DIGITAL INVENTORY: REFORMAT RISK OPTIMIZATION MODEL FOR A LAPTOP

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Abstract

In recent times, due to advancements in technologies specially in the computer world, people face problem related to limited digital capacity of a digital devices. Many reasons exist such as unwanted or unnecessary files stored in (a) System digital space (b) ROM space (c) Working space for users and (d) Hard disk space. By the regular use of a laptop, user space and hard disk digital space get occupied because of the creation of new files and new folders at every moment. Such a situation motivates for development of a digital inventory model for digital space. This paper presents a digital inventory model which is a useful tool for laptop reformat risk minimization. Users Categories are defined as per their intensive professional involvements. Several graphs are drawn showing the output analysis and importance of the study. Theoretical findings are supported by the numerical computations. It is found that reformat risk is directly proportional to the growth of file/folder creation in either of categories.

Keywords: Digital Inventory, Mathematical Model, Memory Space, Digital Space Digital Files, Reformat Risk, Digital devices, Risk Optimization, Users Category, Risk Computation, Random Access Memory(RAM), Read Only Memory(ROM).

1. Introduction

The inventory management is a key factor in the supply chain of business for achieving the goal of higher profit. Such is useful to maintain a continuous flow between production and demand. Inventory of items keeps the market stable over the varying demand scenario and investors are aware enough about the cost-profit ratio. With the emergence of Internet in late nineties and drastic spread of the use of digital payments technologies, various companies have started business of producing digital devices. Some most popular digital devices are (i) Mobile phones (ii) Desktop computers (iii) Laptops (iv) tablets etc. Each digital device has memory spaces like RAM, ROM, Hard disk, Memory card, SSD, Flash memory etc. The information in digital form are stored in files and folders in the available digital spaces. A file is a basic unit used for digital inventory. The collection of similar types and similar nature of files constitutes a folder. The basic digital space unit is bit and 8 bits constitute a byte. The file sizes are usually measured in terms of bytes like kilobytes (KB), Megabytes (MB), Gigabits (GB), terabytes (TB), petabytes (PB) etc. In computer sciences literature, there exist basic and well-established rules of classification like (i) System files storage space (ii) Application Program Storage space and (iii) User files storage space. In term of specific terminologies such spaces are called memory spaces like (a) Internal memory space and (b) External memory space. The operating system of a laptop needs a prefixed size memory space allocation which is mandatory and cannot be reformatted unless corrupted. The

software like Browsers, MS Office packages and downloaded programs are the part of application software. These can be deleted or updated or reloaded by users from time to time. The creation of Word files, Excel files, Power Point files, Photo files, Music files and videos are the part of users- files. A digital storage of files in memory of a laptop can be assumed as a digital inventory of files and folders.
A laptop is an excellent tool, but without systematic organization of files (or folders), the same may be troublesome during files search. Every day users of electronic devices create large number of files and delete the same too (if not in use). Following are steps for file management:

- Review of files.
- File size and content evaluation.
- Shorting of files and allocation in appropriate folders.
- Folder indexing and folder organization.
- Safety of storage of files/folders.
- Storage of files/ folders at earmarked location.
  Which file to delete and which file to store is a continuous process. When the creation is faster than deletion, digital storage gets saturated after a duration and situation of reformatting the laptop appears.

2. Literature Review

The problem of dealing with digital inventories have rare academic contributions in terms of models as appeared after web search. The said way of thinking where the storing unit is a digital file (or folder) and digital devices are like a warehouse it is a unique approach attempted in this paper.

Govani[1]proposed a digital supply chain marketing model and operation interactions. Such contributions provide comparisons between static and dynamic solutions of the procedure involved in the supply chain while shifting from traditional to digital platforms.

Al-dulaime et al.[2]suggested inventory management based on the EOQ model for laptop spare parts and analyzed such using XYZ technique. Excess inventory of spare parts and over stocks provide the larger holding cost. The EOQ cost management model is suggested by the author in the form of digital hardware inventory.

Muckstadt and Sapra[8] contributed on the thought provoking idea related to EOQ inventory models advocating that such can be used in practice for prediction and profit maximization. For example, inventory models can be effectively employed in automotive, pharmaceutical and retail sectors of the economy for many years.

Chung[9] advocated for a new EOQ model under the situation of permissible delay in payments. The cost function assumed convex and a theorem is developed for optimality of EOQ. Dhoka and Chaudhary [10] discussed the complexities of managing supply chains that are affected by many external factors like global effect, increase in product portfolio and decentralization. A variety of inventory models and metrics are available today to monitor the supply chains. The main focus of paper[10] is to study the volatility of supply chains and its impact on inventory.

Tersine et al.[11] contributed on the inventory reduction methods and technologies that hold inventory by nature at idle. The intentional and negligent stockpiling inspires reform and heralds the redesign of operating system. If the quest starts with immediate reduction of stocks, it ends with complete system conversion.

Prameswari et al.[13] attempted for product inventory optimization using EOQ model approach by suggesting circular economy model which aims to minimize waste and maximize the use of resources. The EOQ in the content is used as a tool to optimize product order quantities using the circularity index.

Di Nardo et al. [15] worked on stochastic dynamic optimization depending upon logistic environment. Such contains a stock dynamic sizing optimization where the safety stock is conceived to fill up to variation in demand. The contribution aims at to reduce the occurring stock-out events using the link among wear out items rate downstream logistic demand.

Hemant [17] proposed to optimize an inventory model for a company who reduces inventory cost and provides better inventory management system. Such contains quantitative approach as a solution of the problem. Cotribution [17] suggested an idea of computing the appropriate order quantity in dynamic form.

Turkolmez at al. [18] attemped the use of machine learning approch for resolving the pricing of end-of-life remanufactured laptop. Some other useful contributions to the EOQ based inventory models and their applications are due to Khan[7], Taha[12], Vandeput [14], Shah[16], Celik et al.[19], Khedlekar et al.[3],[4],[5]and Shukla et al.[6]

2.1. Motivation

All the EOQ models consider the physical stock of items in the warehouse. The problem to handle is when to fill the stock and when to vacate and sale. with when digital inventory the optimization idea changes quite heavily.

This paper considers the digital inventory of files/folders and presents risk computation of reformatting a laptop over time by presenting a model.

3. Symbols

- S_m- Maximum digital inventory space of laptop,
- S_0- Initial minimum digital storage of laptop (when purchased),
- T - Total time,
- t - Reformat Time of the laptop(when entire digital space occupied),
- R - Rate of filling of digital storage at time t (rate of file/folder creation),
- R_f - Reformat risk,
- ϕ_A - Area of representing unoccupied digital inventory space.

4. Formation of Model

4.1. Assumptions

- Let total digital inventory storage in laptop is S_m at a time $t = 0$ (when purchased from the market).
- Assume that laptop initial storage already (captured by operating system files and necessary user application programs files) is S_0 at a time $t = 0$.
- R is the rate of creating files/folders by users at time t which is assumed constant over $t(R > 0)$.
- It is assumed that there is no deletion of files by laptop user.
- T is the total life time of a laptop.
- t represents time when laptop digital inventory is completely filled and reformat is needed.

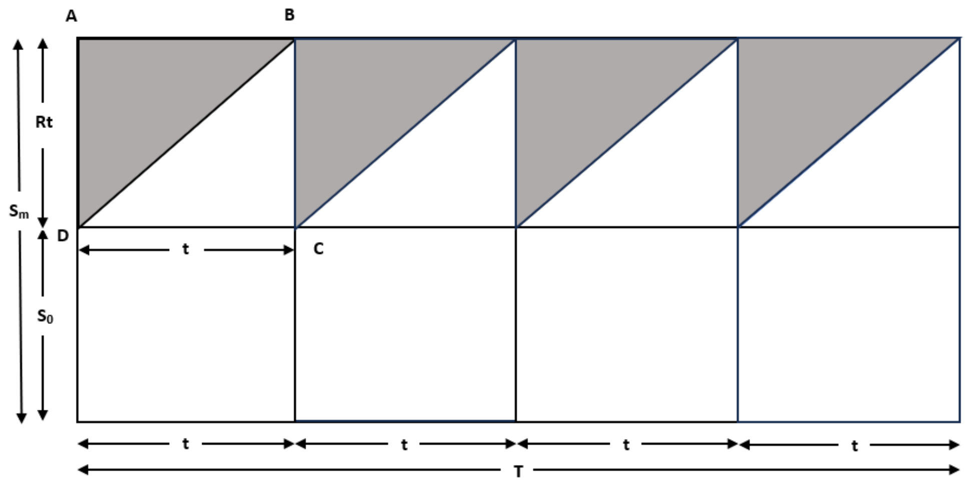

Figure 1: *Working process of occupancy of digital inventory space and reformat at time t*

4.2. Optimization

Consider figure1 who represents the diagram of occupied and free digital inventory space. It is clear that when area of $\triangle ABD$ increases then reformat risk decreases, So

$$\textit{Laptop reformat risk } R_f \propto \left[\frac{1}{\textit{Area of } \triangle ABD}\right] \tag{1}$$

Maximum (total) digital inventory storage space $= S_m$ at time $t = 0$. therefore, area of entire rectangle $= S_m t$. Internal pre-occupied digital inventory storage $= S_0$. Now $S_0 t$ is area representing the pre-occupied digital inventory space. Area of $\triangle DBC = \frac{1}{2}Rt^2$ which is occupied space. The available digital inventory space is represented by

$$\triangle ABD = \phi_A = [S_m t - S_0 t - \frac{1}{2}Rt^2] \tag{2}$$

for optimizing time of risk of reformat

$$\frac{\partial \phi_A}{\partial t} = 0$$

$$(S_m - S_0 - Rt) = 0$$

$$t_{opt} = \left(\frac{S_m - S_0}{R}\right) \tag{3}$$

Using equation2

$$\phi_{A_{opt}} = S_m\left(\frac{S_m - S_0}{R}\right) - S_0\left(\frac{S_m - S_0}{R}\right) - \frac{1}{2}R\left(\frac{S_m - S_0}{R}\right)^2$$

$$= \left(\frac{S_m - S_0}{R}\right)\left[S_m - S_0 - \frac{1}{2}S_m + \frac{1}{2}S_0\right]$$

$$= \left(\frac{S_m - S_0}{R}\right)\left[\frac{1}{2}S_m - \frac{1}{2}S_0\right]$$

$$[\phi_A]_{opt} = \frac{(S_m - S_0)^2}{2R} \tag{4}$$

Equation4, provides the maximum area of storage space in which the reformat risk at time t is minimum. By equation 2,

$$\frac{\partial^2 \phi_A}{\partial t^2} = -R$$

Since $R > 0$ so,

$$\frac{\partial^2 \phi_A}{\partial t^2} \leq 0 \text{ for all } t$$

Therefore the optimum value of $t_{opt} = \left(\frac{S_m - S_0}{R}\right)$ maximizes the area of $\triangle ABD$.

Now reformat risk

$$R_f = C\left[\frac{2R}{(S_m - S_0)^2}\right] \text{ where } C \text{ is proportionality constant.} \tag{5}$$

4.3. Category of laptop users

Category I: Beginner laptop users.
For this category the value of C will be fixed as $C = 25$ and R varies.
Category II: Moderate laptop users.
The value of C will be fixed as $C = 50$ and R varies.
Category III: Professional laptop users.
For this category, one can choose $C = 75$.
Category IV: Expert IT professional.
For this, it is advised to choose $C = 100$.
Overall the constant C lies between $0 \leq C \leq 100$. It helps to calculate the risk of reformatting category-wise.

5. Numerical Simulation

The expression of laptop reformat risk has been computed using simulation at pre-fixed values $S_m = 10$, $S_0 = 2$ keeping variation over $C = [25, 50, 75 \text{ and } 100]$ and $[1, 2, 3, ..., 30]$. Detailed descriptions of R_f are given in tables and graphs attached herewith.

Table 1: *Risk calculation (R_f)*

(a) *Risk calculation (R_f) for Category I*

S_m	S_0	C	R	R_f
10	2	25	1	0.78125
10	2	25	2	1.5625
10	2	25	3	2.34375
10	2	25	4	3.125
10	2	25	5	3.90625
10	2	25	6	4.6875
10	2	25	7	5.46875
10	2	25	8	6.25
10	2	25	9	7.03125
10	2	25	10	7.8125
10	2	25	11	8.59375
10	2	25	12	9.375
10	2	25	13	10.15625
10	2	25	14	10.9375
10	2	25	15	11.71875
10	2	25	16	12.5
10	2	25	17	13.28125
10	2	25	18	14.0625
10	2	25	19	14.84375
10	2	25	20	15.625
10	2	25	21	16.40625
10	2	25	22	17.1875
10	2	25	23	17.96875
10	2	25	24	18.75
10	2	25	25	19.53125
10	2	25	26	20.3125
10	2	25	27	21.09375
10	2	25	28	21.875
10	2	25	29	22.65625
10	2	25	30	23.4375

(b) *Risk calculation (R_f) for Category II*

S_m	S_0	C	R	R_f
10	2	50	1	1.5625
10	2	50	2	3.125
10	2	50	3	4.6875
10	2	50	4	6.25
10	2	50	5	7.8125
10	2	50	6	9.375
10	2	50	7	10.9375
10	2	50	8	12.5
10	2	50	9	14.0625
10	2	50	10	15.625
10	2	50	11	17.1875
10	2	50	12	18.75
10	2	50	13	20.3125
10	2	50	14	21.875
10	2	50	15	23.4375
10	2	50	16	25
10	2	50	17	26.5625
10	2	50	18	28.125
10	2	50	19	29.6875
10	2	50	20	31.25
10	2	50	21	32.8125
10	2	50	22	34.375
10	2	50	23	35.9375
10	2	50	24	37.5
10	2	50	25	39.0625
10	2	50	26	40.625
10	2	50	27	42.1875
10	2	50	28	43.75
10	2	50	29	45.3125
10	2	50	30	46.875

Table 2: *Risk calculation (R_f)*

(a) *Risk calculation (R_f) for category III*

S_m	S_0	C	R	R_f
10	2	75	1	2.34375
10	2	75	2	4.6875
10	2	75	3	7.03125
10	2	75	4	9.375
10	2	75	5	11.71875
10	2	75	6	14.0625
10	2	75	7	16.40625
10	2	75	8	18.75
10	2	75	9	21.09375
10	2	75	10	23.4375
10	2	75	11	25.78125
10	2	75	12	28.125
10	2	75	13	30.46875
10	2	75	14	32.8125
10	2	75	15	35.15625
10	2	75	16	37.5
10	2	75	17	39.84375
10	2	75	18	42.1875
10	2	75	19	44.53125
10	2	75	20	46.875
10	2	75	21	49.21875
10	2	75	22	51.5625
10	2	75	23	53.90625
10	2	75	24	56.25
10	2	75	25	58.59375
10	2	75	26	60.9375
10	2	75	27	63.28125
10	2	75	28	65.625
10	2	75	29	67.96875
10	2	75	30	70.3125

(b) *Risk calculation (R_f) for category IV*

S_m	S_0	C	R	R_f
10	2	100	1	50
10	2	100	2	100
10	2	100	3	150
10	2	100	4	200
10	2	100	5	250
10	2	100	6	300
10	2	100	7	350
10	2	100	8	400
10	2	100	9	450
10	2	100	10	500
10	2	100	11	550
10	2	100	12	600
10	2	100	13	650
10	2	100	14	700
10	2	100	15	750
10	2	100	16	800
10	2	100	17	850
10	2	100	18	900
10	2	100	19	950
10	2	100	20	1000
10	2	100	21	1050
10	2	100	22	1100
10	2	100	23	1150
10	2	100	24	1200
10	2	100	25	1250
10	2	100	26	1300
10	2	100	27	1350
10	2	100	28	1400
10	2	100	29	1450
10	2	100	30	1500

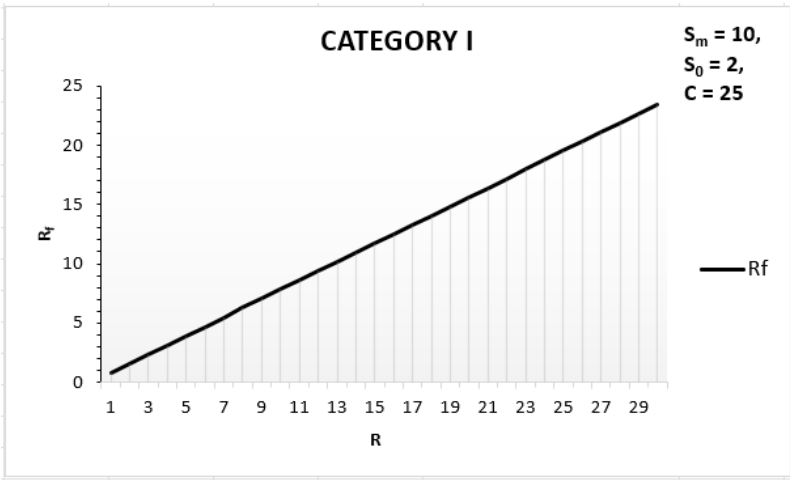

Figure 2: *Risk calculation for category I*

Fig.2 shows laptop reformat risk when $S_m = 10, S_0 = 2, C = 25$.
As the term R increases, the reformat risk increases in a linear manner for the user category of beginners.

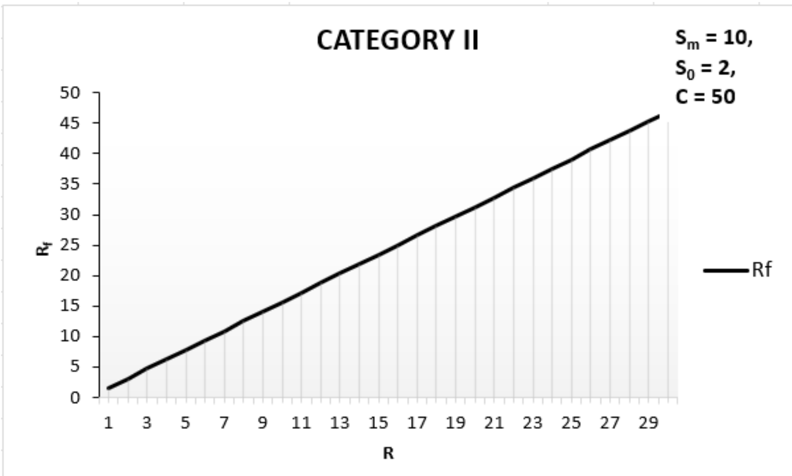

Figure 3: *Risk calculation for category II*

Fig.3 reveals the same pattern (as in fig.2) when $S_m = 10, S_0 = 2, C = 50$ for the category of moderate users.

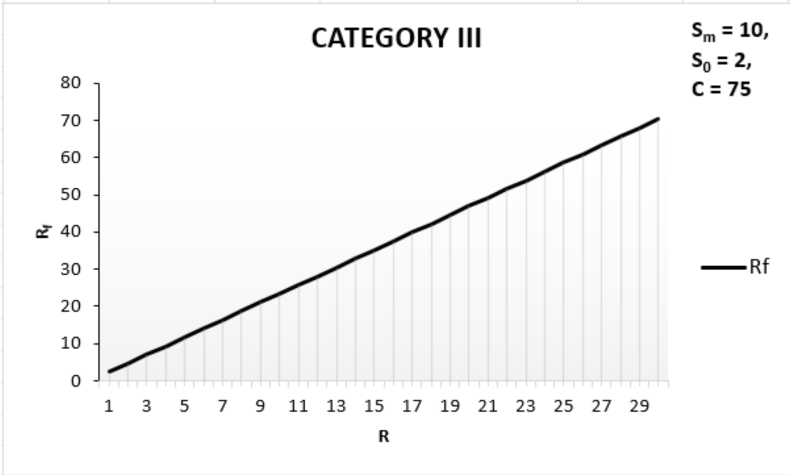

Figure 4: *Risk calculation for category III*

Fig.4 reveals the linear growth of laptop reformat risk when $S_m = 10, S_0 = 2, C = 75$, for the category of IT-professional laptop users.

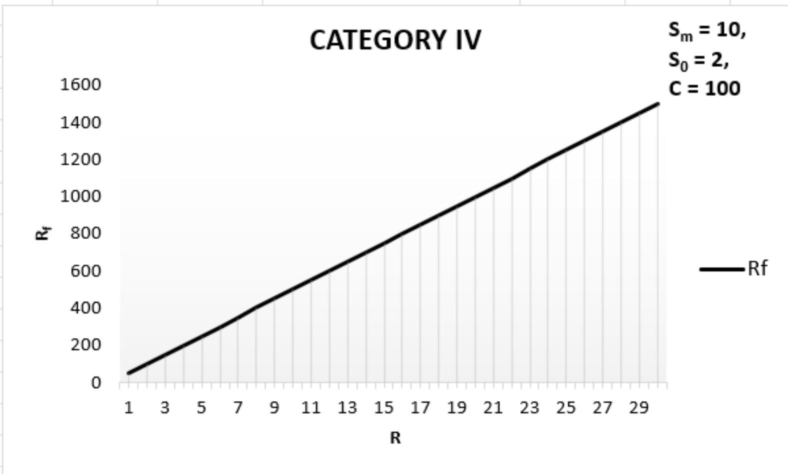

Figure 5: *Risk calculation for category IV*

Fig.5 reflects an increment in risk when $S_m = 10, S_0 = 2, C = 100$, for the category of IT-experts/coders.

6. Conclusion

A digital inventory model is proposed in this paper assuming the digital files/folders creation rate is constant over the time span with with no occurrence of detection of files/folders. The model parameters like S_m (maximum available digital inventory) and S_0 (pre-occupied digital inventory) are kept constant throughout the analysis and computation. An expression for optimal reformat time for a purchased laptop (using the proposed model) is derived. The users vary in terms of their hours spent with laptops. Children spend less, business people provide more, IT-Service providers have high-level associations with their laptops. Four categories with varying constant C values are defined like; beginners, moderate users, professional users, and expert users. The computation of reformat risk of a newly purchased laptop is performed using the proposed digital inventory model.

Figures 2,3,4,5 along with tables 1a,1b, 2a, 2b reveal that compared reformat risk is a linear function over time span in all four categories. The category of IT- Experts bears the highest risk of laptop reformat than the category of beginners.

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