

Supporting the life cycle of household appliances during the operation stage

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Abstract. The last decade of the twentieth century was characterized by a rapid digitalization of all areas of activity from traditional research to the automation of production, trade, commerce, banking, and other activities. The CALS technology has become largely popular in the world, including Russia. Continuous Acquisition and Lifecycle Support (CALS) stands for the continuous information support of supplies and the life cycle of products, or the information support for product life cycle (IPS). The product life cycle comprises a set of processes performed from the identification of needs for specific products to the satisfaction of such needs and the scrapping of the products. The analysis of the household appliance service companies helped identify the key causes of equipment failure, one of which is failure to meet the operating requirements. We also established that servicing household appliances takes too much of the consumers' time. They have to understand what consumables they need, when and where to buy them, and how to carry out the maintenance (themselves or through an agent). This article presents an instrument for the operation of products and services required by average consumers in their everyday lives. The tool is made up of a database that stores information about the useful life of different products by specific users as well as information about the maintenance, adjustment, and other actions required for the rational operation of the said products. The database will be used by specific vendors who will keep a database of their clients and products. Alternatively, a retail chain may keep a register of its clients and products sold to them and offer household appliance registration and maintenance services. The third option is creating a cloud service to register consumers, vendors, and service agencies.

1 Introduction

The last decade of the twentieth century was characterized by a rapid digitalization of all areas of activity from traditional research to the automation of production, trade, commerce, banking, and other activities. In a market economy, only companies that use modern information technology (IT) in their operations can outrun the competition [1-10].

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Continuous Acquisition and Lifecycle Support (CALS) stands for the continuous information support of supplies and the life cycle of products, or the information support for product life cycle (IPS) is an approach to the design and production of high-tech products that stipulates the usage of computers and information technology at all of the product life cycle stages [11].

The product life cycle comprises a set of processes performed from the identification of needs for specific products to the satisfaction of such needs and the scrapping of the products [12].

Currently, CALS technology in Russia only covers the life cycle states before the sales of products and technologies, such as design and production [13].

This is because the majority of companies are trying to follow international standards. However, maintaining and providing the information support during the product life cycle shall include such processes and operation and scrapping that are only formal in real life.

Life cycle processes like operation, maintenance, and scrapping are only carried out for high-value products, whose loss due to failures may have a significant economic impact on the owner. The automobile is a good example of such a product. Since a breakdown of a car stipulates significant material losses for its owner due to repairs and the need to hire a substitution car or a taxi. Here we can see that the majority of drivers want their cars to keep the warranty so that they could be repaired for free at the dealership. They are also ready to pay a little extra because the maintenance prices at dealerships are usually higher than in mechanical shops. The majority of dealerships provide quality maintenance at inflated prices that are supposed to cover the unplanned warranty repairs, even though the majority of such losses are incurred by the manufacturer who supplies the parts for free. However, the dealership incurs losses associated with maintenance.

2 The relevance of the problem and a brief review of the literature

Products like washing machines, vacuum cleaners, computers, and laptops may often not receive proper or any maintenance throughout their life cycle until they break down. Clients don't see such products as investments, unlike cars. Owning a car means one can sell or exchange it, and owners assume they have some capital in their cars. Household appliances, especially when they are large, may be hard to scrap because there are only a few scrap collection points and the products need to be delivered there. Even fewer collection points offer pick-up services. Not many people want to buy or sell used appliances. One of the ways to scrap old equipment is by taking it to the shop to get a discount for a new appliance. This option has been developing lately, and such services are offered by an increasing number of retail chains.

However, it is impossible to get a lot of money out of old equipment. Therefore, the maintenance of such household appliances is not prioritized. Since there is a large number of household appliances, their maintenance can be very diverse in terms of time inputs and the amounts and types of consumables, which means the clients will have to spend a lot of time to keep the equipment running.

Note that the equipment that does not receive proper or any maintenance breaks down much faster and may impose indirect losses on the owner. E.g., a dirty filter or heating element may result in increased power consumption. Thus, the owner incurs additional losses without knowing it.

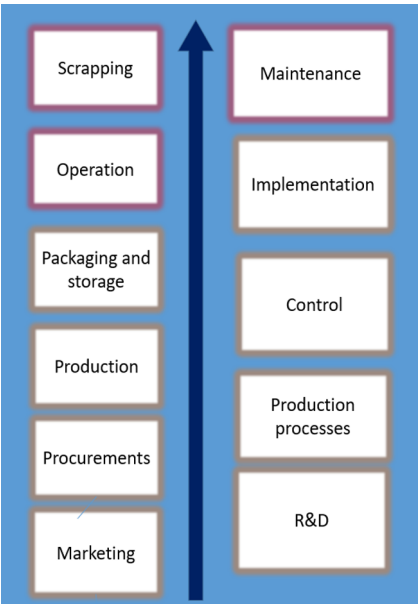


Fig. 1. Stages of CALS technology

Table 1. The fire statistics for household appliances

Fire statistics	
<i>Fire start location</i>	<i>Number of fires in 2021</i>
Cables and wires	40,232
Switches, sockets, plugs, extension cords	5344
Panelboards, electricity meters	3317
Household heating equipment: oil radiators, convectors, etc.	3301
Lighting	927
Refrigerators	775
Power tools	719
Boilers	707
Electric ovens	623
Transformers, rectifiers	478
Washing and sewing machines, etc.	437
TV sets	294
Automatic switches	290
Computers and peripherals	287
ACs	170
Microwaves	146

The analysis of the household appliance service companies helped identify the key causes of equipment failures:

- voltage swing in the grid;
- water or other liquids, including condensation, entering the electrical appliances
- Improper handling of equipment (dropping, mechanical impacts, random bumps);
- non-stop operation for prolonged periods;
- failure to meet the operation requirements.

The most fire-hazardous household appliances according to the Emergencies Ministry.

Cables and wires catch fire are the most fire-prone. They are followed by sockets and panelboards.

A lot of fires happen due to problems with boilers, TV sets, AC units, and even electric doorbells.

1. Statement of problem

Thus, servicing household appliances takes too much of the consumers' time. They have to understand what consumables they need, when and where to buy them, and how to carry out the maintenance (themselves or through an agent).

This means that it is necessary to develop a household appliance maintenance service to solve the following problems:

- Selecting consumables;
- Reminding the user about the replacement terms;
- Providing replacement options.

2. Statement of problem

We suggest developing a tool for the operation of products and services required by average consumers in their everyday lives.

This tool shall promptly provide users with informational, technical, and economic support concerning the maintenance and operation of the products they own.

The tool is made up of a database that stores information about the useful life of different products by specific users as well as information about the maintenance, adjustment, and other actions required for the rational operation of the said products.

The database will be used by specific vendors who will keep a database of their clients and products. Alternatively, a retail chain may keep a register of its clients and products sold to them and offer household appliance registration and maintenance services. The third option is creating a cloud service to register consumers, vendors, and service agencies.

3. Theory

To implement the stated problems, we established 3 development areas for software products.

The first one is a database maintained by a salesperson from a small chain dealing in a specific product type.

Name	Type
Tables (16)	
accounts_customer	
accounts_order	
accounts_products	
accounts_products_tags	
accounts_tag	
auth_group	
auth_group_permissions	
auth_permission	
auth_user	
auth_user_groups	
auth_user_user_permissions	
django_admin_log	
django_content_type	
django_migrations	
django_session	
sqlite_sequence	
Indices (20)	
Views (0)	
Triggers (0)	

Fig. 2. Database fragment

In other words, when the salesperson sells their products, they create (with the client’s permission) a database of products sold stating the client's last, first, and second names and contact data (postal address, mobile number, email) and purchased products. When it is time to perform the maintenance, the vendor selects the consumables (2-3 best options in terms of price, quality, and availability) and offers services like delivery and installation.

Table: accounts_order					
	id	date_created	status	customer_id	product_id
...	Filter		Filter	Filter	Filter
1	1	2023-04-15 13:00:49.487705	Pending	1	1
2	2	2023-06-07 20:43:58.009559	Pending	1	2
3	3	2022-12-25 10:07:07.176242	Completed	1	3
4	4	2023-01-17 12:14:15.502827	Completed	1	4
5	5	2023-04-10 13:12:32.430650	Pending	2	2

Fig. 3. Database fragment

The client selects the suitable type of consumables as well as the service type: they can pick up the consumables and install them themselves or pay for the delivery and installation. The specifics of this type is that the database is maintained by a specific salesperson who works directly with the clients who purchased their products. This is possible for small sales volumes and quality services.

Another option is when large retail chains with high sales also offer their customers to register on their website and service their household appliances.

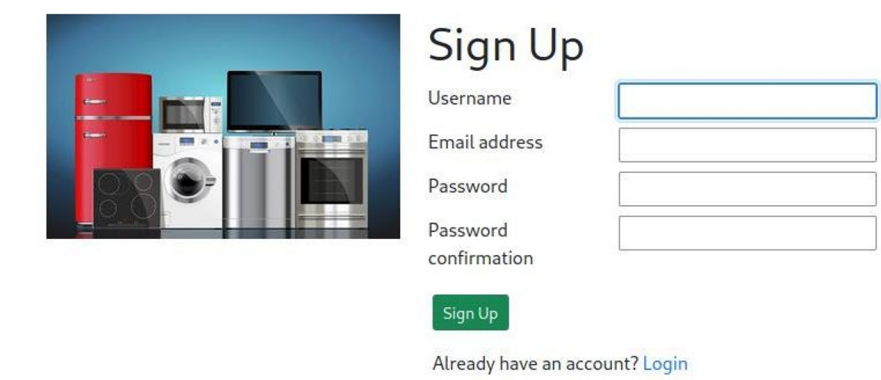


Fig. 4. Authorization

The clients register on the retail chain website and enter their personal data: full name, address, phone number, email, notification preferences, etc. Then they go into their back office and register their appliances, indicating the name, brand, model, and production year. The service department of the chain finds maintenance procedures for the given appliance, as well as the vendors offering the consumables and maintenance works for it among their partners and then makes a maintenance decision. If the decision is positive, the maintenance is carried out similarly to the first option, i.e. the chain offers a selection of servicing options.

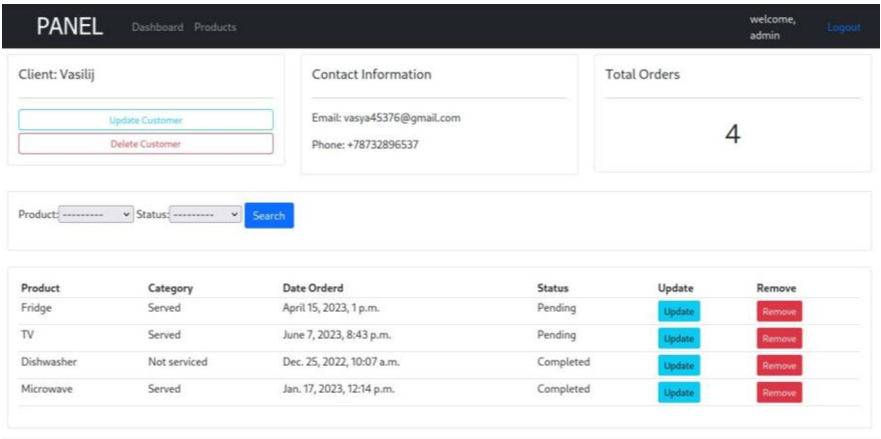


Fig. 5. Personal account.

This type features a database run by a large chain that does not only deal with the appliances it sold but also with the equipment purchased in other shops. This stipulates greater volumes and quality service at lower prices.

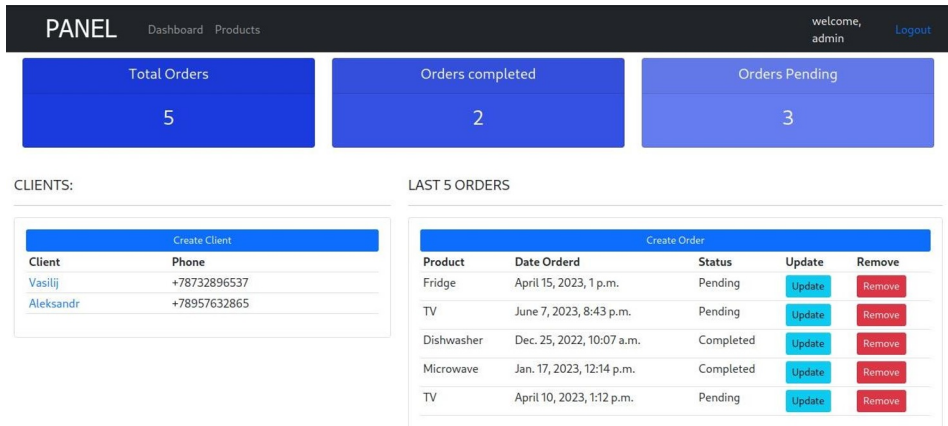


Fig. 6. Administrator's Office

The third option is creating the database in a cloud service. In this case, clients, irrespective of where they bought their appliances, register on the website and enter their personal data like in the second option. They also register their appliances by entering the brand, model, and production year. Companies that sell consumables for maintenance also register on this website. They have to pay a registration fee or commissions for deals they make on the platform. Companies that provide maintenance services can also register for a fee. Initially, while there are not many companies offering consumables and maintenance services, the support service shall be looking for consumables and service providers on external platforms. Besides, the support service shall facilitate the maintenance of the products that is not provided on the developed platform. However, this system will develop through the influx of clients, new consumable and component vendors, and service providers. This type features a self-developing database due to large volumes and low prices for services, however, the quality of service may reduce due to the pricing policy, which calls for control measures and a system of consumer feedback.

One of the prioritized goals - saving consumers' time - can be achieved by the development of a mobile app. The mobile app shall facilitate the second and third product development options. However, the key goal of the mobile app is the development of the third approach. Note the key advantage of the mobile app. Mobile phones are essential for today's life. They are always around, and whenever there is time, clients may open the app, read messages, and make decisions about the maintenance of their equipment.

3 Practical significance, suggestions, and implementation results

Thus, introducing a life cycle support program for household appliances during the operation stage shall solve the following problems for the consumers: selecting consumables, reminders about the replacement terms, and providing replacement options. This shall help promptly perform the maintenance works on household appliances and prolong their useful life. The consumables vendors and service providers shall be able to increase their client base, develop, and, consequentially, increase the income. There is also a social effect: reduced power consumption and risks of fire.

4 Conclusions

This article reviewed CALS information technology. We presented the advantages brought by the deployment of such technologies and established that during the maintenance stage, there are currently problems with the implementation of the life cycle support of household appliances. We identified some of the factors that affect the implementation of this process and reduce the quality of maintenance works. Here are some tools to solve this problem.

The tool is made up of a database that stores information about the useful life of different products by specific users as well as information about the maintenance, adjustment, and other actions required for the rational operation of the said products.

The database will be used by specific vendors who will keep a database of their clients and products. Alternatively, a retail chain may keep a register of its clients and products sold to them and offer household appliance registration and maintenance services. The third option is creating a cloud service to register consumers, vendors, and service agencies.

We analyzed these approaches and concluded that the first one features a database that is maintained by a specific vendor who works directly with the clients who purchased their products. This is possible for small sales volumes and quality services.

The specifics of the second approach is that the database is run by a large chain that does not only deal with the appliances sold by it but also the equipment purchased in other shops. This stipulates greater volumes and quality service at lower prices.

The third approach features a self-developing database due to large volumes and low prices for services, however, the quality of service may reduce due to the pricing policy, which calls for control measures and a system of consumer feedback.

Thus, the developed life cycle support system for household appliances during the operation stage has the following positive effects. The consumers get the selection of consumables, reminders about replacement terms and replacement options, which shall help maintain household equipment promptly, efficiently, and at low prices to prolong its useful life. Consumables vendors and maintenance service providers receive client base expansion and, consequentially, the development of business and increased income. There is also a social effect: reduced power consumption and risks of fire.

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