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Modelling the Digital Camera Use
(The “Opportunity-benefits” paradox)

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Abstract

Digital cameras have made revolution in photography by enabling enormous opportunities for the photographer. However, for an ordinary person, most of the pictures shot with digital camera cannot be fully utilized because they remain hidden into computer archives for a long time without being developed. This creates a paradox between the opportunities and the achieved purpose. This study develops a System Dynamics model of digital camera to present phenomena where exponentially growing opportunities are not necessarily proportional to the benefits achieved. Model analysis results describe existence of the paradox due to a growing pattern during the picture-taking and passivity during the deletion of unnecessary pictures. This lack of activity in balancing the system creates a paradoxical situation and a growing accumulation of photos into computer archives.

Key words: System Dynamics, small behavioural systems, paradox, modelling.

Introduction

The photo camera was developed through intensive innovation of new technologies. The latest versions, digital ones, enable wide range of benefits to the user: more photos, instant visibility, small size, independence from the developer, different effects, change of picture quality, etc. However, from everyday experiences in using the digital camera, it can be realized that produced pictures are constantly accumulating into a computer with little chance of being utilized. This kind of situation shows a paradox of disproportion between the abundant opportunities created through innovation and the final benefits generated by camera use. The paradox problem is widely investigated within a range of subjects related to management theory, such as: economy (Clark, 2008), psychology, marketing (Jules & Good, 2014), leadership (Smith & Lewis, 2011), technology (Norman, 2013), etc. Norman (2013, p.34.) identifies technology paradox as pressure on the user created from requirements to use technology: "*The same technology that simplifies life by providing more functions in each device also complicates life by making the device harder to learn, harder to use.*"

Modelling the system of digital camera is primarily aimed at developing a small model of behavioural nature that can be used for discussion of different similar paradoxical situations. Small models are characterized with a limited number of core variables in a system. Such situations can be considered closed systems because they present unique phenomena that can be independently analyzed. They are usually systems that describe a pattern of behaviour and that can also be considered similar with other situations. Examples of small systems are: Bass model (Bass, 1969), Lotka – Volterra (LV) model (Groesser, 2012), TAM model (Davis, 1985), etc. One important issue related to these models is the subject of analysis. The model can take into consideration a particular population or individual. The digital camera model aims to describe the behaviour of the individual and not generalize behaviour of the population like in the cases of Bass and Lotka-Voltera models. Furthermore, such a model is not developed to describe solely technical flows of the pictures but also to describe a system of behaviour that enables the use of camera and human policies that rely in the background. These types of small models that describe behaviour should be considered a specific modelling field and might be identified as models of Small Behavioural Systems (SBS).

The developed Digital Camera Model presented in this paper is not considered a completed task. The parameters for the model are supposed by the author based on personal experiences and further measurements should be undertaken to define precise values. Ideas for the next stage of developing the Digital Camera Model are to continue with more precise quantitative analysis and model details, with validation of the model and development of an interactive simulation device.

Dynamic hypothesis of Digital Camera Model

Through the description of the model of digital camera use, the core intention of this study is to analyze the paradox between opportunities and benefits. If the new technology brings more opportunities it could lead to the increase of self-indulgence which then dominates over the growing pattern and causes unintended consequences. With uncontrolled growth, there is risk from overload, time constraints, and deformation of the system itself. This situation therefore requires adequate balancing policies to reduce the possibility of creating extremities. General pattern of the behaviour related to use of digital camera follows situations where different opportunities are utilized by the particular subject. This "Used opportunity" life pattern is basically “Limit to grow” archetype because the opprotunities has growing character and the necessity to control the accumulation creates a balancing loop (figure 1.)

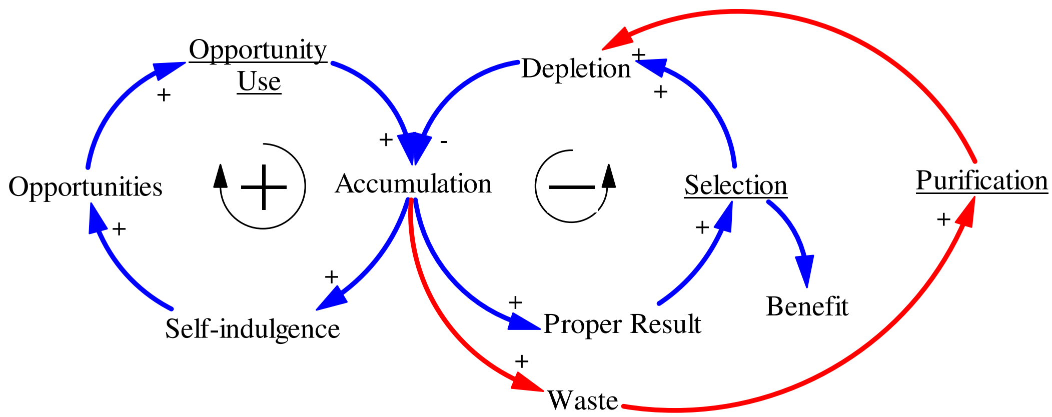

Figure 1. “Used opportunity” life pattern

However, in this case the balancing of the accumulation is represented by two feedbacks. One balancing feedback selects the proper results and utilizes them as benefits while the second balancing loop accumulates waste and purifies the system. If this pattern is described through the digital camera use, then the Digital Camera Model has three subsystems: ‘Picture-taking’, ‘Download’, and ‘Select’ (figure 2.). While the photos are taken in several sequences that are randomly distributed in time, during the picture taking process, the camera memory is accumulated. When the camera is filled with photos, they are downloaded into a computer archive. If the user does not select the photos immediately, then he/she decides after a delay to deal with the photos in the archive by selecting which photos are appropriate for further processing. Selected photos can be distributed further for hard copy development to make the selected photos usable.

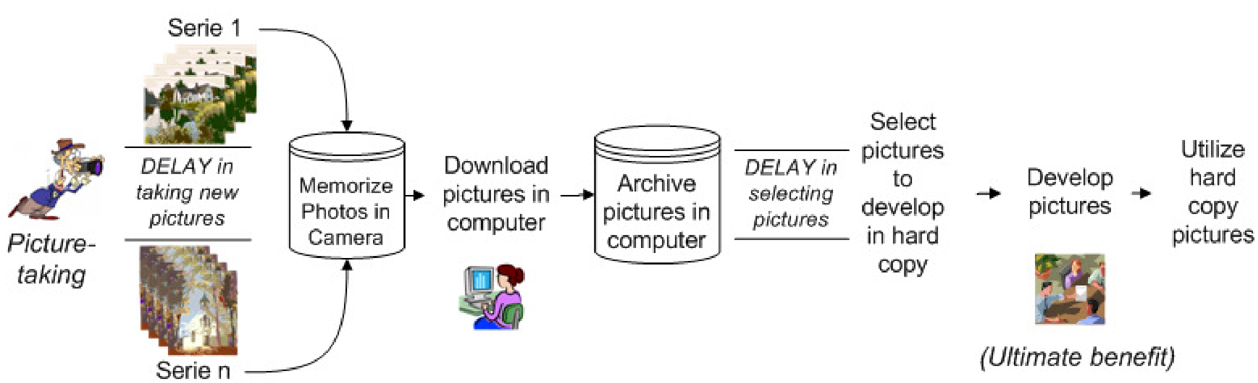

Figure 2. Camera use sequences

Casual loop diagram for the camera use is shown below (figure 3.). Picture-taking and downloading the photos are presented within the same positive loop. Selection of the pictures and their deletion are presented by two other loops. First of these loops is “Memory purification” loop that enables the user to clear the archive from unsuccessful photos. The second of these loops is called stimulation loop that enables the user to select the best pictures, utilizes them and thus create a personal stimulus to make more pictures. This loop is different from the general pattern presented in the figure 1 because development of the digital photos not necessarily means that these photos will be deleted from the memory. The user might leave the digital copy into an archive.

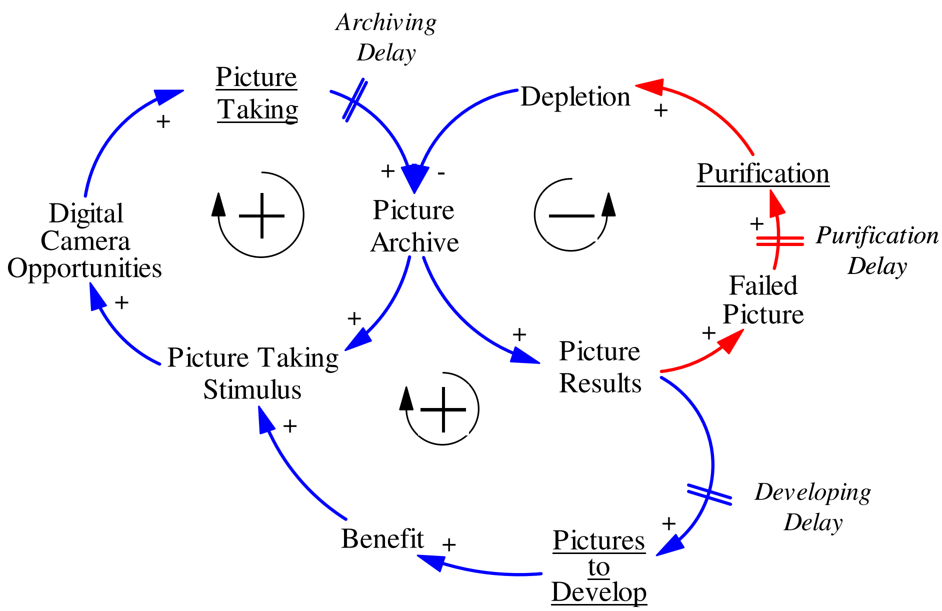

Figure 3. Casual loop diagram of camera use

The first “Picture-taking” subsystem is characterized with two elements: the Picture-taking process, the state of photos in the camera, and the downloading of the pictures into a computer archive. Picture-taking depends on two factors. The first is availability of space in the camera memory. The second is the picture-taking strategy. There are three basic options to deal with this sub-system:

a. In the simplest option, the user takes pictures until the camera is completely full and then downloads them, while by downloading the pictures they are also deleted from the camera memory;
b. The second option is that after each series of shooting, the user downloads the camera photos that have been taken. After that, since the camera memory is not emptied, the photographer can choose to delete the downloaded photos or leave them in the camera;
c. The third option is when the user randomly downloads the photos after more shooting series or when the camera is full.

This model considers only the first option that the photographer is using the camera until the memory is full and then downloads all photos into a computer while deleting the photos from the camera memory.

The second variable that influences the shooting rate is the activity related to camera use or “Picture-taking strategy”. This variable is not very easily predicted but has some specific characteristics. The use of camera is done on the occasional basis by undertaking sets of photos through a certain period of time. For instance, the user is on travel and takes a lot of photos. This means that the camera is used for a certain period of time (during the travel) and a certain amount of photos is taken. However, there is also another way of using the camera when the timing between two sets of shootings is very short because the camera is used very often. This can be a case of the professional photographer or a photograph shop. In this case, the shooting variable can be predicted as the average daily shooting rate. In this phase of the model, two options for the shooting strategy variable will be considered:

1. The flat rate of the specific number of photos per day, and
2. The random impulse functions of several impulses during the time horizon period.

It is also considered that time available for shooting is reserved by the photographer independently from his/her overall available time and therefore, in this study, the time used to take photos will not have any influence on the shooting strategy. Otherwise, it is necessary to connect the shooting strategy with the photographer available time.

The “downloading” sub-system starts after the camera memory is full. In one day, the downloading empties the camera and fills the computer archive with photos.

Through the “Selection” sub-system, the computer archive is reduced from time to time when the user deletes unsuccessful pictures. How the user deletes the photos depends on the implemented deletion strategy that can have two options:

1. Immediately after downloading the photos, the user checks the successful and unsuccessful ones and deletes the failed pictures;
2. The user accumulates all pictures after the download and delays the deletion of particular photos for some other time while the selection process has been undertaken.

Both of these options are possible and feasible and should be considered separately during the quantitative modelling. Moreover, the selection subsystem enables the user to reconsider the pictures that are accumulated into a computer and select the particular ones to be further developed as hard copies and framed or placed in albums. Development of the pictures as hard copies can be considered a final user benefit achieved from the digital camera.

Stock and Flow model

Model boundaries are defined by ignoring issues such as the technology innovation cycle, opportunities to intervene in the quality of picture, and the available time of the user. Endogenous variables are related to the activity of the person to manipulate the camera. At this stage, Digital Camera Model covers basic variables that enable camera use. These activities are presented in more detail for each particular sub-system in the next chapters.

The overall stock and flow model of the digital camera is illustrated in the figure 4. The timeframe of this model has been set to 1,200 days. The basic model has two stocks: the camera photo archive and the archive of photos in the computer. These two stocks are changing based on the picture-taking, the download and the deletion rates. Other auxiliary variables are enabling functionality of the camera use according to the logic of the system. Each camera has its own maximal capacity on the memory and this memory is depleted by the camera use until the moment the memory is full. In this model, maximal capacity is set to 4,000 pictures. When the memory in the camera is full, the downloading starts and at this moment the 'Picture-Taking Switch' blocks the 'Picture-Taking Rate' because of the assumption that when the camera is downloading it is not used to take pictures.

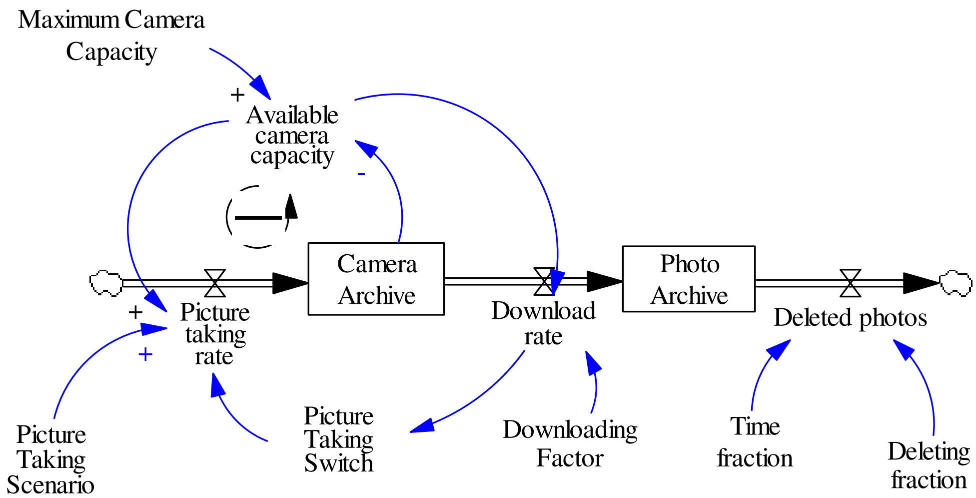

Figure 4. Basic model of digital camera use

The picture-taking depends on the scenario that has been decided by the user. In this basic option of the model, the 'picture taking scenario' is considered a flat value of 100 pictures per day. Downloading is a very fast activity that is usually performed within few hours and therefore it is estimated equal to the camera memory value per day. Deletion of the photos in this stage of modelling is also considered a constant value. It is estimated that 250 photos will be deleted within a week of 5 working days.

Results of the simulation show that flat rates of picture-taking are constantly utilizing camera, which is then downloaded into a computer after its capacity has been depleted. Due to the constant flow of pictures into a computer, the archive of pictures in the computer increases linearly (Figure 6). Because of the constant deletion of pictures, the linear increase of pictures in the computer archive is being constantly reduced for a certain amount during the deletion (Figure 6.). However, since the inflow rate into a computer archive is higher than the outflow rate from deleting the photos, the archive is growing fast. The diagrams in the figure 5 show that the archive is empty until the first photos are downloaded and there is also no deletion of the photos while the archive in computer is zero.

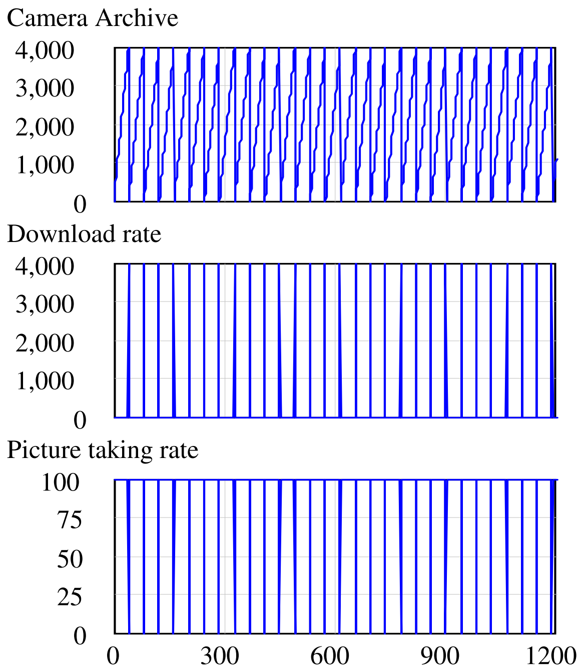

Figure 5.

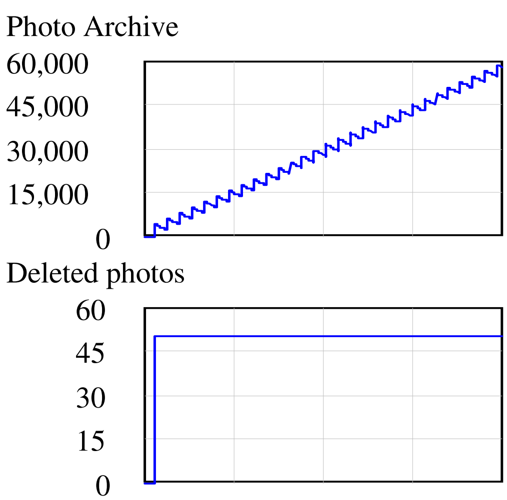

Figure 6.

Flat rates for picture-taking and deletion do not present the realistic behaviour of the system. Picture-taking is usually not a flat rate but series of random pulses with different height and different timing. The user takes pictures at different moments in time in the length of a time interval. The deleting rate is also more complex than the constant option. Figure 7 shows another level of details identified in the DC model. These additional variables are mostly related to the intention to define key stocks and flows in a more comprehensive manner.

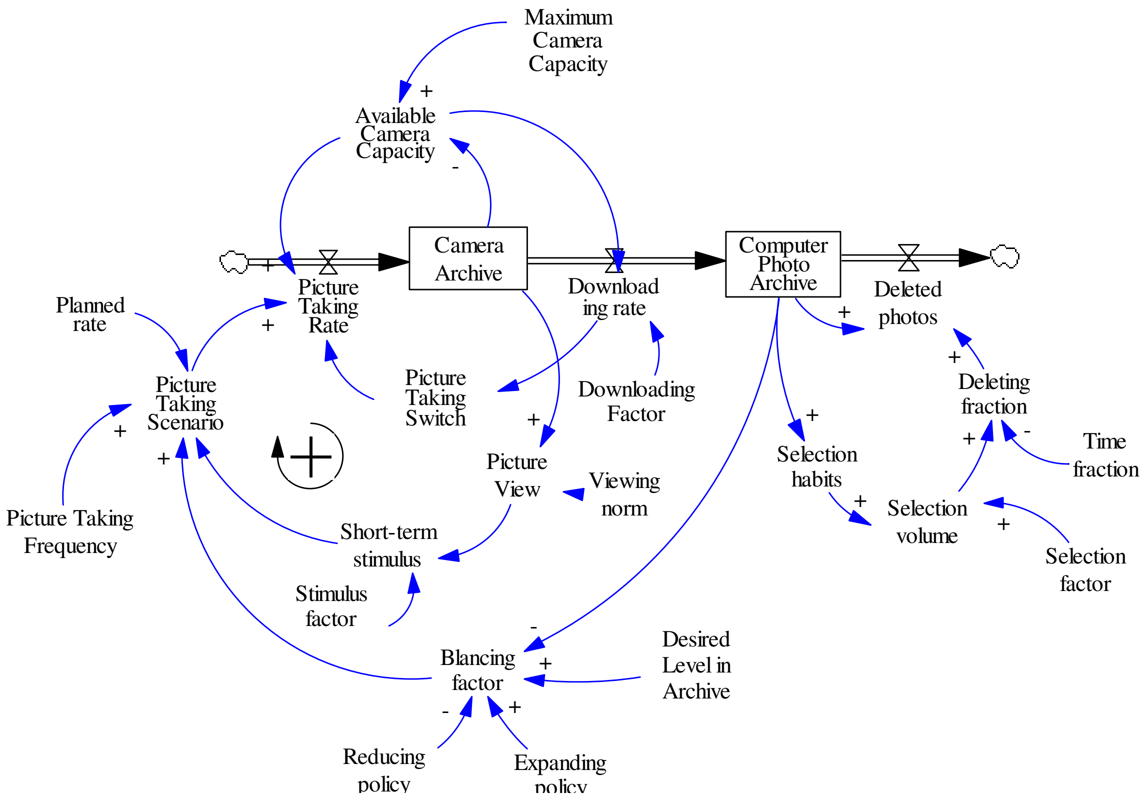

Figure 7. Overall model of the digital camera

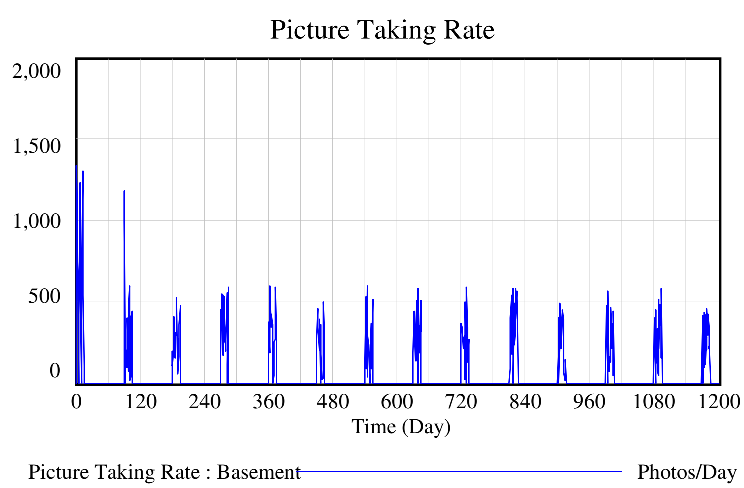

Figure 8.

To define a Picture-Taking Rate, a new picture-taking scenario was assumed. The basis of this scenario is a pulse function with random frequencies (figure 8). This type of function shows the initial behaviour in the form of occasional activities of the camera user. Under this regime of camera use, the stock of photos in the camera changes frequently with filling and emptying the camera memory (figure 8).

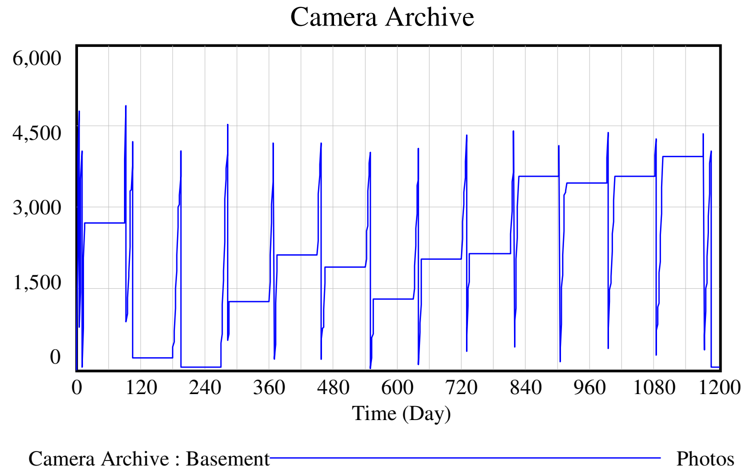

Figure 9.

The scenario for taking pictures is also influenced by two loops related to individual policies of the user. The first loop is the short-term satisfaction with camera use as a result of the possibility to see the taken picture on the camera display. When a picture is taken, the user looks at it on the display and usually decides to take another photo if the actual one is not satisfactory or makes a new photo with a new outlook. The second loop is related to the activity of the user to control the amount of pictures in the computer archive. This is regulated though the balancing policy of the user. Based on the desired level of the computer photo archive, the user can choose to either reduce or expand the camera activity.

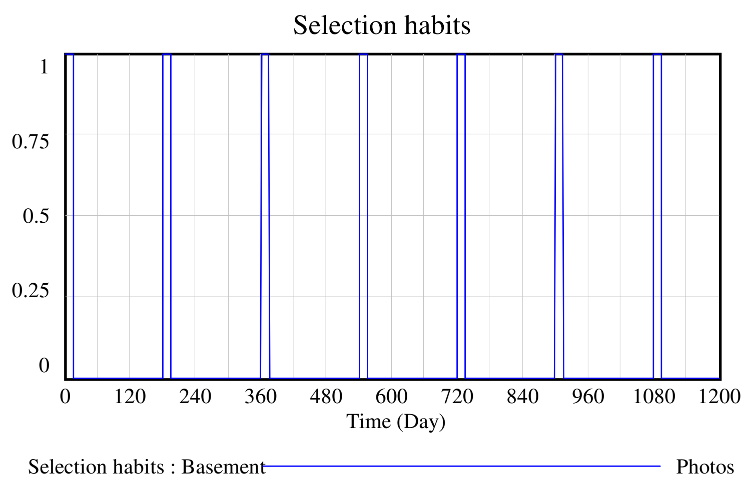

Figure 10.

Finally, additional variables are attached to the cycle of deleting photos. Similar to the picture-taking scenario, it has been assumed that the user will tackle the computer photo archive from time to time. Again, a pulse repetition variable has been set (figure 9) which then creates a basis for the deleting rate. Influenced by the downloading and deleting rates, the computer storage changes accordingly (figure 10).

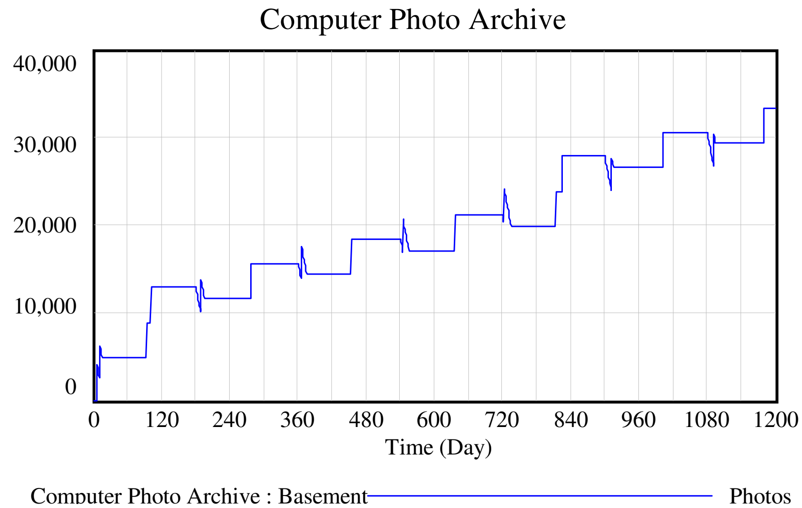

Figure 11.

Discussion and conclusions

The above described model presents an initial effort to describe the dynamics of the system to use the digital camera. The actual model shows that if the camera is constantly utilized, the computer archive grows rapidly. This growing loop is reduced only by deleting the photos or by setting up policies to reduce-picture taking levels. If the pictures are selected and deleted with a slower pace than the picture-taking, then there is overload of the computer's archive. This overload is a sign of the paradox that the system lacks a balanced use.

This level of quantification of the system is not intended to be comprehensive enough because the model requires further details and analysis. In the further stages, the model requires interventions in:

1. Additional modelling features about the system;
2. Consideration of the new factors that influence the behaviour (see figure 12); and
3. Further experimentation with the model to identify characteristic behaviour.

Further modelling of the system requires more precise quantitative analysis, definition of the parameters, definition of the exogenous variables, calibrating and validation of the model. New factors that should be taken into account are available time of the user, additional engagements of the user, increased technological innovations, and social networks impact.

Finally, experimenting with the model could bring important answers about the behaviour of the camera user but also about the behaviour of different systems that perform under similar circumstances, like: the level of personal satisfaction in case of saturation with personal activities, addiction towards the use of social networks, situations of quality improvements that are not increasing usefulness of the product, behaviour that creates obesity, or our behaviour towards the environment when we increase our investments without control and destroy the nature.

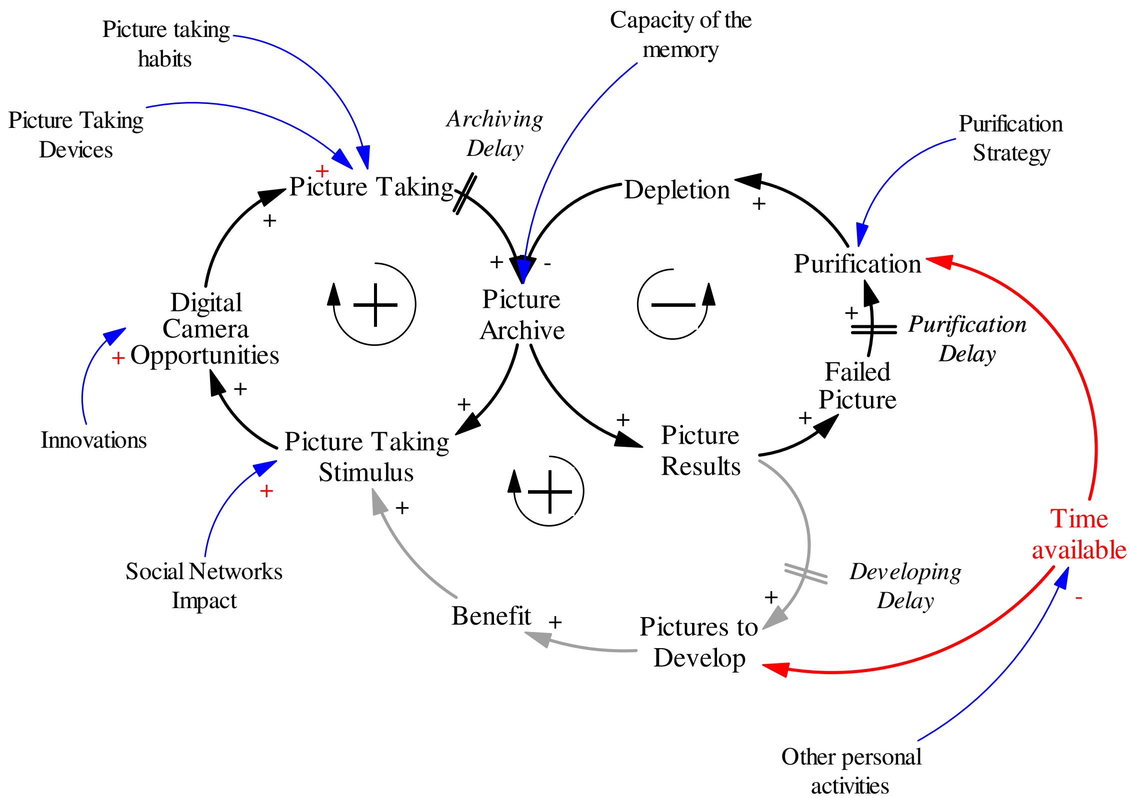

Figure 12. Different additional factors that might influence behaviour

In general, there are three conclusions from this study which relate to the basic principles that describe the behaviour of the situation where opportunity paradoxical situation occurs:

1. The Digital Camera model shows situation of accumulating large amounts of results which are not necessarily utilized in the same proportion, thus, describes the paradox that is created from abundant life opportunities that create limited or sometimes distorted benefits;

2. Digital Camera Model describes situation based on a “Limits-to-grow “archetype and belongs to the category of “Small Behavioral Systems (SBS)” which describe simple behavioral patterns that could be used to explain other similar living phenomena.

3. Extension of the model by taking in account other constraints, shows domination of positive loops and necessity to undertake more balancing measures to create harmonized conditions.

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