Min + (Max-Min)*0.77+ 0.49)	7	(CUST_P > 5 and CUST_R > 1) or (CUST_P > 3 and CUST_R > 3) or (CUST_P > 1 and CUST_R > 5)	7	**Business Channel Name**	$\boldsymbol{u_{lp}}$

# features < round(Min + (Max-Min)*0.66+ 0.49)	6	(CUST_P > 5 and CUST_R >= 0) or (CUST_P > 3 and CUST_R > 1) or (CUST_P > 1 and CUST_R > 3) or (CUST_P >= 0 and CUST_R > 5)	6	BC 1	9
# features < round(Min + (Max-Min)*0.55+ 0.49)	5	(CUST_P > 5 and CUST_R < 0) or (CUST_P > 3 and CUST_R >= 0) or (CUST_P > 1 and CUST_R > 1) or (CUST_P >= 0 and CUST_R > 3) or (CUST_P < 0 and CUST_R > 5)	5	BC 2	7
# features < round(Min + (Max-Min)*0.44+ 0.49)	4	(CUST_P > 3 and CUST_R < 0) or (CUST_P > 1 and CUST_R >= 0) or (CUST_P >= 0 and CUST_R > 1) or (CUST_P < 0 and CUST_R > 3)	4	BC 3	5
# features < round(Min + (Max-Min)*0.33+ 0.49)	3	(CUST_P > 1 and CUST_R < 0) or (CUST_P >= 0 and CUST_R >= 0) or (CUST_P < 0 and CUST_R > 1)	3	BC 4	6
# features < round(Min + (Max-Min)*0.22+ 0.49)	2	(CUST_P >= 0 and CUST_R < 0) or (CUST_P < 0 and CUST_R >= 0)	2		
# features < round(Min + (Max-Min)*0.11+ 0.49)	1	CUST_P and CUST_R < 0	1		
PSD	X_{ij}	**RSD**	U_{Ip}	**FOT**	U_{Ip}
PSD =0	9	RSD =0	9	Confirm	9
PSD < round(@GLOBAL_MIN(PSD) + ((@GLOBAL_MAX(PSD)-@GLOBAL_MIN(PSD))*0.14) + 0.49)	7	RSD < round(@GLOBAL_MIN(RSD) + ((@GLOBAL_MAX(RSD)-@GLOBAL_MIN(RSD))*0.14) + 0.49)	7	Not confirm	7
PSD < round(@GLOBAL_MIN(PSD) + ((@GLOBAL_MAX(PSD)-@GLOBAL_MIN(PSD))*0.28) + 0.49)	6	RSD < round(@GLOBAL_MIN(RSD) + ((@GLOBAL_MAX(RSD)-@GLOBAL_MIN(RSD))*0.28) + 0.49)	6	Internal	5
PSD < round(@GLOBAL_MIN(PSD) + ((@GLOBAL_MAX(PSD)-@GLOBAL_MIN(PSD))*0.43) + 0.49)	5	RSD < round(@GLOBAL_MIN(RSD) + ((@GLOBAL_MAX(RSD)-@GLOBAL_MIN(RSD))*0.43) + 0.49)	5	R/B	3
PSD < round(@GLOBAL_MIN(PSD) + ((@GLOBAL_MAX(PSD)-@GLOBAL_MIN(PSD))*0.57) + 0.49)	4	RSD < round(@GLOBAL_MIN(RSD) + ((@GLOBAL_MAX(RSD)-@GLOBAL_MIN(RSD))*0.57) + 0.49)	4	null/blank	1
PSD < round(@GLOBAL_MIN(PSD) + ((@GLOBAL_MAX(PSD)-@GLOBAL_MIN(PSD))*0.71) + 0.49)	3	RSD < round(@GLOBAL_MIN(RSD) + ((@GLOBAL_MAX(RSD)-@GLOBAL_MIN(RSD))*0.71) + 0.49)	3		
PSD < round(@GLOBAL_MIN(PSD) + ((@GLOBAL_MAX(PSD)-@GLOBAL_MIN(PSD))*0.85) + 0.49)	2	RSD < round(@GLOBAL_MIN(RSD) + ((@GLOBAL_MAX(RSD)-@GLOBAL_MIN(RSD))*0.85) + 0.49)	2		
PSD > 85% of PSD range	1	PSD > 85% of RSD range	1		

III. RESULTS

Thus, based on the descending order values obtained from TOPSIS method, the orders are prioritized . The ith customer order whose value is closer towards 1 gets higher priority. The orders are then transferred to their respective production departments as illustrated in table 2. The overall flowchart of model is presented in fig 5. In order to make the system presentable for users, an interface is designed for the visual display of TOPSIS output that can be utilized for orders management as well as the prioritization for different channel shown in fig 6. The software used for dashboard display is Visual Basic. The overall importance values calculated for defined attributes, using proportional method equations, is presented in the table 3. It defines the importance of an attribute relative to other. According to the table, the most significant attributes are PSD and FOT. Thus the final orders prioritized have been significantly affected by these attribute values since our objective was to defined the orders list based on both the operation and strategic level attributes.

TABLE III. IMPORTANCE MATRIX

NUMBER OF FEATURES	PSD	RSD	FOT	SHIPPING DESTINATION	CUSTOMER SATISFACTION	BUSINESS CHANNEL NAME
5	9	7	9	5	7	8

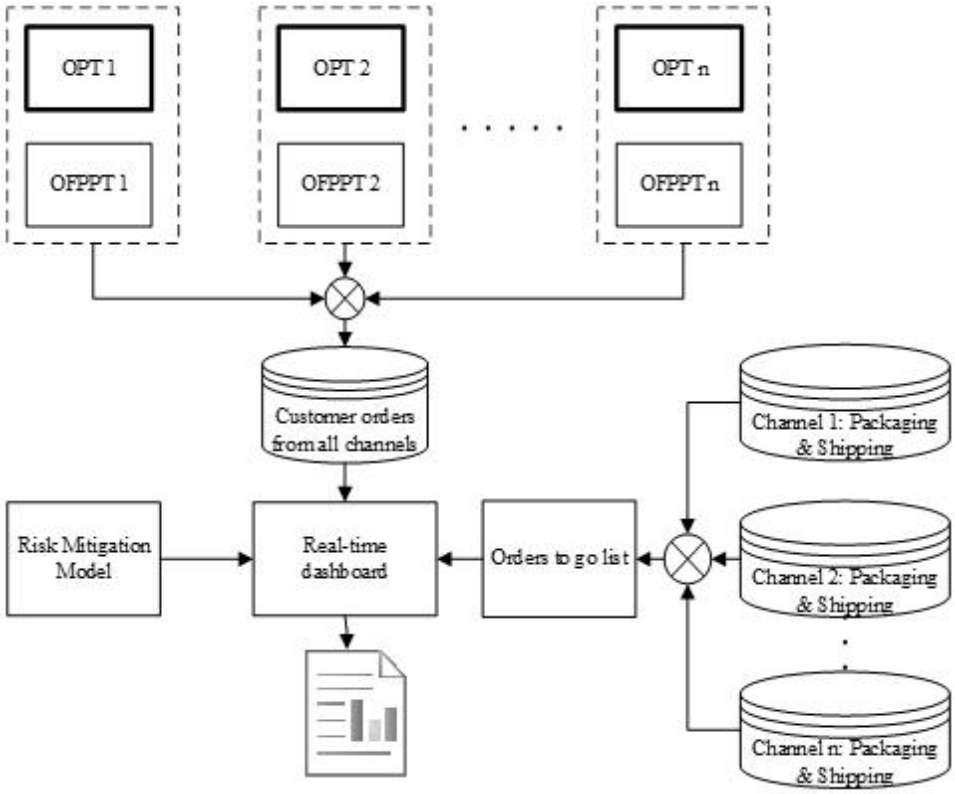

Fig 5: Illustration of OPT with dashboard interface

ROW COUNT	CHANNEL	SALES ORDER #	DUE DATE	SHIP DESTINATION	PACK & SHIP INSTRUCTION	COMPLETION TIME (HOURS)
1	1	107996038	10/12/2014	DOMESTIC	9244	25
2	1	149534652	10/13/2014	FOREIGN	9130	71
3	1	190172561	10/14/2014	FOREIGN	9571	99
4	4	101860454	10/15/2014	FOREIGN	9327	48
5	4	122753121	10/16/2014	FOREIGN	9244	79
6	1	124370982	10/17/2014	DOMESTIC	9130	100
7	4	106551220	10/18/2014	FOREIGN	9327	23
8	1	140382454	10/19/2014	FOREIGN	9327	24
9	4	191319434	10/20/2014	DOMESTIC	9244	56
10	3	189764527	10/21/2014	DOMESTIC	9571	37
11	1	118901527	10/22/2014	FOREIGN	9327	64
12	1	106772665	10/23/2014	FOREIGN	9701	31
13	1	122679494	10/24/2014	DOMESTIC	9244	48
14	1	191406460	10/23/2014	FOREIGN	9701	41
15	2	124865854	10/26/2014	DOMESTIC	9248	27
16	1	126092751	10/27/2014	DOMESTIC	9244	48
17	3	166024605	10/28/2014	FOREIGN	9248	54
18	2	159144444	10/29/2014	FOREIGN	9701	85
19	2	138863406	10/30/2014	DOMESTIC	9571	91
20	1	187782142	10/31/2014	FOREIGN	9248	78
21	4	131681819	11/1/2014	FOREIGN	9244	86
22	4	147023708	11/2/2014	FOREIGN	9701	49
23	4	138811335	11/3/2014	DOMESTIC	9130	43
24	4	183398472	11/4/2014	FOREIGN	9701	62

Fig 6: Order Management Dashboard

IV. CONCLUSION:

The study presents an order prioritization model for a multi-channel business environment. Based on the real-time data, the customer order prioritization tool prioritizes the orders for a shared production stage within a multi-channel business environment.. The technique incorporated multiple strategic and operational levels attributes for decision making. The TOPSIS method eliminates the biasness in the decision support mechanism. Therefore, the model can be applicable in a production environment where strategic and operation levels decision support attributes needs an equilibrium. It can be utilized in any multi-channel business environment with the effective results on the order placement process for different production lines, on the basis of multiple attributes regarding production lines as well as the company's strategies. In future, this research can be extended by conducting a comparative study among various methods of decision making with multiple criteria including TOPSIS, AHP, weighted product model, and weighted sum model.

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