Always fresh. But always available?

Managing inventory

Dan Busilan

Bryan Meneses

Angela Climenhaga

Angelica Chavez

Sandeep Sharma

4/2/2015

TABLE OF CONTENTS

1.0 EXECUTIVE SUMMARY

Since opening its first restaurant in Hamilton, Ontario in 1964, Tim Horton's has focused on top quality, always fresh product, value, exceptional service and community leadership. It has become the largest quick service restaurant chain in Canada with a growing number of locations globally.

Recently, the Tim Horton's located in the Katz Building at the University of Alberta has been experiencing inventory issues during high demand periods. This has resulted in staff borrowing stock from other Tim Horton's branches; frustration from customers and staff alike and general confusion on the actions needed to better manage the inventory issues. As customer growth has continued over the past 5 years, resulting from excellent brand marketing by Tim Horton's and limited competition near this location, the inventory shortage continues to become more frequent.

A better understanding of inventory assessment and optimization is needed to manage this increasing problem. Several proposed solutions are further detailed and deal with specifics in applying Material Requirement Planning techniques to identify: root causes surrounding the inventory shortages and performance levels; regular monitoring of the changing seasonal demands and applying appropriate purchasing strategies to effectively improve forecasting of inventory usage and eliminate consistent shortages; and advance the work flow of staff to allow more engagement in monitoring the inventory demands.

Upon implementation of the proposed solutions, there will be efforts of continuous improvement and monitoring of inventory, forecasting of demands and managing of staff competency, to ensure that processes and systems continue to be well managed and optimized. The DMAIC technique will be applied for continual refinement of the inventory management systems.

An effective inventory management system and appropriate training for staff will achieve optimal inventory quantities and reduce overall operating risk. It will also ensure that Tim's Horton's continues to evolve with the changing environment and deal with future uncertainties in the market.

2.0 COMPANY DETAILS

Tim Horton's focus on top quality, "always fresh" product, value, exceptional service and community leadership has allowed it to become the largest quick service restaurant chain in Canada, with a growing number of locations globally. Tim Horton's has over 3,670 restaurants, some of which are a number of non-traditional locations in gas stations, convenience stores, universities, hospitals, office buildings and airports. Tim Horton's is the undisputed coffee leader in Canada, the #1 most trusted coffee retailer brand and also one of the top 100 most loved companies in the world.

Tim Horton's operation is primarily franchise owned and operated. Five warehouse distribution centers, located in Guelph, Ontario; Calgary, Alberta; Delbert, Nova Scotia (Truro); Kingston, Ontario; and Aldergrove (Langley), British Columbia presently service the Tim Horton's restaurants across Canada and the US. A fleet of branded trucks deliver food and supplies from its distribution centers to the restaurants.

Tim Horton's located in the Katz Building within North Campus of University of Alberta and next to Children's Hospital, has been serving coffee, tea, donuts, breakfast, and sandwiches since November 2009. This location offers the Tim Horton's products not only for over 39,000 students taking programs in at the university but also for doctors, patients and their families, and other people who visit Children's Hospital and its surroundings, such that long queues are observed every day in this restaurant.

This location is currently operating with a staff of twenty employees, including one supervisor, one assistant manager and one store manager. It is open Monday to Friday from 06:30 to 18:30. This location has a storage area within the restaurant. For receiving and storage of store products, the manager counts all products received and ensures that first-in-first-out inventory methodology is being practiced.

3.0 ISSUE IDENTIFICATION

The Tim Horton's restaurant, located in the Katz building at University of Alberta, finds itself running out of large coffee cups almost every week for the past 5 years of operation. Shortage of coffee cups affects operations during peak periods, straining both employees to find alternatives and customers receiving service below expectations.

The occurrence of running out of cups typically happens during the week on average of 3 times per month. This issue is most prevalent during the peak seasons, when the student population increases during start of the semester and exam week. Inventory is typically not an issue through reading week (February) or spring/summer sessions (May-August).

The lack of large coffee cups typically results in the restaurant needing to borrow inventory from other stores during shortages. This is typically done by the manager travelling to other Tim Horton restaurants during business hours.

To further analyze the issue, a cause and effect method was utilized (Ishikawa). This technique structures brainstorming and issue identification to organize and focus ideas and concepts to identify underlying issues and apply operations management concepts for potential solutions. Using a service industry model, the categories analyzed - surroundings, skills, suppliers and systems

Surroundings:

- Limited space for stocking/ holding cups
- Borrowing stock from other restaurants
- Cold weather increases coffee consumption

Skills:

- Not effective forecasting of usage for peak hours of operations
- Monitoring the cup usage with no distinct inventory management procedures
- Not effectively communicating inventory needs for the next shift
- Manager has no planning methodology on purchasing and re-ordering
- “Double-cupping” of customers wasn’t monitored or anticipated with reordering

Suppliers:

- Limited number of suppliers
- Recalls/ rejects are not accounted for
- No substitute available for cups
- No alternative for “Double-cupping” request of customers

Systems:

- No effectiveness in inventory management practices
- No monitoring of cup losses in the inventory management system
- Retrieval for shortage are done manually

It is understood that there are no issues with the coffee cup supplier because communication between the restaurant and supplier are good and inventory is regularly replenished when the supplier receives an order. This indicates that vertical integration linkages are well established and operating.

4.0 OPERATION DEFINITION

In order for the Katz building Tim Horton's to improve on its customer service, management must first improve the inventory issues surrounding large coffee cup shortages. By applying the theory of Six Sigma and DMAIC (Define, Measure, Analyze, Interpret and Control), and examining the current procedures, Tim Horton's can evaluate different methodologies to resolve the underlying issues previously identified.

Process flow charting is a simple and basic quality control tool used in quality improvement programs to collect, present and analyze any type of process. In service operations, flowcharts are often referred to as "service blueprints". The purpose of using this application is to provide management with the proper information to make better decisions about how to design and improve process performance. In flowchart analysis, the various tasks required to produce a given product or service are properly sequenced and any bottlenecks that limit the overall capacity of the process are identified. From a quality improvement perspective, flowcharting helps identify those steps in the process that could be further improved.

The steps required to produce either a good or service are identified in the process flow charts. Tasks are typically represented as rectangles, wait times or inventories as inverted triangles and decision points as diamonds. Arrows connecting these activities show the direction of flow in the process, as per Figure 1.

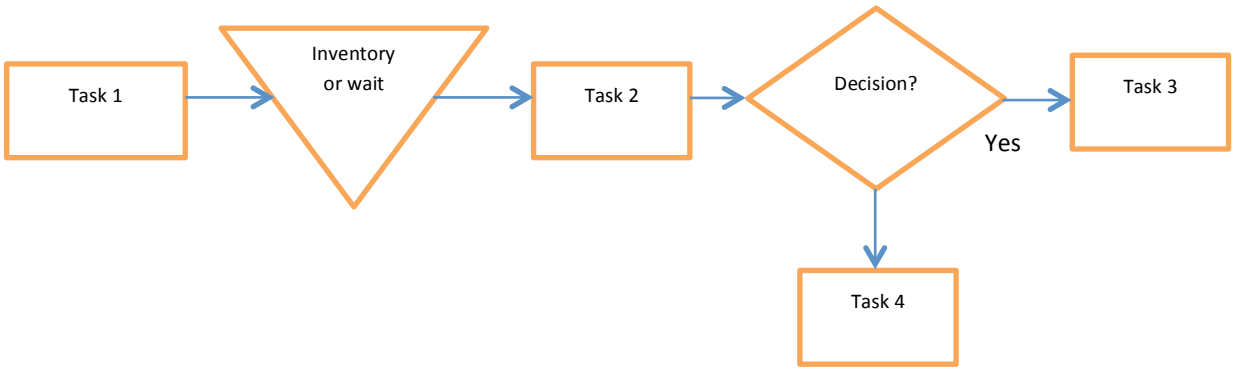


FIGURE 1: PROCESS FLOW CHART EXAMPLE

MATERIAL REQUIREMENT PLANNING

One of the main tasks identified in this process flow chart deals with inventory. It is important to understand the concept of material requirement planning and how inventory levels are affected by purchasing strategies. Well-defined purchasing strategies allow for development and management of supplier relationships to acquire goods and services for optimizing the supply chain needs and mitigating inventory issues.

Successful material planning requires continual communication between all levels of the supply chain. Strong vertical strategic linkages spanning from the parent company, Tim Horton's, all the way down to its suppliers align each level to be consistent with the overall corporate strategy. Without this open communication, these supply chain levels may try to forecast demand separately, using past data and trends. Forecasting incorrect demand throughout the supply chain can lead to the bullwhip effect, which is a phenomenon of variability magnification that starts at the customer and moves down through the supply chain to the producer. Therefore rather than attempting to forecast demands, there are two common material planning techniques that companies can employ to meet demand: lot-for-lot (L4L) and economic order quantity (EOQ). Both techniques deal with balancing the set-up costs and holding costs associated with meeting net demand requirements.

Lot-for-lot (L4L) purchasing uses set planned orders that exactly match the demand requirements. The exact number of items demanded are purchased and sold, with none maintained in the inventory. This eliminates holding costs, however due to the multiple set-up costs affiliated with each planned order in L4L, and the fact that set up costs tend to be higher than holding costs; L4L often results in higher total purchase costs.

The second technique, economic order quantity (EOQ) calculates the optimal quantity required for each purchase order by evaluating the total annual demands along with the set-up costs and annual holding costs, as shown below:

$$EOQ = \sqrt{\frac{2DS}{H}}$$

Where, D = annual demand

S = set-up cost

H = holding cost

As noted, EOQ tends to have the lowest total purchase costs based on the balanced set-up and holding costs and therefore is the recommended purchasing strategy for material requirement planning.

Even when the holding costs and set up costs for items are negligible, there may be additional justifications for considering an economic order quantity (EOQ) purchasing strategy over lot-for-lot (L4L), such as:

- Lower probability of stocking out
- Meeting the needs of customers ordering large coffee cups
- Greater customer service equals positive customer reviews

INVENTORY SYSTEMS

Once a strategic purchasing method is defined, it is important to understand which inventory system to apply. Though high inventory holding costs are not ideal, it is recommended to have some inventory based on the following reasons:

- To create a buffer between operations
- To meet variations in demand
- To allow flexibility in production scheduling in case of unanticipated lead times
- To provide a safeguard for variation in raw material delivery time
- To minimize set-up costs

Calculating the required optimal inventory levels for meeting demand requirements is important, to avoid high holding costs. Holding costs are typically comprised of costs for storage facilities, handling, insurance, pilferage and breakage. An inventory system provides the organizational structure and operation policy for maintaining and controlling the goods to be stocked. There are two types of inventory systems that can be applied to a company. Either a single-period inventory model, which is a one-time purchasing decision for a fixed period of time, where the item is not re-ordered; or a multi-period inventory system, which involves multiple purchase orders periodically with inventory being kept on demand.

Since Tim Horton's requires multiple purchases periodically, we will consider the multi-period inventory system. There are two types of multi-period inventory systems:

- Fixed-order-quantity model
- Fixed-review-period model

The main differentiator between the two is that fixed-order quantity is "event triggered" – an order is initiated once the inventory drops to a certain level, whereas fixed review period is "time triggered" – an order is placed at the end of pre-set review periods.

5.0 RECOMMENDATION

Action Plan Implementation

The ABC Inventory Classification theory was used to determine the most prominent issue that Tim Horton's should solve. The purpose of this theory is to divide the inventory items by groupings through their values (2013, Jacobs, Chase, Balakrishnan, Snider).

The cup inventories were based on the following criteria: size, weekly quantity usage and weekly dollar usage, as shown below in Table 1.

Table 1: Weekly Usage of Inventory Value

Cup sizes	Price per piece	Per week usage(d)	Weekly Dollar Usage	Percentage of Total Value
Small	$0.30	1900	$570.00	18%
Medium	$0.34	2700	$918.00	28%
Large	$0.40	3400	$1,360.00	42%
Extra large	$0.42	970	$407.40	12%
Total		8970	$3,255.40	100%

After determining the weekly dollar usage, the coffee cup inventory was evaluated based on the percentage of total value.

This process helped Tim Horton's establish a level of importance between the inventories. ABC classification suggests that inventory items should be classified into A-C, with the items on group A having the highest percentage of value or criteria (Jacobs, F.2013). The existing inventory was recorded and these two criteria were used to reflect the current inventory cycle.

TABLE 2: ABC GROUPING OF INVENTORY ITEMS

Classification	Cup Size	Weekly dollar usage	Percentage of Total
A	Large	$1,360.00	42%
B	Small/Extra Large	$977.4	30%
C	Medium	$918.00	28%
Total		$3,255.40	100%

Based on this classification, it is obvious that aside from frequent shortages, large coffee cups should be treated with the highest priority and controlled due to the fact that they are ranked highest for weekly dollar usage costs.

In order to identify and eliminate variations in the inventory planning processes, the root causes of the large coffee cup shortages were evaluated using a detailed root-cause methodology, otherwise known as an Ishikawa Diagram, detailed in Figure 2.

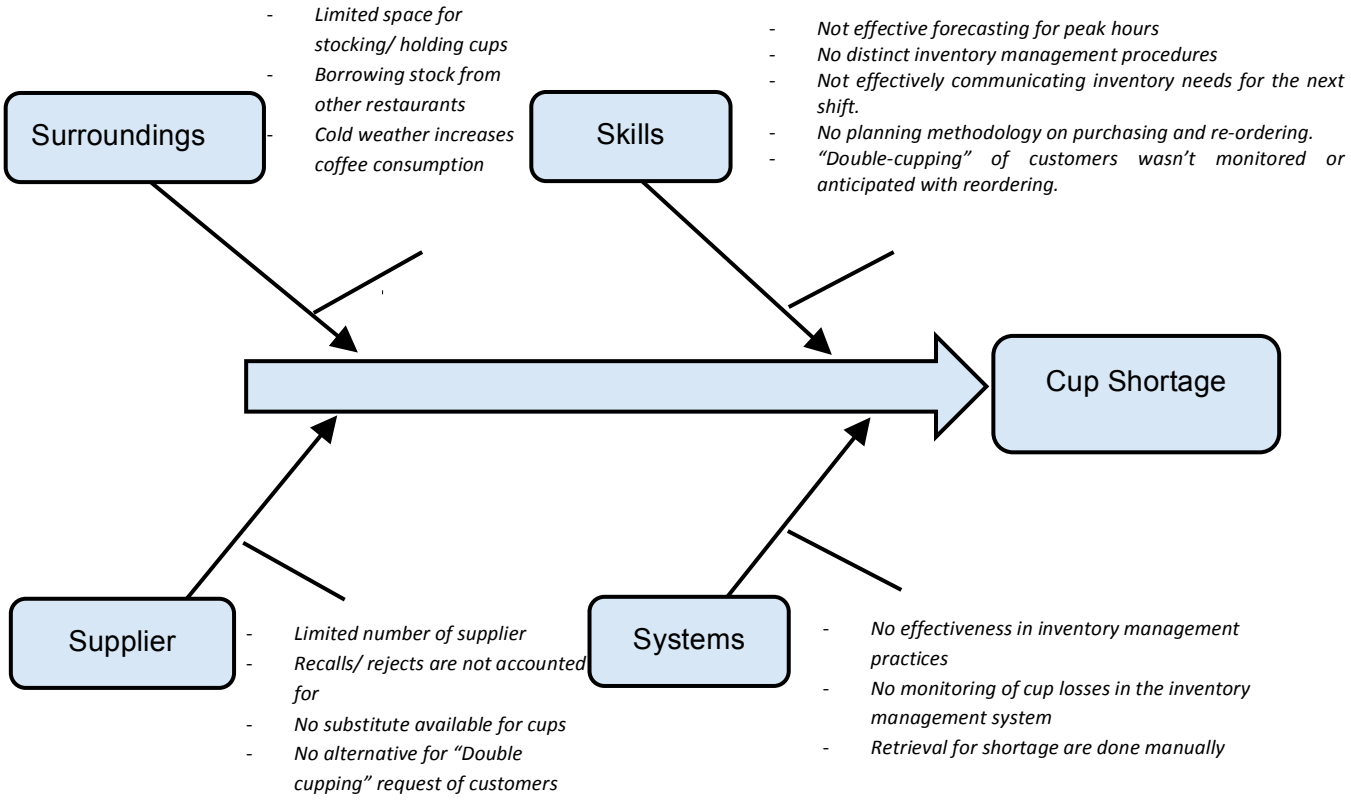


Figure 2: Cause and Effect diagram - Ishikawa Diagram

As part of the strategy for solving the issue, topics of material requisition planning and purchasing strategies are viable tools to implement for multiple reasons. Using the economic order quantity (EOQ) purchasing strategy, applied in a fixed-review period method, can specifically benefit the four root-causes; surroundings, skills, supplier and systems, in the following ways:

Surrounding:

With the Fixed Review Period the company can ensure the efficient amount of inventory to be stocked, lessen/eliminate the borrowing stock from other restaurants and prepare proper inventory for the high season.

Skills:

The Fixed Review period will provide monitoring of inventory and improve purchasing strategy by ordering what is needed, therefore eliminating problems on forecasting and monitoring usage, inventory updates and purchasing methodology.

Supplier:

The Fixed Review model takes into considerations average daily usage. With the inclusion of all possible inventory transactions on the forecasted demand, the model will provide efficient number of orders, therefore solving the issues on recalls/rejects and wastage.

System:

The Demand model offers a set of systematic way of monitoring and controlling inventory. Application of Fixed Review model introduces a system that can help to effectively manage the inventory transactions for the particular branch.

QUALITY ASSURANCE & CONTROL

Considering the four root-causes and EOQ purchasing strategy, it is advised that Tim Horton's applies the mentioned strategy to solve the inventory issues.

In order to successfully implement this method, a well-defined process flow chart must be created identifying the specific tasks, inventories/wait times and decisions. A process flow chart exemplifying these key process factors is shown below in Figure 3.

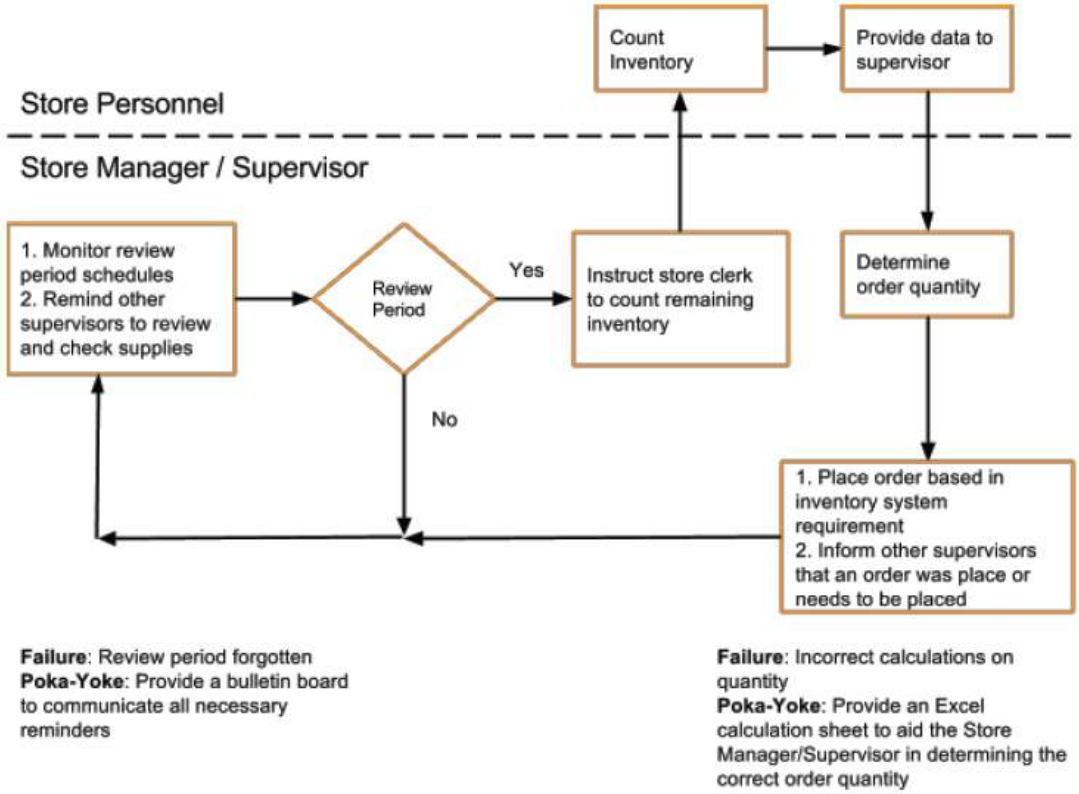


FIGURE 3: KEY PROCESS FACTORS IN QUALITY CONTROL

This method is significantly simpler and easier for staff to manage within than the managing inventory previously, as represented in the flow chart in Appendix A.

PURCHASING STRATEGY

Using the Fixed-Review Period Model, Tim Horton's can mathematically determine the optimum order quantity for large cups. Currently, the Katz building Tim Horton's orders exactly 3400 large cups per week. This results in either too much inventory during some weeks or stocking out during other weeks.

Since it was identified that the demand varies between two distinct periods during the year, the optimum quantity was evaluated using the two separate average demands. In addition, a safety stock was also calculated for each period to mitigate the risk of stocking out. The time periods were grouped into high and low season, from October – March and April – September, respectively.

The Fixed-Review Period Model equation can be seen below:

$$q = d(T + L) + SS - I \qquad \text{Equation 1}$$

$$SS = z * \sigma_L (T + L) \qquad \text{Equation 2}$$

where, d = average weekly demand

T = time between review period
L = lead time
SS = safety stock
I = inventory
d = average weekly demand
z = z-Value, using a probability of 95% of not stocking out

First the optimum order quantity was calculated for the high season, October to March, using an average weekly demand of 4600 large cups per week with an initial inventory level of 150. Then the optimum order quantity was calculated for the low season, April to September, using an average weekly demand or 2200 large cups per week with an initial inventory of 50. Refer to Table 3.

TABLE 3: SEASONALLY OPTIMUM ORDER QUANTITIES

		Oct - Mar	**Apr - Sept**
d	Average Weekly Demand	4200	2600
L	Lead Time, in weeks	1	1
T	Time between Review Periods, in weeks	0.5	0.5
z	z-Value, assuming a 95% probability of not stocking out	1.64	1.64
σ(T+L)	Safety Stock	276	62
q	**Optimal Quantity**	**6670**	**3886**

Though the optimal quantity considers the customer usage during varies demand periods, it does not take into account wastage quantities. A percentage of cups actually do not get to the customer and are otherwise considered wastage as a result of factory defects of the cup, incorrect orders being placed and having to be redone, double cup of when contents are very hot and cardboard sleeve is not available, and pilferage that may occur during Roll-Up Rim contest. Revised optimal quantities are determined in Table 4.

Table 4: Wastage Quantities

Wastage Issues	Description	Oct-Mar	Apr-Sept
Quality Defects	Defective cups	0.2%	0.2%
Incorrect orders	Orders incorrectly prepared	2.0%	1.0%
Double Cup	Requested by customers, no coffee sleeves are not available	0.5%	0.3%
Pilferage	Roll up rim results in occasional thefts	1.5%	0.0%
	Wastage %=	**4.2%**	**1.5%**
	Wastage amount = q x wastage % = W =	**280**	**58**
	$\mathbf{q_{(EOQ + W)}}$ =	**6950**	**3944**

Based on the results, Tim Horton's should change their purchasing strategy from purchasing 3400 large cups per week to 6950 cups during October to March, and 3944 cups per week during April to September. Since there are 440 large coffee cups in a single box, this is equivalent to approximately 16 boxes and 9 boxes each week during the time periods. Further details on the seasonal optimum order quantities and wastage calculations are provided in Appendix B.

Figure 4 below illustrates the changes in weekly demand during the high and low seasons, as well a noticeable spike in demand during the high season when the Roll-Up the Rim contest is running - between February and March (diamond data-line, between week 20 – week 26).

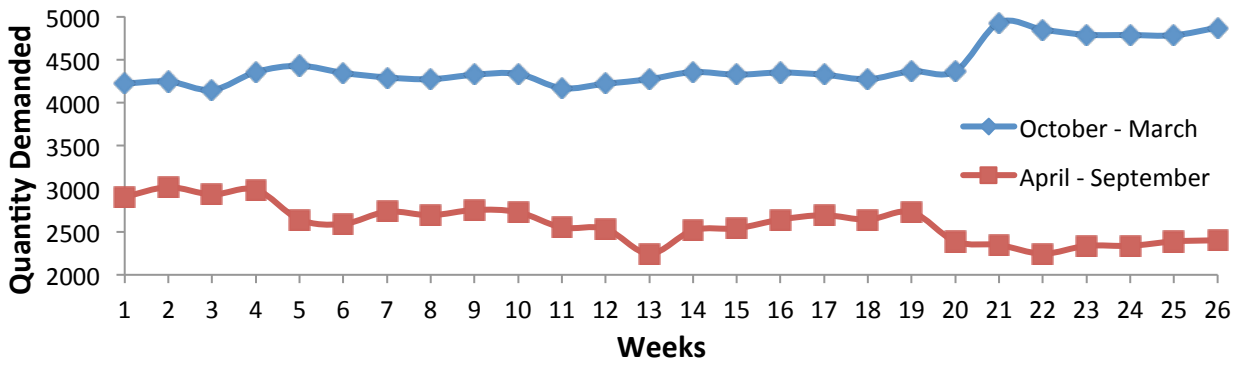


FIGURE 4: CHANGES IN LARGE CUPS DEMANDED

6.0 CONCLUSION AND FUTURE RECOMMENDATIONS

In conclusion, it was determined that the main reason for the issue of stocking out was due to the lack of a good inventory management system and practices. In addition, the existing inventory process flowchart was not simple and clear enough to be easily understood, followed, or implemented by the staff.

The foregoing study shows that the problem of cup shortages can be solved by putting in place an effective inventory management system, accompanied by a clear and simple process flowchart, to guide all staff in carrying out the necessary tasks to maintain the system. The following solutions for implementation are being proposed to solve the problem of cup stocking out as well as the related problems that were identified with it.

- Implement a Fixed Review Period inventory management system that takes into account varying demand periods due to factors such as seasons, weather and contests
- The operating year shall be divided into two separate demand periods – high demand season (October to March), and low demand season (April to September)
- High demand season = 6670 large cups shall be ordered, assuming an existing inventory of 150 cups
- Low demand season = 3885 large cups shall be ordered, assuming an existing inventory of 50 cups
- Process flow charts shall be provided to guide staff to effectively fulfill inventory tasks and ensure the inventory management system is applied correctly
- A clear policy shall be communicated to staff and ultimately to customers, if required to avoid the unnecessary use of cups

The problem of cup shortages is expected to be eliminated, considering that the demand will not significantly increase beyond current parameters over time. However, it is a dynamic world and change is inevitable. Demand may suddenly increase or decrease due to factors that are not foreseeable, such as added competition and changes in customer attitudes. To proactively deal with uncertainties, the following are future recommendations:

- Utilize the proposed inventory management system at others Tim Horton's locations
- Maintain effective communication among staff carrying out inventory control
- Account of wasted products and understand the impacts for a period over 24 wks
- Ensure shelves are organized to easily identify current available inventory product
- Generate visual aids for inventory procedures

7.0 REFERENCES

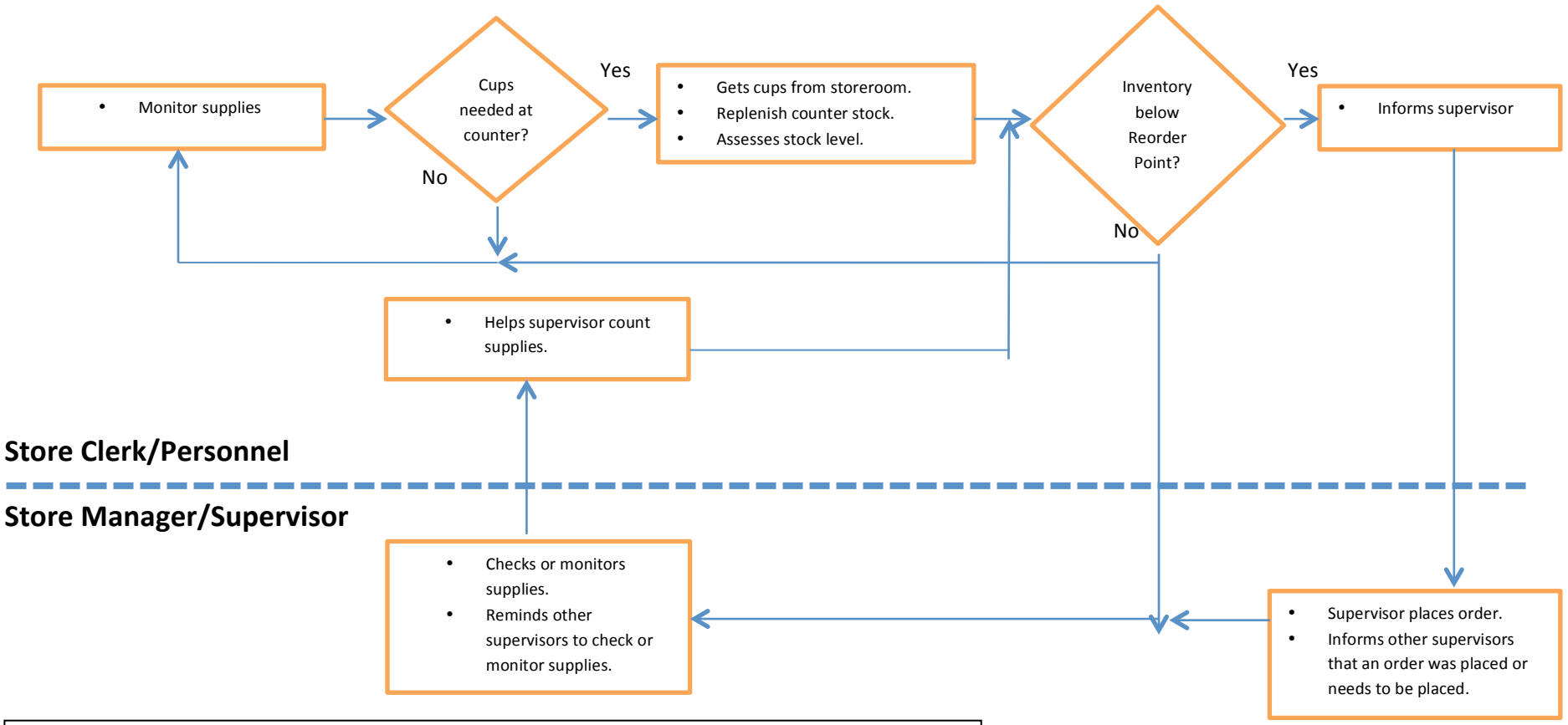
American Society Quality Retrieved from: http://asq.org/learn-about-quality/cause-analysis-tools/overview/fishbone.html

The Story of Tim Horton's retrieved from: http://www.timhortons.com/ca/en/about/the-story-of-tim-hortons.php

Jacobs, F.(2013) Operations and Supply Management. 12th. Edition, New York, NY: McGraw-Hill Irwin, 2009

8.0 APPENDIX

APPENDIX A: CURRENT INVENTORY MANAGEMENT FLOWCHART



Failure: Incorrect calculations of quantity due to sudden change in demand.

Poka-Yoke: Provide an Excel calculation sheet to aid the Store Manager/Supervisor in determining the correct order quantity.

Failure: Other supervisors not aware of the need to order or that an order was already placed.

Poka-Yoke: Provide a bulletin board that is visible to all or send out email reminders or alarms.

APPENDIX B: WEEKLY INVENTORY DEMAND CALCULATIONS

TIM HORTONS
Store # 3198

	Cups (Small Size)	Cups (Medium Size)	Cups (Large Size)	Cups (Extra Large Size)	Average Total Cups demand per week	Dark Roast Coffee per week
Average weekly demand (d)	1900	2700	**3400**	970	**8970**	1794
Lead time	1 week	1 week	1 week	1 week	**1 week**	1 week

SAMPLE CALCULATION FOR LARGE CUPS

Calculation for SD, σ

October - March			**April - September**		
Actual weekly demand values (Assumed values)		$(Xi - \mu)^2$	**Actual weekly demand values (Assumed values)**		$(Xi - \mu)^2$
Week 1	4050	37796.2	Week 27	2860	92396.0
Week 2	4075	28700.6	Week 28	2970	171368.7
Week 3	3980	69914.0	Week 29	2888	109870.4
Week 4	4180	4149.0	Week 30	2943	149356.8
Week 5	4250	31.2	Week 31	2600	1933.1
Week 6	4170	5537.2	Week 32	2550	36.4
Week 7	4120	15478.5	Week 33	2690	17947.2
Week 8	4100	20855.0	Week 34	2650	8829.8
Week 9	4150	8913.7	Week 35	2710	23705.8
Week 10	4160	7125.5	Week 36	2685	16632.5
Week 11	4000	59737.5	Week 37	2510	2119.0
Week 12	4050	37796.2	Week 38	2495	3725.0
Week 13	4100	20855.0	Week 39	2210	119738.8
Week 14	4180	4149.0	Week 40	2478	6111.5
Week 15	4150	8913.7	Week 41	2500	3139.7
Week 16	4175	4818.1	Week 42	2600	1933.1
Week 17	4150	8913.7	Week 43	2650	8829.8
Week 18	4100	20855.0	Week 44	2600	1933.1
Week 19	4189	3065.3	Week 45	2685	16632.5
Week 20	4189	3070.6	Week 46	2350	42449.6
Week 21	4730	235795.2	Week 47	2310	60532.2
Week 22	4653	166943.7	Week 48	2210	119738.8
Week 23	4596	123546.8	Week 49	2300	65552.9
Week 24	4593	121438.5	Week 50	2300	65552.9
Week 25	4590	119348.4	Week 51	2350	42449.6
Week 26	4675	185405.6	Week 52	2364	36876.7
Average Weekly Demand, μ	**4244**		**Average Weekly Demand, μ**	**2556**	
Standard Deviation, σ	$((\Sigma(Xi - \mu)^2/7)^{0.5})$	**226**	**Standard Deviation, σ**	**51**	

Inventory, I	(Assumption)	150		50	
L	Lead time, weeeks	0.5			
T	Time between Review Periods	1			
z	(Assuming a 95% probability of not stocking out)	1.64			
σ(T+L)	Safety Stock	276		62	
q	$(d(T+L) + z\sigma(T+L) - I$	**6670**		**3886**	Number of Large cups to be ordered at the
LOT	440 cups per box	15		**9**	particular review period
				58%	

The concept of Shortage Cost or Opportunity Cost may also be included in the discussion.

Assuming cost of Large Cup, Lc =	$0.50	
Cost of Large cup Mocha =	$4.00	
Cost of Medium cup Mocha =	$3.00	
Cost of Lost Revenue per cup	$1.00	Due to shortage of Large Cups, customer may opt for the smaller available size, say Medium size. So the amount of lost revenue is $1.00 per cup.
		It can also be viewed as a lost opportunity of earning $1.00 per Large cup of Mocha or Cappuccino?

Same calculation may be done for the Small, Medium, and X-Large cups.

WASTAGE SUMMARY

		High demand period		Low demand period	
Wastage Issues	Description				
Quality Defects	Defective cups	0.2%		0.2%	
Incorrect orders	Orders incorrectly prepared	2.0%		1.0%	
Double Cup	-Double cup requested by customers -Customers are provided with a double cup, when coffee sleeves are not available.	0.5%		0.3%	
Roll up the rim	Contest results in occasional prifled	1.5%		0.0%	
	wastage % =	4.2%		1.5%	
	q =	6670		3886	
	wastage =	280		58	
	$q_{EOQ + Wastage}$ =	**6950**		**3944**	