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Improving Cash Availability of ATM using Lean Replenishment Pull for Sharia Bank in Indonesia

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ABSTRACT
To maintain the company's sustainability of quality and the increasingly rapid competition between banking institutions, a bank must continue to protect its customers from the ease and availability of services when needed anytime and anywhere. Automated Teller Machines (ATM) are the most common banking products and services used by the public. Previously, Activities carried out by the teller can already be done through an ATM. Availability of the ATM has been a special attention among the banking industry and CIT (Cash in transit) company. Factors that cause ATM unavailable are: hardware, receipt, network, and cash, one of the most critical factors is cash availability. Previous study shows some concern of cost and risk of inventory cash on ATM, that leads to study of cash prediction method to replenishment cash of the ATM. Current conditions, Bank ATMs have an average percentage of cash availability in the last 6 months of 92.86%, which means there is 7.1% of cash not available. The aim of this study is to adapt the lean replenishment pull system to manage cash replenishment of the bank ATMs and to achieve level 4 of sigma (99.38%) on ATM cash availability. By collecting, measuring and analyzing availability data and transactions data on both on-site and off-site ATMs samples for the certain period. The proposed model is to determine warning to do the cash replenishment and the Kmin of cash status. Improve the cash availability of ATMs with a replenishment pull system formula to determining at what point the branch office must conduct replenishment. 4 (four) statuses will be applied to the system; warning, Kmin, Safety Stock, and Kmax. The result of this study by using lean replenishment pull system found that cash supply at the ATM machine is sufficient, and no idle money occurs

Keywords: *ATM, Cash Replenishment, Lean Pull Replenishment*

INTRODUCTION

To maintain the company's sustainability of quality and the increasingly rapid competition between banking institutions, a bank must continue to protect its customers from the ease and availability of services when needed anytime and anywhere (Sharia Bank, 2012). Automated Teller Machines (ATM) are the most common banking products and services used by the public. Previously, activities carried out by the teller can already be done through an ATM. With the development of technology, the ability of ATMs is not only for cash withdrawals and balance checks but also makes it easy for customers to

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make transfers between accounts, bill payments, and others (Bank of Indonesia, 2005). Availability of services for 24 hours makes customers have no worry about making transactions outside the bank's operating hours.

Complaints are often raised by internal customers, namely employees and management regarding the frequent ATMs that cannot be used properly. Current conditions, ATMs have a 96% availability percentage, which means there are 4% ATMs with not available conditions. Factors that cause ATMs in not available conditions are hardware, network, cash, and receipts (Sharia Bank, 2009). ATMs have an average percentage of cash availability in the last 6 months of 92.86%, which means there are 7.14% of ATMs in a condition not available on the cash side each month. Improvement of cash services at the ATM does not mean carrying out as much cash stock as possible, but it also concerns cash efficiency at each ATM terminal. So, this study discusses about how to increase the availability of ATM cash to 99% by emphasizing the effectiveness side, so that there is no excess or lack of cash supply in an ATM unit.

Replenishment pull system is one of the lean methods that provides efficiency for inventory. Instead of pushing material into the inventory buffers based on a schedule, replenishment pull is merely looking at what the customer is using and replenishing that before it runs out (Liker, 2004). What made the Pull Replenishment initiative unique is the fact that the sales team participated in and supported it from the beginning. Pull is positioned and sold as a sales enablement initiative. This organizational alignment and support ultimately created the momentum necessary to improve customer delivery, employee engagement, and shareholder value (Kumar, 2017). Aligning of Six Sigma concept that seeks to reduce the variation, which results in the occurrence of fewer defects and the production of higher quality goods and services (Kumar, 2017).

The aim of this study is to increase the availability of cash at Bank ATMs 99% by analyzing the need for cash so that the cash supply at the ATM becomes effective. It is expected that the increased availability and effectiveness of ATM cash, can increase fee-based income for network transactions, reduce idle money at ATMs for the past 6 months amounting to IDR 348,894,700,000 and can improve the image of Bank ATM services. This study is to adapt the lean replenishment pull system to manage cash replenishment of the bank ATMs and to achieve level 4 of sigma (99.38%) (George, 2002). Collecting, measuring and analyzing availability data and transaction data on both on-site and off-site ATM samples for the period October to March. The proposed model is to determine warning to do the cash replenishment and the *Kmin* of cash status. Thus, the cash supply at the ATM machine is sufficient, and no idle money occurs.

LITERATURE REVIEW

Availability of the ATM has been a special attention among the banking industry and CIT (Cash in transit) company. Factors that cause ATM unavailable are: hardware, receipt, network, and cash, one of the most critical factors is cash availability. Previous study shows some concern of cost and risk of inventory cash on ATM, that leads to study of cash prediction method to replenishment cash of the ATM. Formulating the ATM replenishment problem as a special inventory management model with safety stocks and a replenishment quantity. The model considers both the risk of out-of-cash and the risk of full-of-cash, which is suitable for the recycling ATMs commonly used today (Yongwu et al, 2020). Forecasting predicts the demand for cash from numbers of ATMs by statistical method, artificial neural network intelligent method, support vector machine, convolutional neural network (Soodabeh Poorzaker & Hosein Ebrahimpour, 2018), and neural network approach to achieve an optimal replenishment amount as indicated for the test data (Dandekar & Ranade, 2015). Regression techniques which commonly used to analyze quality (Nusraningrum & Gana Senjaya, 2019) have been applied to predict how much cash inflow would be needed for the next day by examining and learning from past transactional data to solve the "Cash Estimation" problem (Rajwani et al, 2017). Studies show that companies should consider continuous recalculation of the reorder level, based on real time demand forecasting. This means a replenishment is triggered by simultaneously evaluating the reorder level and the inventory level (van Anholt & Vis, 2015). The Global Positioning System (GPS) is technology can be used to route the ATM location, implementation of this nearest ATM finder application will be able to assist users in locating the places that they need (Nugroho & Ma'ruf Alvansuri, 2017)

Furthermore, factors that affect the cash replenishment of the ATM are routing problems and ATM locations. Formulating an integer linear program that jointly optimizes cash management and routing for new generation ATM networks. The objective of formulated problem is to minimize the total cost of cash management in ATMs, which consists of logistic cost and idle cash cost (Batı & Züpek, 2017). Combining VRP (Vehicle Routing Problem) and Inventory Allocation Problem is Inventory Routing Problem (IRP). IRP objective is to minimize the overall inventory cost (holding and transportation) given that customers (i.e. ATMs) do not run out of stock at any given time (Kurdel & Sebestyénová). One of the study is to develop systems to identify both expected and unexpected changes in external factors affecting cash withdrawal from ATMs. The system relies on streaming information received from ATM channels, the social media, cooperating retailers, social trending sites, the weather, financial services or other sources are properly exploited (Velivassaki, Panagiotis , & Panagiotis , 2012).

RESEARCH METHOD

The framework of this study shown at figure 1, began with complaints often raised by internal or external customers, the voice of customers said transactions failure often occur. Then monitoring system also shows that the cash availability of the ATMs is 92.86%, which means there is 7.1% the cash is unavailable of the ATMs. After that, setting up the improvement process to the level of availability to 99% (level 4 of Sigma). Then, measuring how bad ATMs with a not available condition by collecting transaction data for the period October to March with the data collection plan as follows; availability data on both on-site and off-site ATM samples, onsite and offsite ATM duration data which services are not available, successful and failed transaction data because there is no cash on the onsite and offsite ATMs samples.

Furthermore, identify the components of replenishment pull on each ATMs sample. This method is used for managing replenishment that provides efficiency for inventory. Thus, the cash supply at the ATM machine is sufficient, and no idle money occurs.

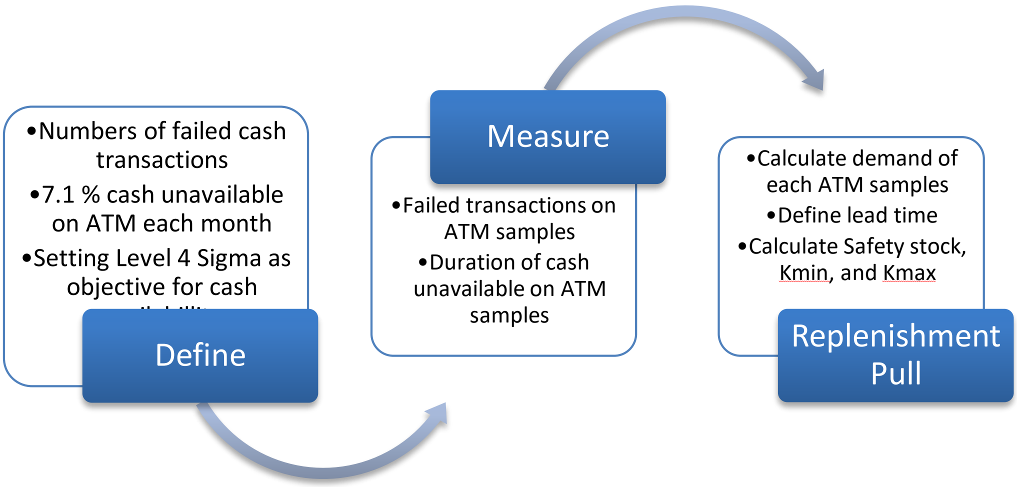
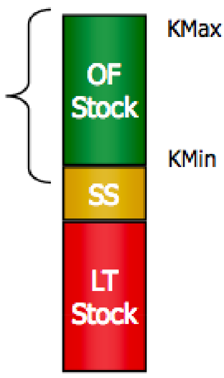


Figure 1. Research Framework

Replenishment pull is a Lean tool that establishes strategically located buffers of "items" (consumables, for example) within a process and then de-couples the supplying process from the consuming process via the buffer inventories. Figure 2 shown that the stock should be in green zone between *Kmin* and *Kmax*. When stock reach *Kmin*, it is the warning to do replenishment so it can reach as *Kmax* point. Meanwhile the yellow zone is safety stock, standard deviation stock added the lead time. Lead Time(LT) is the total time to receive a new component from the supplier once the component has been used. This calculation must also include: PO Process + Supplier LT + Fulfillment + Shipment + Receiving (Jones, 2006).



source: Steven Jones (2006)

Figure 2. Replenishment Pull System Methodology

$$Kmax = [(SLT * DMD) + (OF * DMD) + SS]$$

$$Kmin = [(SLT * DMD) + SS]$$

$$SS = STD * \text{Service Level} * (SLT)^{0.7}$$

The Explanation of figure 2 and equation above are as follows, OF Stock (Order Frequency Stock) is the inventory level required to cover daily usage until it is time to issue another consumable order. While, OF (Order Frequency) is the frequency of reordering inventory. Then SS (Safety Stock) is the inventory level required to cover for variation in the consumable daily demand or variation in supplier lead times. LT Stock (Lead Time Stock) talks about the inventory level needed to cover the daily consumption demand while the consumables are on order.

Kmax (Max Kanban) is an inventory level that is filled at the time of replenishment. Kmax condition is sufficient inventory up to when the branch office should do the next replenishment. Kmin (Min Kanban) is the condition of the inventory supply must be replenished. Kmin is the level of safety stock added to the estimated needs during the lead time. DMD is Demand, while STD would be Standard deviation of demand and last is Service Level that is the point where inventory will never be exhausted. Could also fill with sigma level targeted

RESULT AND DISCUSSION

ATM samples are represented 71% of the Bank ATMs transactions population from October - March with cash availability below 99%. Total onsite and offsite ATMs transactions that were sampled were 340,694 transactions for the period October – March. Table 1 is list of ATMs onsite samples which are located on branch offices, there is 6.9% of transactions failed due to customer wanted to make cash withdrawal but cash is unavailable.

Table 1. Onsite ATMs samples

Onsite ATMs				
No	ATM	Cash Availability	Failed transactions due to cash unavailable	Total transactions
1	ATM onsite 01	81.33%	3	2,892
2	ATM onsite 02	83.08%	154	10,220
3	ATM onsite 03	88.75%	111	11,939
4	ATM onsite 04	90.23%	25	6,120
5	ATM onsite 05	95.11%	238	9,719
6	ATM onsite 06	82.80%	276	8,344
7	ATM onsite 07	90.17%	322	11,232
8	ATM onsite 08	91.41%	795	11,335
9	ATM onsite 09	95.25%	405	8,730
10	ATM onsite 10	95.26%	656	20,231
11	ATM onsite 11	96.01%	139	22,661
12	ATM onsite 12	95.04%	676	15,846
13	ATM onsite 13	96.39%	351	12,129
14	ATM onsite 14	95.51%	405	9,035
15	ATM onsite 15	96.02%	342	25,348
16	ATM onsite 16	97.06%	256	14,858
Average		91.84%	5,154	200,639

Table 2 is list of ATM offsite samples which are located on other public locations such as malls, hospitals, airport, etc, there is 8.1% failed cash withdrawal transactions.

Table 2. Offsite ATMs Sample

Offsite ATMs				
No	ATM	Cash Availability	Failed transactions due to cash unavailable	Total transactions
1	ATM offsite 01	75.04%	12	1,078
2	ATM offsite 02	93.60%	238	11,434
3	ATM offsite 03	95.35%	803	23,528
4	ATM offsite 04	96.59%	23	903
5	ATM offsite 05	97.05%	140	7,656
6	ATM offsite 06	98.62%	1.072	29,249
7	ATM offsite 07	95.72%	242	11,909
8	ATM offsite 08	93.39%	119	16,281
9	ATM offsite 09	94.24%	162	7,516
10	ATM offsite 10	93.89%	72	3,812
11	ATM offsite 11	93.63%	658	8,209
12	ATM offsite 12	84.80%	88	5,756
13	ATM offsite 13	94.19%	155	5,665
14	ATM offsite 14	95.96%	162	6,494
Average		93.01%	3,946	139,490

Besides the failed transactions, figure 3 shows the duration of cash not available on Onsite ATMs of each event is about 2 (two) to 5000 (five thousand) minutes per event.

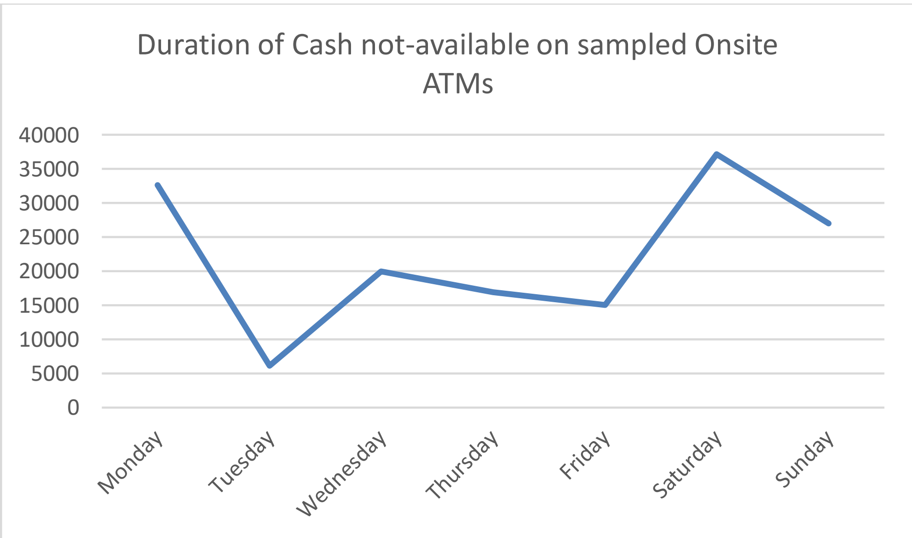


Figure 3. Duration of cash not available on sampled onsite ATMs

While figure 4 shows the duration of cash not available on Offsite ATMs is around 4 (four) to nearly 4000 (four thousand) minutes per event.

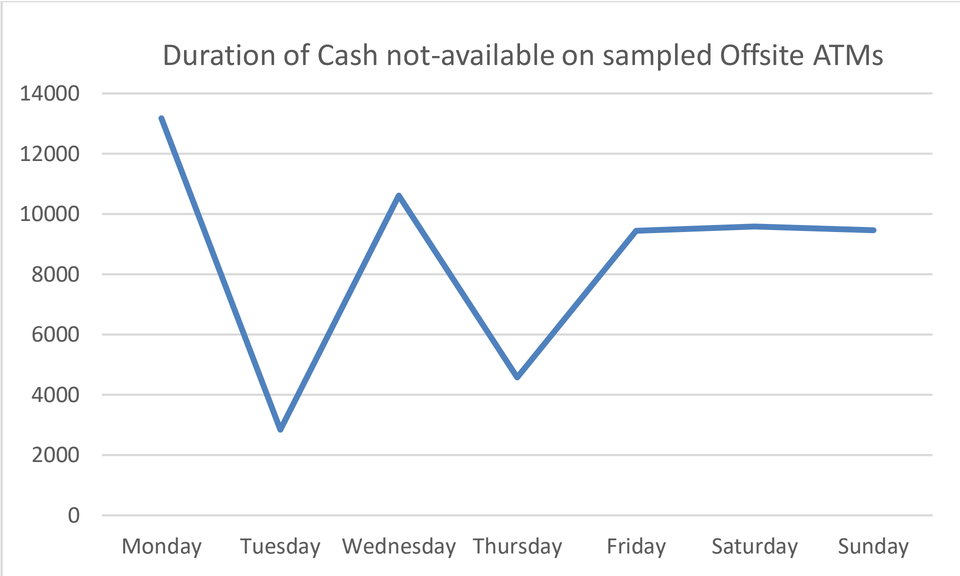


Figure 4. Duration of cash not available on sampled offsite ATMs

High duration of cash not available on Monday, most likely due to the high duration of cash not available on Sunday. Tuesday dropped dramatically, because the branch office had done replenishment on Monday and Tuesday. The duration of not available decreases to Friday, where branch offices are encouraged to do replenishment. Because demand for cash tends to be high at the end of the week so the duration of not available cash increases on Saturdays and Sundays. Replenishment pull system is a formula to determine at what point we should do replenishment. In accordance with the basic concept of Lean, every process should be done with pull, not push (Jones, 2006). Then Figure 4 is the concept of pull replenishment system which is adapted to the ATM cash replenishment process.

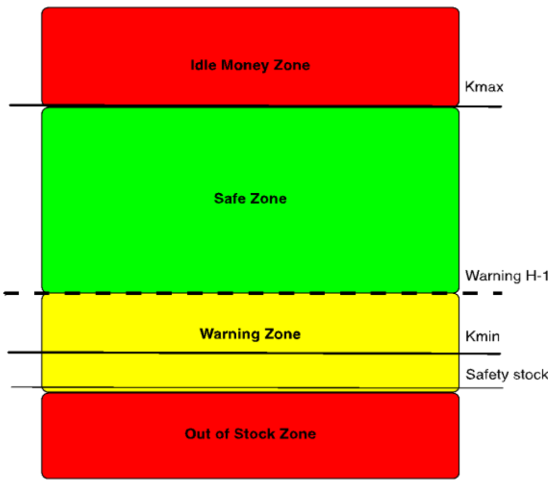


Figure 5. ATM replenishment pull system research framework

Safety stock: Standard deviation * Service Level * (lead time/day^0,7)

Kmin: Safety Stock * (requirement/day * *lead time*/day)

Kmax: (*lead time* * requirement/day) + (*order frequency* * requirement/day) + *Safety Stock*

Figure 5 is a research framework to describe the replenishment pull system is adapted for ATM cash replenishment. Out of Stock is the conditions where ATM cash is not available at an ATM terminal, while Safety Stock is about condition of cash supply provided to minimize out of stock risk due to fluctuations in needs. Then, Kmin is the condition of the cash supply must be replenished. Kmin is the amount of safety stock added to the estimated needs during the lead time. Lead time is the time needed by the branch office to prepare replenishment. However, Warning is the condition was formulated for the branch office to start preparing the cash supply that would be put on the ATM cassette. Next is Kmax, Kmax is the nominal value of cash that is filled at the time of replenishment. Kmax condition is sufficient inventory up to when the branch office should do the next replenishment. Last is idle money zone, describe the condition of the value of cash above Kmax which means an excess of cash supply.

Table 3 describes the components of pull replenishment calculation; average demand, standard deviation, lead time (in days), safety stock, needs during lead time, Kmin, Warning H-1, Kmax. The lead time for onsite ATMs is set at 60 minutes, while for offsite ATMs it is set at 60 minutes + (add) travel duration from branch offices to offsite ATMs. Aim of this study is to improve cash availability to 99% which is the 4-sigma level, so the service level is set to 4 (four). Warning will be a solution for branch offices that often experience shortages of cash, when warning conditions arise, branch offices can disburse funds to the local regulator bank. This is also intended for tellers to sort money that requires extra time to be calculated. For recommendations and calculations of lead time in the warning condition is set to 1 (one) day, so the warning might appear one day before *Kmin* replenishment. *Kmax* is a condition of sufficient inventory until the branch offices should do the next replenishment which is the following week. Because the current procedure recommends replenishment every Friday, the order frequency will be set 7 (seven) days.

Table 3. Replenishment Pull System Calculations for ATMs sample

No	Branch offices	Average demand	Standard Deviation	Lead time (in days)	Safety Stock	Estimated needs during lead time	Kmin	Warning H-1	Kmax
ATM Onsite (in millions)									
1	ATM onsite 01	8,412	6,480	0.0667	3,894	561	4,454	12,866	63,338
2	ATM onsite 02	24,776	14,104	0.0667	8,475	1,652	10,127	34,903	183,562
3	ATM onsite 03	31,824	13,510	0.0667	8,118	2,122	10,240	42,064	233,008
4	ATM onsite 04	15,490	7,761	0.0667	4,664	1,033	5,696	21,187	114,129
5	ATM onsite 05	25,953	11,189	0.0667	6,723	1,730	8,453	34,406	190,121
6	ATM onsite 06	20,711	11,677	0.0667	7,017	1,381	8,397	29,108	153,371
7	ATM onsite 07	31,768	13,576	0.0667	8,158	2,118	10,275	42,043	232,650
8	ATM onsite 08	26,396	11,411	0.0667	6,857	1,760	8,616	35,012	193,386
9	ATM onsite 09	21,829	10,439	0.0667	6,273	1,455	7,728	29,556	160,527
10	ATM onsite 10	37,387	15,782	0.0667	9,483	2,492	11,976	49,363	273,684
11	ATM onsite 11	49,725	31,404	0.067	18,870	3,315	22,185	71,910	370,257
12	ATM onsite 12	35,873	15,126	0.0667	9,089	2,392	11,481	47,354	262,592
13	ATM onsite 13	20,711	11,677	0.0667	7,017	1,381	8,397	29,108	153,371
14	ATM onsite 14	21,799	10,710	0.0667	6,435	1,453	7,889	29,688	160,481
15	ATM onsite 15	40,088	14,400	0.067	8,653	2,673	11,325	51,414	291,944
16	ATM onsite 16	36,794	15,111	0.0667	9,080	2,453	11,533	48,327	269,089
ATM Offsite (in millions)									
No	ATM	Average demand	Standard Deviation	Lead time (in days)	Safety Stock	Estimated needs during lead time	Kmin	Warning H-1	Kmax
1	ATM offsite 01	8,378	7,769	0.0778	5,201	652	5,852	14,230	64,499
2	ATM offsite 02	11,938	7,866	0.0833	5,526	995	6,520	18,458	90,085
3	ATM offsite 03	55,681	20,783	0.1333	20,287	7,424	27,711	83,393	417,482
4	ATM offsite 04	3,816	5,059	0.0889	3,718	339	4,057	7,874	30,772
5	ATM offsite 05	18,448	12,341	0.0944	9,463	1,742	11,206	29,654	140,344
6	ATM offsite 06	62,386	71,163	0.0889	52,301	5,545	57,846	120,233	494,551
7	ATM offsite 07	25,487	13,852	0.1000	11,055	2,549	13,604	39,091	192,014
8	ATM offsite 08	24,813	27,812	0.0889	20,440	2,206	22,646	47,458	196,334
9	ATM offsite 09	13,266	7,540	0.1000	6,018	1,327	7,344	20,610	100,206
10	ATM offsite 10	6,858	4,457	0.0889	3,275	610	3,885	10,743	51,891
11	ATM offsite 11	14,351	12,130	0.0944	9,302	1,355	10,657	25,008	111,112
12	ATM offsite 12	12,109	10,126	0.0667	6,084	807	6,892	19,001	91,657
13	ATM offsite 13	15,868	10,795	0.0667	6,486	1,058	7,544	23,413	118,624
14	ATM offsite 14	13,110	5,028	0.0667	3,021	874	3,895	17,006	95,668

CONCLUSION

Improve the cash availability of ATMs with a replenishment pull system formula to determining at what point the branch office must conduct replenishment. 4 (four) statuses will be applied to the system, namely (1) Warning: Conditions where branch offices must prepare for replenishment by ensuring the availability of money. Warning is set with a lead time of 1 (one) day, so the status appears H-1 before replenishment. (2) Kmin: The condition of the branch office finalizes replenishment preparations such as filling out forms and entering the money provided in the ATM cassette. After all the preparations are finished, the branch office can do the replenishment. (3) Safety stock: The condition of the branch office immediately replenishes. In this condition, the branch office must complete the replenishment preparation. (4) Kmax: a condition where an ATM has been replenished properly and can be used up to 7 days in the future. The nominal on Kmax status is the nominal that must be replenished by the branch office. If it exceeds the nominal value, the excess will become idle money.

Implementing this system can help branch offices to have longer time to prepare for replenishment, such as providing cash, sorting money, scheduling operational vehicles, and finding branch employees who can help with replenishment. Branch offices can also find out how much money must be filled in to meet customer needs for 1 week so that if this system is implemented, replenishment does not have to be carried out on Friday. It is determined by warning H-1 and Kmin on the status of money. The above recommendations must also be accompanied by appropriate controls so that can be carried out consistently such as making additional procedures to standardize improvements implemented by the Operations divisions. However, lean concept is not only for inventory but also the business process itself. Future suggestions would be having lean six sigma in means to have business process improvement. Reduce non-value added process and variations, improve quality and services to better serve customers, and combine with BPMN tool to design these processes with agility and precision, and also eliminate defects.

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