Creating a KPI Tree for Monitoring and Controlling Key Business Objectives of First Mile Logistics Services

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Abstract

One of the key assets of an Ecommerce platform is its logistics services. First Mile Logistics is a term usually applied to the leg of supply chain which is responsible for picking products from sellers and delivering them to the hub or warehouse of an ecommerce company. Effectively defined key process indicators in any organization help them to be both efficient and effective.

By applying the methodology discussed in this paper an E-commerce organization of global repute was able to successfully define the Key Performance Indicators (KPI) related to its First Mile Logistics section of the overall supply chain. The KPI tree helped the organization to create a supply chain reliability measurement and control visualization platform that enabled it to control the existing process, identify and resolve assignable abnormalities there by ensuring stable supply chain. A well designed KPI tree will also enable an organization with insights required for future capability building.

Keywords: Logistics; KPI; First Mile; Ecommerce; Supply Chain

1. Overview of Supply Chain Logistics Ecosystem

E-Commerce organizations across the world usually resort to a two-prong approach to cater to their customer demand. Products purchased online by the customers, will be fulfilled either from the Inventory placed in the fulfillment centers (FC) or warehouses or through marketplace created by aggregations of sellers who are listed in the platform and can cater to the orders placed by customers. Once the purchasing cycle is over the product flows through the fulfillment cycle within the supply chain before it is delivered to the customer at his doorstep.

The detail processes are as explained below:

For marketplace model, the process starts from picking up the shipments from seller's location and connecting it to the sortation center. In case of inventory led model, the products are procured from sellers, brands, original equipment

manufacturers and distributors well in advance basis demand forecasting and are labeled and stored in the FC/warehouses until an order is placed. Once an order is placed the product is picked packed and are made ready for downstream connection from sortation centers. In both the models once the product reaches the source sortation centers they are segregated basis the destination location and are connected through the line haul/transport network to destination sortation center. From the destination sortation center in the next step the product gets re-sorted to the pin code wise delivery hub locations and are connected by the transport network. On reaching the delivery hub the shipments are segregated basis ultimate destination locations and using the last mile logistics network they are delivered to the customer.

Another important aspect of e-commerce is the reverse logistics. The returned shipments are picked from the customers, connected back to sortation hub, which in turn connects it to the source which can be a FC or seller. The returned goods, basis the product condition, are cycled back into the inventory, refurbished, restocked and relisted.

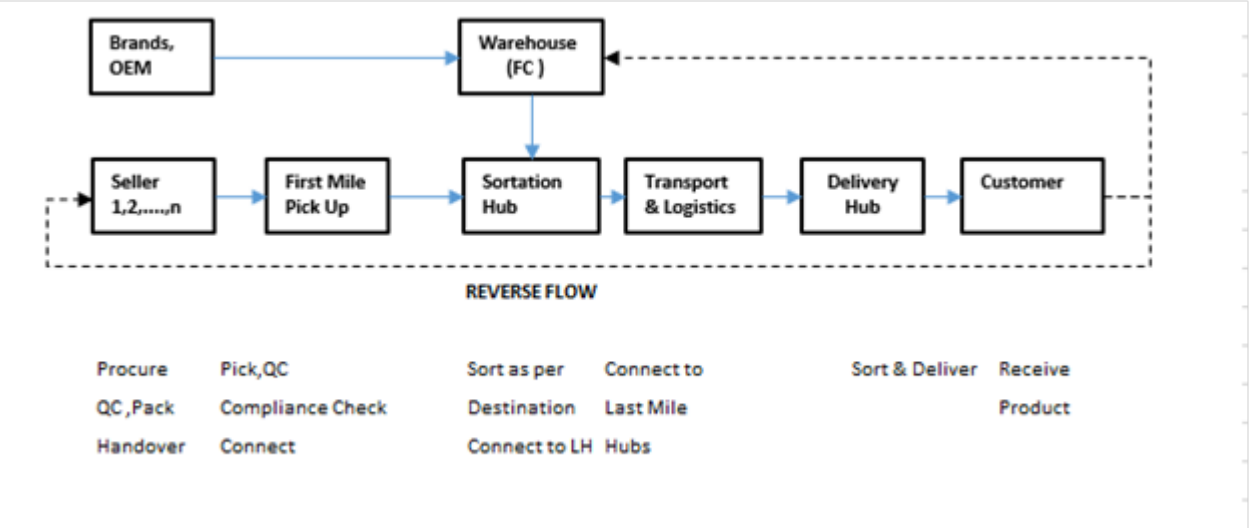

Fig 1: Supply Chain Value stream

2. Defining the First Mile of a Supply Chain

First Mile essentially refers to the leg of fulfillment cycle where products are picked up from sellers and are connected to the sortation centers to facilitate the further downstream connections to deliver the product on time to the customers. The essential value adds in First Mile process is to pick up the right product at the right time, carry out quality inspection to ensure right product quality and packaging standards, connecting the product to the downstream network at the right time and enhance seller experience during this entire journey. First Mile also has a reverse logistics arm through which undelivered or returned customer products are connected back in the right condition to the origin in this case the sellers.

3. Why Key Performance Indicators (KPI) are important in any Supply Chain

Management thinker Peter Drucker is often quoted as saying that "you can't manage what you can't measure." Drucker means that you can't know if you are successful unless success is defined and tracked. Key Performance Indicators or KPI's help organizations measure business and process performances to have better control on their performance and as next step helps organizations to improve from the existing state to a future state. KPIs should follow the SMART criteria. This means the measure has a *Specific* purpose for the business or organization, it is *Measurable* to really get a value of the KPI, the defined norms should be *Achievable*, the improvement of a KPI must be *Relevant* to the success of the organization, and finally it must be *Time phased*, which means the value or outcomes are demonstrated for a predefined and relevant period. KPI's helps organization focus on their supply chain priorities and formulate strategies to have a competitive advantage.

4. Key guiding principles that need to be considered while defining critical factors for First Mile Logistics

Critical factors and KPI's in a supply chain organization reflect the design philosophy based on which a supply chain process has been designed and optimized for. When we talk about First Mile supply chain for any E-commerce organization we believe the key design philosophy that should form the guiding principles should primarily be pivoted on five pillars as depicted in figure 2.

Fig 2: First Mile Supply Chain Design guiding principles

4.1 Speed & Reliability: Speed plays an important role in defining the time for completion of set of operational activities in the supply chain. Speed in FM is an intricate part of the overall commitment of our time of delivery to end customer. The idea is to design and validate a time between which a customer should be delivered a product once it is ordered on the E-commerce platform. Organization across the world have done detailed analysis to arrive at the optimum time beyond which customer willingness to order from the platform drops. For first mile supply chain speed is also a key differentiator and a great value proposition to have the best sellers in your market place ecosystem. Great speed ensures more order conversion, less cancellation and overall revenue growth for sellers. One important proxy for speed is the ability to define and measure the breach to defined time lines. While speed gives an organization a competitive advantage, being able to demonstrate speed repeatedly i.e. being reliable helps in building the trust or credibility in front of your sellers and finally for your customers. So, speed and reliability together are what drives seller and customer experience.

4.2 Cost & Shrinkage: One of the unique and winning value propositions for customers to shop on the online E-commerce platform apart from convenience is the price advantage. One important driver to pass on the price advantage to customer for E-commerce supply chain is to optimize on cost. Apart from the buy sell margin, logistic cost is an important element which determines the overall profitability of any E-commerce organization and determines its sustenance and valuations in the long run. Hence the objective function of a supply chain design is to maximize speed and reliability but at the right or optimal cost. Apart from supply chain delivery cost another key component of overall logistic cost is the losses incurred in the supply chain due to shrinkage or pilferage, shipment damaged or wrong shipment picked and delivered. So, an effective first mile supply chain cost should include both logistic cost as well as shrinkage cost.

4.3 Resource View: The internal engine that drives the effectiveness and efficiency of first mile supply chain is the resource-based approach. To evaluate its supply chain performance all organizations typically try to measure the output that is delivered given a set of input resources. Few commonly used metrics that are frequently taken into consideration are productivity, availability or its inverse, absenteeism and utilization of manpower and fleet. While productivity gives us a measure of the capability of a resource to pick up a certain quantity of shipments within a finite time availability gives us a measure of how often this resource is at the disposal of the supply chain to carry out its task. Utilization on the other hand is like a compass which measures the effectiveness of supply chain while it is being efficient.

4.4 Employee Experience and safety: At the heart of any sustainable supply chain design are its people or employees. It is the single most important prerogative of any leader to ensure superior employee experience and engagement. Hence an employee centric sustainable supply chain process should be able to measure and improve the experience of internal stakeholders who run the supply chain engine. The objective is to maximize employee satisfaction, minimize incidents and prevent accidents so that we can create a supply chain ecosystem based on learning, safe practices and performance orientation.

4.5 Seller experience: While the above four principles are important for any leg of a supply chain, seller experience is something specifically applicable for first mile logistics. The basic tenet of this guiding principle is to design the processes such that it leads to seller delight. Also, equally important is to create a process for Seller escalation/grievance management and resolution and to create proactive measures to prevent future incidents. Two important metric which helps us measure and improve seller experience are seller NPS & seller incidents per unit (IPU) count and resolution time.

5. Methodology used for KPI Tree creation

The First Mile process can be thought of as a flow of physical product and information that originates from a customer order and moves in the direction is picked up by FM logistics team, and processed further. The flow terminates when the Mother Hub confirms receiving of the product(s) from FM.

5.1 Process Mapping

The efficiency of the overall process is a function of efficiency of the individual processes and sub-processes. Thus, to develop metrics to define, measure and control the efficiency of the process, it was important that process performance indicators(PPIs) be collected and prioritized. The first task that was undertaken was to map the process from end to end, and at a level that was granular enough for the team to be able to determine the potential root cause of a failure mode.

A high-level process flow of the forward leg is given below:

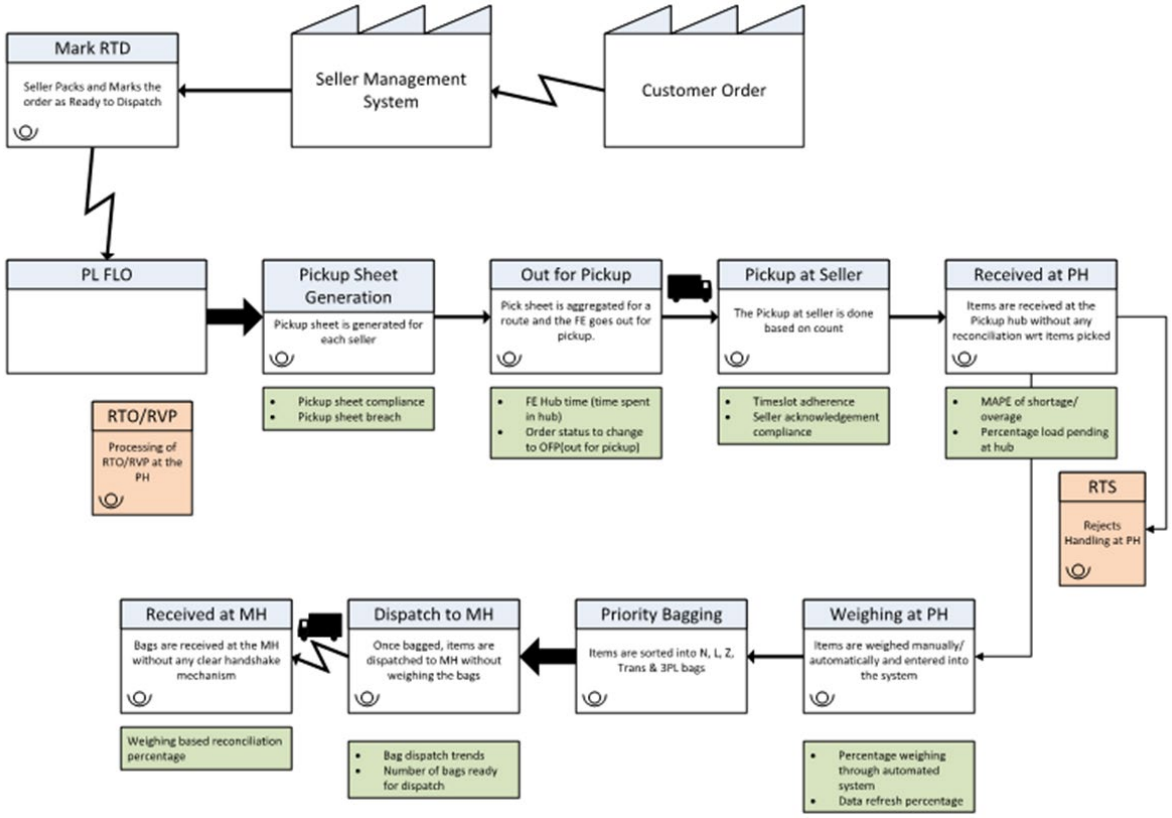

Fig 3: High level process map of FM forward flow

Every process step was subjected to metric mining, so that the end would be a repository of all possible PPIs. As a demonstration of the stated method, the metrics from the process boxes and their corresponding PPIs (shown in Green boxes) as displayed in Fig 3 were created using a variant of FMEA (Failure Modes and Effects Analysis)[1].

5.2 Process Analysis using FMEA

FMEA is a process analysis tool which employs a step-by-step approach of identifying potential failures in a process or product. The primary objective of creating an FMEA is to identify ways the product or process can fail and eliminate or reduce the risk of failure. A high-level schematic of FMEA is provided in the figure below Fig 4.

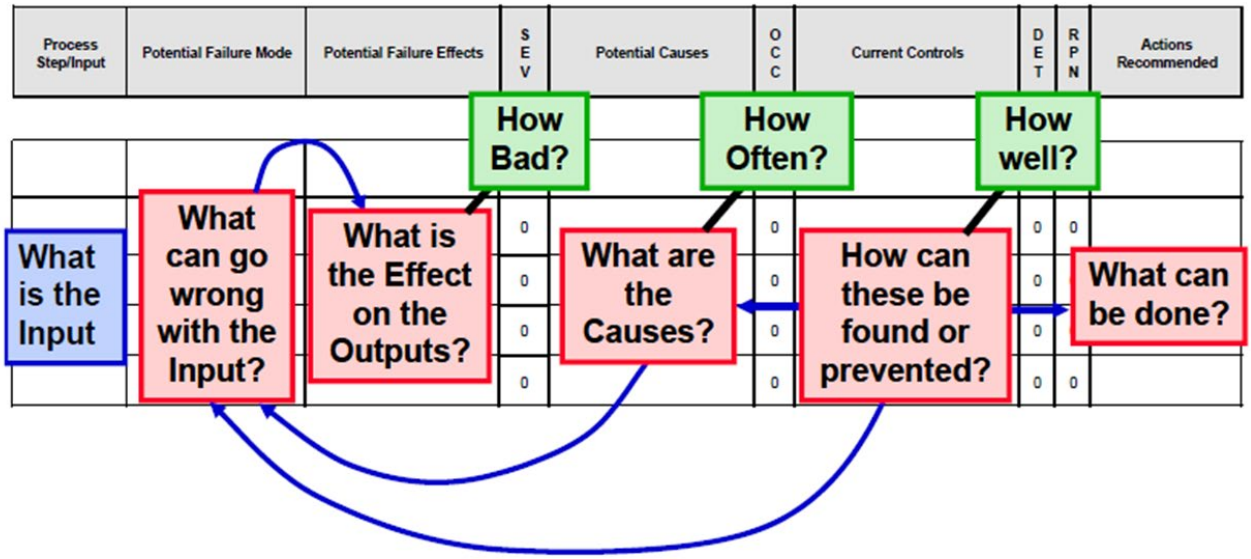

Fig 4: Schematic of FMEA

For each function, all potential ways a failure could happen are identified. These are labeled as potential failure modes. For each failure mode, all the consequences on the system and related processes are identified. These are potential effects of failure.

For each failure mode, potential root causes are determined. There are other steps involved such as creating a scale and rating parameters such as severity (of failure effects), occurrence (of potential causes) and detection (capability of control mechanisms). A product of the three is called RPN (Risk Priority Number) which is used to prioritize the risks.

However, our purpose was not to create a complete FMEA, but to generate metrics which would capture occurrences of causes and effects of failures. An example of our metric generation process is shown in the table with the box labeled 'pickup at seller' from Fig 5. The column 'Control Metric' was what the team was interested in, and outputs from our abridged FMEA exercise were collected to form the repository of PPIs.

Process Step	**Failure Mode**	**Potential Cause**	**Control Metric**
Pickup at Seller	Wrong product picked	HHD/Server Failure	HHD adherence
			HHD uptime
		Manual picking error	Imperfect pickup
	Product not picked	HHD/Server Failure	HHD adherence
			HHD uptime
		FM Logistics planning issue	Pickup compliance/Pickup sheet creation breach
		Seller not ready with product	Seller Pickup Adherence
			Seller Acknowledgement Compliance
			Seller Reattempt%
	Delay in picker arrival	FM Logistics planning issue	Pickup attempt breach

Fig 5: Generating PPIs using FMEA philosophy

A similar exercise was conducted on process map of the reverse flow, the bird's eye view of which is given in Fig 6.

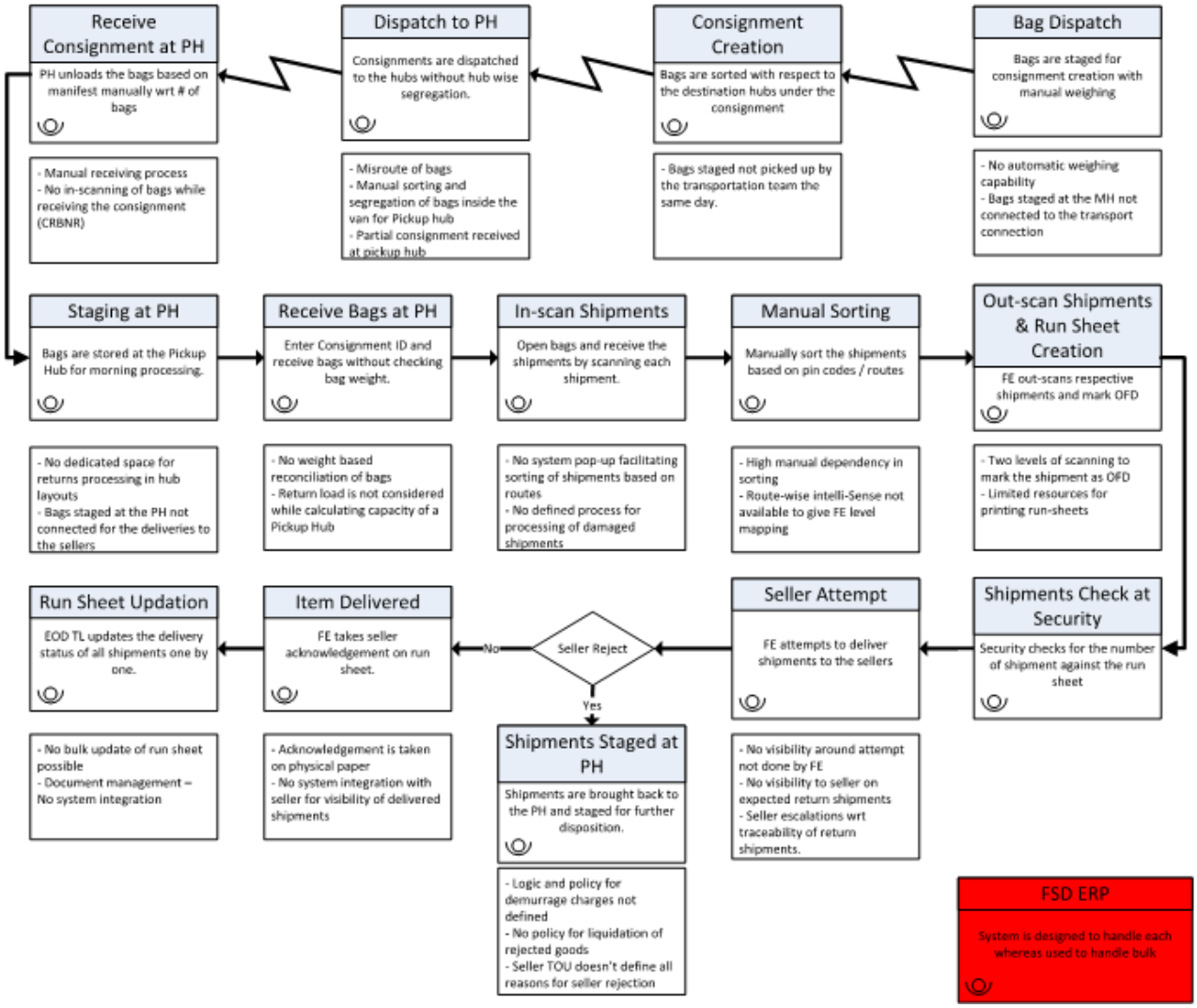

Fig 6: High level process map of FM reverse flow

We continued metric generation through the method stated above. While this is a robust method of generating PPI's, there were other metrics we wanted to add, which was not generated through the process above. There were metrics such as vendor satisfaction metrics, pin code serviceability, employee performance indices, seller classification and capacity utilization, which needed an additional effort to create. The team conducted a 6-3-5 brainwriting [2] session to collect ideas for such metrics.

5.3 Collecting additional metric via brainwriting

The 6-3-5 brainwriting exercise involved 6 participants who were required to write down 3 ideas on a specific worksheet within 5 minutes. The sheets were then passed on to the next member, and based on the ideas already on the sheets, the members wrote additional metrics or tried to build upon what was suggested by the earlier writer. The iterations were conducted 6 times, after which the participants were asked to collate the ideas. The ideas were captured as metrics and added to the repository that contained information captured through the variant FMEA exercise.

The next step forward was to define, organize and structure the metrics in a form that could be better comprehended. The nomenclature was defined, as in the data type that was to be used, the calculation logic, purpose, reporting level (city, pan nation) as well as reporting periodicity from the point of view of whether the reporting would make most

value if circulated daily, monthly, weekly or a combination of these. A snapshot of the outcome of this evaluation exercise is give in the fig below.

	Report	Definitions	Purpose	Frequency							
				Daily	Weekly	Monthly	L1	L2	L3	L4	
Receiving process	RTO/RVP Received vs	RTO/RVP Received vs OFD	Visibility of pending						City Level	Hub Level	
	RTO/RVP Received vs Actual	RTO/RVP OFD vs actual	Visibility of pending					Zonal	City Level	Hub Level	
	RTS %	RTS % of total shipments	Visibility of shipments				National	Zonal			
	RTS outscan TAT	Time elapsed between RTS receive and dispatch	To monitor RTS processing TAT at PH					Zonal	City Level	Hub Level	
	RTO/RVP tat	Time elapsed between RTO/RVP receive and OFD	To monitor RTO/RVP processing TAT at hub					Zonal	City Level	Hub Level	
	FE Productivity (Bike)	# of FEs vs. # shipments	To monitor FE productivity				National	Zonal	City Level	Hub Level	
	Van Productivity	# of vans vs. # shipments	To monitor hub productivity				National	Zonal	City Level	Hub Level	
	Shipment Connection % (Day 0, 1, 2, 3, 3+)	# shipments dispatched to TC vs # shipments picked	To monitor hub efficiency				National	Zonal	City Level	Hub Level	
	Shipment Picked % (Day 0, 1, 2, 3, 3+)	# shipments picked vs # shipment pickup request	To monitor day-wise pick up percentage					Zonal	City Level	Hub Level	
	Seller Performance - Load	# shipments handed over	To understand pickup								
	Shipment Receiving Breach (Route end time slot +	Percentage of shipments received at PH or MH post	Reduce late receiving at MH						City Level	Hub Level	
	Weight Related Escalations	Number of seller escalations related to	Reduce shipment weight related issues					Zonal	City Level	Hub Level	
Dispatch process	Bag Dispatch Time Trend	number of bags dispatched	To monitor and smoothen						City Level	Hub Level	
	Bag Dispatch Breach - Not Meeting the Dispatch time to	Percentage of bags dispatched to MH post	Reduce late dispatch from PH					Zonal	City Level	Hub Level	
	Bag Receive Time Trend	number of bags received at	To monitor and smoothen						City Level		

Fig 7: PPI definition and reporting matrix

The purpose of building an exhaustive PPI collection was to ensure that no aspect of the process which could negatively impact the business, customer or seller, could slip through the cracks.

6. Selecting KPIs from PPIs

The BI reporting cluster which monitors the PPIs serves an important role in terms of assessing performance and keeping a close eye on risks. This is of paramount important during special days, such as sales, to understand bottlenecks and potential threats which may hamper smooth functioning of the supply chain.

For enabling a quick glance to understand the health of the FM supply chain, we proceeded to create KPIs from KPIs. The audience of this set of key metrics is functional heads and senior management, including Directors and VPs.

6.1 The Pugh Matrix

The selection of metrics for KPIs was conducted through a method known as solution selection matrix or Pugh matrix [3]. The method involves group discussion to select criteria for PPI measurement, and assigning weights to them based on expert judgement. The weights were given on a scale of 1-3-9, where 1 meant that the criteria were of low importance, and 9 meant that the criteria had high importance. 3 was obviously, the medium importance criteria. The team chose experienced members from multiple teams and created the Pugh Matrix.

Once this was completed, the PPIs were given ratings based on what the team decided the level of impact the PPI had on the corresponding criteria. This again is scaled on a 1-3-9 measurement system, with 1 meaning low impact, 3 meaning medium impact and 9 meaning high impact on the criteria.

The final score of the PPI is the sum product of the criteria weight array and the rating array of the PPI.
An example of the implementation of Pugh Matrix is given in Fig. 8 below. The PPI set belongs to the breach class. All the PPIs from the repository were subjected to this prioritization analysis, and the outcome was a set of KPIs, as they were found to be key among PPIs.

Pugh Matrix		Breach Tree						
Criteria	Weightage	Seller Reattempt%	Reattempt %	Logistics Reattempt %	Seller-related issue	Logistics Issue	Pickup breach	PH Breach Not dispatch same day
Cost	9	3	3	3	1	3	3	3
Utilization	3	1	3	3	1	3	3	3
Breach	3	9	9	9	9	9	9	9
Speed	9	9	9	9	9	9	9	9
Scale	3	1	3	3	1	3	3	3
Reliability	9	1	1	3	1	3	3	3
Seller Experience	3	1	1	3	1	3	3	3
Escalations	3	1	3	3	1	3	3	3
Productivity	3	3	3	3	1	3	3	3
		165	**183**	**207**	**141**	**207**	**207**	**207**

Fig.8: Snapshot of Pugh Matrix for Evaluating Breach related PPIs

6.2 KPI baselines and benchmarks

Baselines were created by deciding statistics which would most suit the nature of the metric, and the underlying distribution of the data. For example, time related metrics such as speed have a skewed distribution with a heavy tail, due to which using an arithmetic mean would not make sense. The statistic used here was a 95^{th} percentile. On the other hand, seller escalations were well captured by using an average escalation in a week, as the data was randomly spread out and could be approximated by using a Poisson distribution.

The next step in creating the KPI dashboard was adding benchmarks. The team studied historical data from the FM process for the past 2 years, and the correlation between risks and metric performances. This helped in defining the acceptable levels of performance for KPIs, that would ensure optimal risks, cost and seller experience.

7. Output of a KPI Tree definition exercise

A simple visualization of the output of KPI tree building exercise can be as depicted in figure 3. The KPI dashboard clearly indicates the metric that needs to be discussed in weekly leadership reviews. The dashboard creates visibility around as is and target values and for situations where as is values do not meet target expectations then respective teams to provide root cause analysis for nonconformance. Organizations most often also measure the trend to predict or understand future state of KPI's.

KPI	Metrics		UOM	July (3-9) Wk-27	July (10-16) Wk-28	July (17-23) Wk-29	July (24-30) Wk-30	RCA
Scale	Shipments Picked	Plan	Lacs	14.8	16.3	15	14.3	
		Actual		12.6	12.42	12.29	11.86	
	Returns Delivered	Plan	Lacs	3.1	3.8	3.99	3.7	
		Actual		3.7	3.6	3.75	3.2	
	Demand Attainment	Plan	%	100	100	100	100	
		Actual		91.1	79.7	84.5	83.7	Category level planning error
Breach	FM CP Breach	Plan	%	0.1	0.1	0.1	0.1	
		Actual		0.09	0.14	0.09	0.2	Seller dependency
	Perfect Pickup	Plan	%	98.8	98.8	98.8	98.8	
		Actual		90.7	99.1	99.1	98.1	HHD down time
Reliability	Spillage	Plan	Days	0.2	0.2	0.2	0.2	
		Actual		0.36	0.11	0.8	0.15	Holiday and absentism
	RTD to MH Connect Day (0+	Plan	%	95.0	95.0	95.0	95.0	
		Actual		98.2	98.8	99.0	99.2	
Seller Experience	CEO Escalations	Plan	%	-	-	-	-	
		Actual		2	2	1	3	Thrid part delivery
	Seller NPS	Plan	%	55	55	55	55	
		Actual		54	55	59	56	Drop in NPS from North zone
Cost	Capacity Utilization	Plan	%	85%	85%	85%	85%	
		Actual		85%	80%	74%	86%	
	CPS	Plan	INR	12.0	12.0	12.0	12.0	
		Actual		11.7	12.1	13.4	13.9	

Fig. 9: Snapshot of KPI Tree Dashboard with Targets and Root Cause Analysis

8. Conclusion

Through this paper we wanted to demonstrate the process and the philosophy that can be adopted by any E-Commerce organization to define KPI tree for any leg of their supply chain. The paper clearly articulates the benefits of a KPI tree for any organization to manage its present and to plan for its future. We also touched upon how to identify the key guiding factors for any supply chain design. We spoke about how process map and FMEA acts like essential building blocks of any KPI tree. Finally, through the representation of a KPI tree visualization dashboard we wanted to communicate how the theory and practical application can be seamlessly merged to create an ecosystem of better monitor and control of any supply chain.

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Biographies

Sarvartha Kanchan is currently working as a Director of Supply Chain Design for Flipkart India Pvt. Ltd. He earned B.Tech. in Electronics and Communication Engineering from Technical University of Uttar Pradesh, India and Masters in Operations Management from ICFAI University, India. Sarvartha has worked in supply chain environment of highly regulated / process driven manufacturing companies like GE Healthcare, Britannia Industries Limited and complex logistics and warehousing domain with Flipkart. He has worked across different supply chain functions namely, Strategic Sourcing, Vendor Development, Process Engineering & Quality, Materials Management and Order Fulfillment. He was responsible for driving efficiency improvement projects in supply chain at a corporate level and was looking at end to end value chain for driving LEAN Six Sigma improvements. Currently he is looking at transforming supply chain design to improve speed, reliability and cost for the logistics function of Flipkart. His interests include vendor development, manufacturing, simulation, optimization, design for six sigma and lean. He is member of ASQ, APICS, WERC.

Tridev Kundu is currently working as a Senior Manager Supply Chain Design in Flipkart Internet Private Limited. He earned his MBA from Indian Institute of Management (IIM) Bangalore, India. In his career spanning over twelve years Tridev has worked across Manufacturing and Consulting organizations in various roles spreading across new product design, SNOP, manufacturing process design and optimization and process excellence leveraging Lean & Six Sigma. In Flipkart, Tridev is trying to build the most responsive, dynamic, cost effective and technology enabled Supply Chain for India.

Sudipto Dasgupta is currently working as a Specialist – Process Design for Flipkart India Pvt. Ltd., the largest e-commerce organization in India. He has 15 years of experience in process improvement, process design and advanced analytics in domains such as software, market research, education and supply chain. He is an experienced Six Sigma Master Black Belt and project management professional (PMP) with an educational background in Mathematics and Statistics. He has an active interest in the Data Sciences.