

## **BUSINESS MODEL OF A PATENTED INVENTION DEVELOPED AT A UNIVERSITY ON THE EXAMPLE OF THE “WAXO” BEESWAX QUALITY ANALYZER**

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**Purpose:** The research purpose is to diagnose the market for beeswax quality analyses in Poland and to develop assumptions for the business model for the commercialization of the WAXO beeswax quality analyzer.

**Design/methodology/approach:** The market analysis was conducted using Computer Assisted Self Interviewing (CASI). The study was conducted among randomly selected 124 respondents in beekeeping throughout the country. Most answered questions on behalf of beekeeping groups or associations, indicating how many members they had. Based on these data, it was determined that the interview results were representative of 2226 respondents. Assumptions for the business model were developed using the Business Model Canvas methodology about: customer segmentation, value proposition, channels, customer relationships, revenue structure, key activities, key resources, key partners, cost structure.

**Findings:** A business model was developed based on which the commercialization of the WAXO device should be carried out.

**Practical implications:** The conducted research allowed for the formulation of conclusions along with the presentation of operational initiatives necessary to introduce the device to the market and further commercialize it.

**Social implications:** The invention of a beeswax quality analyzer protects bee colonies and the natural environment by changing the awareness of the beekeeping community and taking steps to change the applicable legislation. The presented recommendations support the university authorities in making decisions regarding the commercialization strategy of WAXO and the selection of operational solutions necessary to introduce it to the market, production, sales, and customer service.

**Originality/value:** The subject of the invention is a portable electromechanical device allowing the analysis of beeswax for the presence of added impurities.

**Keywords:** commercialization, WAXO, analyzer, beeswax, business model, market diagnosis.

**Category of the paper:** research paper.

## Introduction

Bees are a particular link in the chain linking natural resources with human health and life. With the growing impact of human activity on nature, the level of contamination of natural bee products (honey, wax, wax combs) is increasing (Suyal, Pandey, 2024) which adversely affects the quality of food, cosmetic, and beekeeping products obtained from them, such as food honey, propolis, honey, cosmetics, dietary supplements (Pędziwiatr, Zawadzki, 2017).

Nectar and pollen are deposited in the hive in wax cells produced by bees. The bees' heads beat the pollen and the nectar evaporates from the water. It is closed with wax from above when it obtains the right consistency. For the beekeeper to collect ripe honey from the bees, he uncaps the wax layer with appropriate tools. Bees obtain honey and pollen from flowers and tree leaves while they produce wax themselves.

Beeswax is a mixture of fatty acid esters and long-chain alcohols, free fatty acids, alkanes, free fatty alcohols, and other substances. A review of the literature indicates that the physical properties of alkane samples (e.g., alkanes present in beeswax), in particular their ability to trap electrons, strongly depend on external factors present at the time of sample creation, such as additional substances (including impurities), the type of substrate and crystallization rate (Dekebo, Jung, 2023). These factors modify the number and energy of electron traps, which reflect changes in the structure of the resulting crystals, which can be observed by analyzing them using spectroscopic methods (Pietrow, Gagoś, Kamiński, 2013). The research described in the literature enabled the observation of phase transformations as a function of time and temperature, and thanks to the electron trapping phenomenon, they allowed the observation of local changes in the nanostructure of the samples. Impurities were visible in the obtained spectra (Pietrow et al., 2015).

Wax is used in the cosmetics industry as an additive to some products (Goik, U., Goik, T., Załęska, 2016). It is used to a broader extent in the chemical industry and in furniture production technology: waxing, surface polishing (Wilde et al., 2002), and also as an edible coating for fruits and vegetables (Kozłowicz et al., 2011). Wax is also used to make candles (Mruk, 2019). Beeswax is also used to produce wax foundation, the primary product used in beekeeping. It accelerates the rebuilding of honeycombs by bees. Thanks to it, the honeycomb is more stable and even, and honey extraction is more straightforward. Using wax foundation indirectly increases the honey yield in apiaries (Lyson, 2024). Using wax foundation (Mitsutake et al., 2021) is time-consuming and relatively expensive, which gave rise to the introduction of plastic wax foundation in Poland, but it was not accepted on the market (Bratkowski et al., 2008).

Because bees use their products as building and nutritional resources, their contamination affects the condition of the bee family. Contamination of wax and wax foundation from it is often consciously introduced by people, which is possible due to the lack of applicable standards for the quality of wax and wax foundation.

The poor quality of bee waxes available on the market results mainly from the conscious activities of entities participating in market trade. They rely on adding much cheaper substances to natural bee waxes, e.g. paraffin. This is to reduce production costs and increase profits from the business. This adversely affects the quality of food, cosmetic, and beekeeping products (food honey, propolis, wax foundation, cosmetics, dietary supplements) obtained directly or indirectly from bee waxes. Because bees use their products as construction and fennel resources, their pollution affects the condition of bee families, finally leading to their destruction. The residues of therapeutic agents used to combat varroosis<sup>1</sup> are also a problem. It often happens that beekeepers use improper drugs, often not even intended for treating bees and other animals. They also do not use the correct doses of pharmaceuticals, often inflating them and leading to their residues in the hive environment, including the wax, from where they then go to the wax foundation. It happens that beekeepers, tempted by an attractive price, buy a wax foundation on the Ukrainian market, where less restrictive regulations regarding the use of drugs apply. It happens that such wax may contain, for example, antibiotics. The research described in the literature has shown that honey ripening in honeycombs rebuilt on the wax foundation falsified with paraffin has reduced quality parameters, including higher water and some acids, which may cause its fermentation (Svečnjak et al., 2019). Potential threats to human health associated with the consumption of honey ripening in honeycombs with the addition of paraffin or stearin are also drawn to the European Food Safety Authority (EFSA) in a report published in 2020. In this context, awareness of consumer expectations towards the apiary farm is essential. The main factors convincing direct purchases are the quality and trust in the beekeeper (Bratkowski et al., 2008).

Every mistake affects the quality of the product, which is why the role of beekeepers is so essential. It is recommended that, during honey production, samples be tested for the content of water, HMF<sup>2</sup>, and substances that may be harmful to humans. They should also take care of the health of bees without using antibiotics. Otherwise, honey may hurt the human body. (Szwedziak et al., 2017).

In order to prevent beeswax adulteration, an interdisciplinary team of scientists and practitioners developed and built an innovative wax analyzer, a revolutionary solution. This invention, by changing the awareness of the beekeeping community and taking steps to change the applicable legislation, leads to the protection of bee colonies and the natural environment. This article aims to diagnose the beeswax quality analysis market in Poland and present the assumptions for the business model for the commercialization (Kruachottikul, Dumrongvute, Tea-makorn, Kittikowit, Amrapala, 2023) of the WAXO device. The presented conclusions assist the university authorities in making decisions on the commercialization strategy of WAXO and the selection of operational solutions necessary to introduce it to the market, production, sales, and customer service.

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<sup>1</sup> It is a parasitic disease of bees.

<sup>2</sup> Hydroxymethylfurfural (HMF, 5-hydroxymethyl-2-furfural) is an organic chemical compound naturally occurring in food products.

## **Counteracting counterfeiting of beeswax by introducing the innovative WAXO beeswax quality analyzer**

The problem of adulteration of beeswax in industrial and individual trade is enormous. In the 1950s, a relationship was noticed between the quality of wax used to make wax foundation, the number of bee larvae raised, and consequently the strength of bee families. In the era of mass extinction of bee colonies, this observation becomes very topical, especially in light of the European Commission report 2018, which showed the negative impact of adulterated wax on bee colonies and honey production (European Commission, 2018). Moreover, the adulteration of wax with even a tiny amount of stearin/stearic acid makes it useless for beekeeping (Chęć et al., 2021).

A portable, electromechanical device called WAXO was developed at the Maria Curie-Skłodowska University in Lublin. The innovative WAXO wax analyzer is at the ninth level of technological readiness. WAXO is a portable electromechanical device that examines a small wax sample's physical properties in a thermally stabilized measurement chamber. It allows you to analyze beeswax for adulteration. The device allows you to quickly and at the same time relatively cheaply determine the quality of the tested wax and thus assess its usefulness in beekeeping (Final report on the implementation of pre-implementation support for the results of scientific research and development work as part of the "Innovation Incubator 2.0" project implemented by the consortium of the Maria Curie-Skłodowska University in Lublin, the John Paul II Catholic University of Lublin, the Medical University of Lublin and KUL Creative Sp. z o.o., 2020).

The device, by measuring the mechanical and thermal properties of the tested sample, allows you to assess the similarity of the tested material to pure wax from the caps. This makes it possible to eliminate a product that differs significantly from natural material for beekeeping. The measurement requires preliminary sample preparation (melting the material, forming a pellet, and bringing its temperature to the ambient temperature). The measurement is preceded by a several-minute sample conditioning period by the device and is performed for approximately 100 seconds. The device requires essential maintenance (cleaning) from time to time.

Any beekeeper can operate WAXO. This does not require prior training or technical knowledge. The measurement result is displayed on the device panel. Its interpretation is unambiguous and is based on the following messages:

- good wax,
- bad wax,
- wax of questionable quality (Bio-Tech Consulting, 2019).

The observed differences in the physical properties of alkanes and their mixtures, as well as natural waxes and artificially doped waxes, led to the development of a method for measuring these properties and determining their changes under the influence of doping. The developed method is the basis for constructing the WAXO device, the structure of which has been described in patent applications (three national and three european). These applications concern three separate design solutions related to the measurement of the physical properties of the sample. The measurement principle is based on the susceptibility of the sample to the pressure of the cutting element under specific thermal conditions, which are determined by the local thermal conductivity and wax parameters. They depend on the chemical composition of the sample and the impurities' content. By the decision of the Polish Patent Office experts, national applications received positive decisions granting patent rights (Polish Patent Office, information from 24.09.2021 for P.429881 and from 21.10.2021 for P.429877 and P.429878).

The evaluation of the tested material is based on the unique WAXO algorithm. It was developed based on the results of analyses of several thousand wax samples of various quality and from different parts of the world. The observed regularities in mechanical and thermal properties were verified during tests performed using alternative technologies, such as GC-MS and spectroscopy FTIR<sup>3</sup>. These regularities are included in the WAXO algorithm (MCSU, 2024). Polish and international patents protect WAXO technology.

The invention of a beeswax quality analyzer is being introduced to the market to an increasingly wider extent. In order to efficiently implement commercialization, a business model is necessary, the assumptions of which have been developed in this article.

The essence of every business concept is customers who purchase the offered products, goods, or services and, through this, provide the financing necessary for the further operation of the business. In the era of intense global competition for customer favors, the advantage is gained by those organizations that cannot only meet their expectations but often exceed them. In most industries, there is the so-called “customer market” where supply exceeds demand. Therefore, the bargaining power of customers is high.

## Methods

The main purpose of the research was to develop a business model on which the commercialization of the WAXO device should take place. The business model assumptions were developed using the Business Model Canvas methodology (Osterwalder, 2012). about:

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<sup>3</sup> Fourier spectroscopy (FTIR) is a spectroscopic research technique based on the natural electromagnetic spectrum. This is the common name for the technique used to transform optical data into useful numerical data (Fourier transform).

- customer segmentation,
- value proposition,
- channels,
- customer relations,
- revenue structure,
- key activities,
- key resources,
- key partners,
- cost structure.

For the needs of the quantitative research conducted, the following detailed research purposes were also formulated:

1. Assessing the importance of poor-quality beeswax on the market.
2. Identification of the average (over one year) number of beeswax analyses needed for respondents.
3. Characteristics of beekeepers' actions in the event of a bad wax/ wax foundation analysis result.
4. Identification of information necessary for beekeepers about the quality of the tested wax.
5. Identification of the maximum gross price for performing the test (with the level of detailed result necessary for respondents) of 1 sample of beeswax in an external laboratory.
6. Identify the most advantageous option for beekeepers for wax quality analysis.
7. Identify the number of WAXO devices, if purchased, that would meet the needs of respondents.
8. Identification of sources of obtaining information about technologies and products intended for the beekeeping industry.
9. Identification of sources and frequency of purchase of beekeeping products.

A Computer Assisted Self Interviewing (CASI) was used to conduct the research. The online interview was conducted using a questionnaire. The study was conducted among randomly selected 124 respondents in beekeeping throughout the country. Most answered questions on behalf of beekeeping groups or associations, indicating how many members they had. Based on these data, it was determined that the interview results were representative of 2226 respondents.

## Results. Market analysis

Respondents participating in the study had various representation statuses. The largest part (55%) were beekeeping group representatives and expressed their members' opinions. A much smaller group of respondents (25%) were unaffiliated beekeepers, while affiliated beekeepers had a 15% share in the group of respondents. 5% of the total were representatives of the breeding apiary and beekeepers associated with each other, but speaking on their behalf.

The respondents were quite clear about the importance of the problem of poor quality beeswaxes available on the market. As many as 85% of them stated that this problem is significant (rating 5 on a scale of 1 to 5, where 1 meant that the problem does not occur and 5 that the problem is very important). 10% of respondents rated the importance of the problem as 3, and 5% - 2.

Beekeepers' awareness of the generally poor quality of beeswaxes on the market creates the need to analyze them. The research shows that every beekeeper in Poland is interested in performing an average of 1.18 annual analyses. People participating in the interview most often perform two analyses a year (35% of respondents). Slightly fewer (15%) verify the wax once a year, 15% do it five times, 10% - three times, and the least, 5%, perform analyses respectively: 10 times, 25 times, 75 times, 300 times, and even 1000 times. It should be noted that representatives of beekeeping groups reported the largest number of studies.

If they receive information about the poor quality of beeswaxes, most respondents (95%) do not buy them and look for another product. Only 5% of respondents perform another test using a different method.

For the majority of respondents (70%), the minimum scope of information about the quality of beeswax is marking the product as good, questionable, or poor quality. The WAXO device ensures this diagnostic accuracy. However, for 30% of respondents, it will be insufficient because they expect information on the percentage of impurities in the sample, along with their type.

Respondents gave various answers to the question about the maximum gross price they would pay for testing one wax sample. Most, 35% of respondents indicated the price of 50 PLN and 20% - the price of 100 PLN. The price of 20 PLN was given by 10% of respondents. The exact amount would be able to pay 200 PLN. Prices of 40 PLN, 75 PLN, 150 PLN, and 250 PLN would be acceptable to 5% of respondents. The same proportion of them were unable to provide a price level. It should be added that the maximum weighted average gross price for one wax quality test acceptable to the respondents is 74.17 PLN.

Most, 48% of the study participants would be willing to pay 50 PLN gross for one wax quality test according to the WAXO standard in an analytical laboratory. Fewer respondents (15%) indicated values of 20 PLN and 100 PLN, while 7% indicated values of 150 PLN and 200 PLN. However, 8% of respondents were unable to express their opinion. The weighted

average gross price for performing one wax quality test in the WAXO standard in an analytical laboratory, acceptable to the respondents, is 74.65 PLN.

Half of the respondents want to outsource WAXO tests to an external laboratory. Slightly less, 45% would be interested in purchasing the device. In turn, 5% do not intend to use it in any way.

85% of the study participants plan to purchase one device, and 5% of the research sample declared the purchase of over 20 devices. In turn, 10% of respondents do not intend to purchase WAXO. Respondents gain knowledge about beekeeping technologies and products from various sources. This question allowed for multiple answers. The most popular are conferences, symposia, and seminars. They were mentioned by as many as 80% of respondents. Less than 60% of them use the specialized press, as well as websites, blogs, and online articles for this purpose. The same percentage takes into account the opinions of sellers in specialist stores. Beekeeping clubs and associations are a source of knowledge for 45% of respondents, and social media, universities, and research institutes - for 40% of them. 25% of respondents learn about new products during trade fairs, while 15% use information provided by friends.

Beekeepers most often purchase beekeeping products from specialized online wholesalers (score 2.25 on a scale from 0 to 5). Slightly less popular sources of supply are online specialist stores (score 2.1) and stationary specialist stores (score 1.85). Respondents use stationary specialist wholesalers least often (score 1.05).

## **Results. Assumptions for the business model**

### **Customer segmentation**

The product is addressed to individual and business customers. Individual clients are beekeepers and their associations, e.g. beekeeping clubs. These are usually beekeeping enthusiasts who treat it as a hobby, not a source of income. They have a highly emotional attitude towards bees and are ready to take decisive actions to ensure their well-being.

Business clients include producers of wax foundations and beekeeping products. The increasing awareness among beekeeping market entities of the low quality of beeswaxes and the increasing pressure to improve them will gradually encourage them to monitor their level systematically. Economic reasons mainly guide these clients. They are interested in practical solutions, i.e. that will allow them to achieve the desired results in the shortest possible time and at the lowest possible costs.



## **Value proposition**

Customers expect solutions that ensure: quick and reliable assessment of the quality of beeswax, ease, and comfort of using the device (simplicity of use, mobility), favorable relationship between price and quality of the solution, failure-free, quick and effective removal of possible faults, manufacturer's warranty (considered more in terms of its duration rather than the scope of protection), technical support, especially in the event of problems with the functioning of the solution. Products that meet the above expectations should be addressed to customers. Therefore, the WAXO device was proposed, and - alternatively - an offer of laboratory tests performed using this device. WAXO is a portable, electromechanical device that allows you to analyze beeswax for adulteration. The device allows you to quickly and, at the same time, relatively cheaply determine the quality of the tested wax and thus assess its usefulness in apiary management. Measuring the mechanical and thermal properties of the tested sample allows you to assess the similarity of the tested material to pure wax from the cappings. This makes it possible to eliminate a product that differs significantly from natural material for beekeeping.

## **Channels**

The research shows that target customers learn about innovations in the beekeeping market primarily during conferences, symposia, and scientific seminars. They also use the specialized press, websites, blogs, and online articles. They also take into account the opinions of sellers in specialist stores, as well as members of beekeeping clubs and associations. They use social media and contacts with universities and research institutes. In order to ensure a consistent and effective system of informing customers about the availability of the product, a professional website should be created in polish and english, containing specific and accessible information about WAXO, the possibilities of purchasing it and the possibility of ordering laboratory tests using WAXO, additional support will be provided by videos promoting the device and instructional videos. In the process of product commercialization, it is important to present the device and offer laboratory tests during seminars, scientific conferences, and symposia. An additional, recommended channel for reaching customers may be study visits for members of beekeeping organizations interested in the device and international trade fairs. In order to increase awareness of the availability of the device, an essential action may be establishing cooperation with industry opinion leaders - people who enjoy authority in the beekeeping community and will disseminate positive opinions about the device, as well as disseminating information in the scientific community in the form of scientific articles or participation in conferences. For image reasons, it will be advisable to post information on social media occasionally. The WAXO beeswax quality analyzer will be sold via a website with a store option. Customers will be able to place an order using the form provided and, at the same time, pay a fee, including the sales price and shipping costs. After receiving the payment, the device

will be sent via a courier company to the address indicated in the order. Another option, less frequently used, will be direct sales for cash when presenting the device at conferences, symposia, and scientific seminars. Customers can use telephone and online technical support (helpdesk). The consultant will answer questions from customers and people interested in the device on weekdays, from 10 a.m. to 6 p.m. The device will be covered by the manufacturer's standard warranty care for one year from its purchase. In the event of a failure, the customer will have to send the device to the manufacturer, who will perform repairs free of charge and then send it back to the customer. After one year from purchasing the device, repair, and service activities will be performed for a fee.

### **Customer relationships**

In the beekeeping industry, customers prefer direct contact. To a large extent, the clients are older people who do not use information technology fluently. They prefer to ask questions during a direct conversation, ensuring they understand the answer given and thus increase their sense of security.

Therefore, the manufacturer must establish direct interpersonal relations with customers at all cooperation stages, starting from presenting the offer through handling the placed order to after-sales service. It seems desirable to establish direct contact with customers who have purchased the device to determine their opinions.

### **Revenue streams**

The research shows that customers can accept different price levels for the device. The weighted average gross price was calculated at 3450 PLN and one laboratory test was performed using it: 74.65 PLN.

While the price for the test is acceptable, the device's selling price is not. The production cost of the device is approximately 5000 PLN net. It should be remembered that the sales price must compensate not only the production costs but also the costs of R&D work and include the necessary profit margin. In this context, the sales price of the device should be in the range of 15,000-20,000 PLN net. Based on the opinions of industry experts, this price will not be disqualifying, but it will nevertheless limit the availability of the device and the effective demand for it. WAXO will be offered for a fee. The product will be covered by a one-year manufacturer's warranty, during which any faults not attributable to the customer will be removed free of charge. Customers will also benefit from periodic, paid inspections and services of the device. Laboratory testing services performed using WAXO will also be provided for a fee. It is very important to persuade decision-makers through lobbying activities to subsidize the purchase of WAXO, e.g. from the Oil Crops Promotion Fund. The forecast structure of sales revenues is presented in Table 1.

**Table 1.**  
*Forecasted revenue structure for the years 2024-2026*

Specification	Time		
	2024	2025	2026
Estimated number of WAXO sales (units)	90	100	110
The estimated sales price of WAXO (PLN)	18 000	19 000	20 000
<i>Net revenues from sales of WAXO (PLN)</i>	<i>1 620 000</i> <i>(88,52%)</i>	<i>1 900 000</i> <i>(89,1%)</i>	<i>2 200 000</i> <i>(89,58%)</i>
Estimated number of sales of WAXO laboratory services (units)	3000	3100	3200
The estimated sales price of WAXO laboratory services (PLN)	70	75	80
<i>Net revenues from WAXO laboratory services (PLN)</i>	<i>210 000</i> <i>(11,48%)</i>	<i>232 500</i> <i>(10,9%)</i>	<i>256 000</i> <i>(10,42%)</i>
<b>Total net sales revenues (PLN)</b>	<b>1 830 000</b> <b>(100%)</b>	<b>2 132 500</b> <b>(100%)</b>	<b>2 456 000</b> <b>(100%)</b>

Source: own study.

From mid-2024, sales of the device in foreign markets will be increased. Customers will not repeat the purchase of WAXO during the forecast period, and laboratory services will be renewable annually. A nominal increase in unit net selling prices was assumed: equipment (1000 PLN per year) and laboratory services (5 PLN net).

It is expected that the dominant source of revenue will be the sales of WAXO (from 88.52-89.58% share in the revenue structure). Forecasted revenues from the sale of laboratory services should constitute 10.42% to 11.48% of total net sales revenues.

### Key activities

In order to optimize the commercialization process, key activities should be defined that will motivate customers to purchase the device. The key recommended activities include:

- organizing an effective device production process - selecting and monitoring the activities of a contractor that will ensure high-quality products at affordable prices and short order fulfillment times,
- providing adequate after-sales support,
- establishing cooperation with a courier company that will deliver products to customers,
- monitoring the level of customer satisfaction,
- verification of the value of offered products and services by identifying customer expectations and preferences,
- developing the product in cooperation with users to respond quickly to their needs,
- conducting analysis of foreign markets in terms of future expansion.

Channels for reaching customers and establishing and cultivating relationships with them require key activities. The basic tool for information about the offer (WAXO and laboratory tests) will be a website with a store function. This website should be at least bilingual. The content should be presented in polish and english. The manufacturer's representatives should participate in industry fairs, conferences, symposia, and seminars, during which they will present the offer professionally. Another information medium should be articles popularizing knowledge about WAXO, published periodically in scientific and industry

magazines. A supporting measure should be the organization of study visits for representatives of the beekeeping community in the analytical laboratory, combined with presentations of the device. An essential element of promoting WAXO and laboratory tests performed with its help will be establishing cooperation with opinion leaders, i.e. people with authority in the beekeeping industry, and encouraging them to disseminate information about the device.

### **Key resources**

The key resources needed to create value for customers and establish and maintain relationships with them include:

1. Human resources:

- creators of the device - having comprehensive knowledge about WAXO, presenting it during trade fairs, conferences, symposia, and seminars, preparing articles about it, and dealing with its development (R&D),
- manager managing the work of the business unit (WAXO sales, provision of laboratory testing services),
- laboratory technicians,
- production/service workers.

2. Material resources:

- laboratory rooms with equipment,
- production and service areas with equipment.

3. Intangible resources (non-human resources):

- know-how,
- patents/patent applications,
- certificates required by law,
- website with a store function,
- promotion movie,
- instructional video.

4. Financial resources intended to cover the costs:

- remuneration of human resources,
- laboratory and production and service room equipment,
- operation of rooms,
- device production,
- providing laboratory services,
- purchasing a website with a store function,
- website domain and hosting,
- production of films: promotional and instructional,
- participation in industry fairs, conferences, symposia, and scientific seminars,

- scientific and sponsored publications,
  - R&D works.
5. Relational resources – positive relationships with customers, suppliers, employees, opinion leaders, financial institutions, and business environment institutions.

### **Key partners**

Key partners are an element of the business model describing the network of suppliers and collaborators on whom the efficient functioning of the venture depends (Osterwalder, Pigneur 2012). Competencies are necessary for the successful functioning of an enterprise. These competencies include:

- conducting development work in the field of developing prototypes of new products or subsequent generations of WAXO,
- certification of products in order to admit them to market circulation,
- physical production of products,
- having extensive and effective distribution channels,
- production of films: promotional and instructional.

Development work in developing prototypes of new products or the next generations of WAXO should be conducted in cooperation with external entities. The current generation of WAXO was created with the technical and conceptual cooperation of Amratech sp. z o.o., which additionally exercises substantive supervision over the certification process. The experience resulting from the cooperation so far is positive. Therefore, it is worth including this smaller entity in subsequent development projects. The Institute of Research, Attestation and Certification "OBAC" sp. z o.o. is responsible for the device certification process. Other certification bodies are available on the market, but not all of them offer the required scope of services.

The physical production of products should be outsourced to an external contractor who has the necessary competencies. It is worth considering implementing the production process in a university entity or subject to the management of a special-purpose vehicle. In this aspect, one should strive to obtain an optimal relationship between production costs and time and the quality of products.

The use of extensive and effective distribution channels is the domain of beekeeping wholesalers and chains of specialist stores. It is worth considering establishing a strategic partnership with nationwide distributors and, in the future, covering foreign countries. The production of promotional and instructional films should be commissioned to a specialized media agency. It is recommended that the services of an entity that prepares promotional recordings for the Faculty of Economics of UMCS be used.

The following entities are necessary for the smooth functioning of the enterprise: companies specializing in research, development, and implementation work:

- central distributors/central distributors of beekeeping products,
- device manufacturer,
- courier companies,
- financial institutions (if there is a need to obtain additional sources of financing).

### Cost structure

The projected costs, structure, and expected financial results in 2024-2026 are presented in Table 2.

**Table 2.**  
*Cost structure*

No.	Specification	Time		
		2024	2025	2026
<b>Beeswax Analytical Laboratory</b>				
1	<i>Number of samples</i>	3000	3100	3200
2	<b>Amortization</b>	<b>25 000,00<sup>4</sup></b>	<b>0,00</b>	<b>0,00</b>
3	<b>Laboratory technician's salary (gross + derivatives)</b>	<b>70 000,00</b>	<b>74 400,00</b>	<b>76 800,00</b>
4	<b>Electricity cost<sup>5</sup></b>	<b>9600,00</b>	<b>11 904,00</b>	<b>14 336,00</b>
5	<i>Electric energy consumption in kWh per sample</i>	3,20	3,20	3,20
6	<i>The price of 1 kWh of electrical energy in PLN</i>	1,00	1,20	1,40
7	<b>Laboratory materials costs<sup>6</sup></b>	<b>6000,00</b>	<b>6820,00</b>	<b>8000,00</b>
8	<i>Material costs in PLN (1 sample)</i>	2,00	2,20	2,50
9	<b>External services - service and repair of equipment and production of sample molds</b>	<b>500,00</b>	<b>600,00</b>	<b>700,00</b>
10	<b>External services - rental of laboratory room (15 m<sup>2</sup>)</b>	<b>5 400,00</b>	<b>5 400,00</b>	<b>5 400,00</b>
11	<b>Cost of Beeswax Analytical Laboratory</b>	<b>116 500,00</b>	<b>99 124,00</b>	<b>105 236,00</b>
<b>WAXO sales</b>				
1	Number of devices sold	90,00	100,00	110,00
2	Unit production cost	5 000,00	5 500,00	6 000,00
3	<b>Production cost</b>	<b>450 000,00</b>	<b>550 000,00</b>	<b>660 000,00</b>
4	<i>Help desk<sup>7</sup></i>	<b>12 000,00</b>	<b>12 000,00</b>	<b>12 000,00</b>
5	<b>Warranty service</b>	<b>9 000,00</b>	<b>10 000,00</b>	<b>11 000,00</b>
6	<b>WAXO sales costs</b>	<b>471 000,00</b>	<b>572 000,00</b>	<b>683 000,00</b>
<b>WAXO joint cost</b>				
1	<b>A website with a shop function</b>	5 000,00	0,00	0,00
2	<b>Domain + hosting</b>	100,00	400,00	400,00
3	<b>Videos: promotional and instructional</b>	1 500,00	0,00	0,00
4	<b>Promotion (trade fairs, symposia, press)</b>	10 000,00	20 000,00	30 000,00
5	<b>Manager's salary (gross + derivatives)</b>	96 000,00	96 000,00	96 000,00
6	<b>Joint cost</b>	<b>112 600,00</b>	<b>116 400,00</b>	<b>126 400,00</b>

<sup>5</sup> Electricity cost = (number of samples \* electric energy consumption in kWh per sample) \* price of 1 kWh of electrical energy in PLN.

<sup>6</sup> Laboratory materials costs = number of samples \* Material costs in PLN (1 sample).

<sup>7</sup> Help desk = 1000 PLN/month.

Cont. table 2.

<b>Total costs</b>				
<b>1</b>	<b>Beeswax Analytical Laboratory costs + WAXO sales + WAXO joint cost</b>	<b>700 100,00</b>	<b>787 524,00</b>	<b>914 636,00</b>
2	Beeswax Analytical Laboratory costs	16,64%	12,59%	11,50%
3	WAXO sales	67,28%	72,63%	74,67%
4	WAXO joint cost	16,08%	14,78%	13,83%

  

<b>Gross financial result</b>				
		1	2	2
1	Total net sales revenues (PLN)	830 000,00	132 500,00	456 000,00
2	Total costs (PLN)	700 100,00	787 524,00	914 636,00
<b>3</b>	<b>Gross financial result (PLN)</b>	<b>1 129 900,00</b>	<b>1 344 976,00</b>	<b>1 541 364,00</b>

In the tax year, each entrepreneur can use a one-off amortization limit of 100,000 PLN (Act of July 26, 1991, on personal income tax, Art. 22, section 1s). The forecast shows that the commercialization of WAXO will be economically justified. The positive values of the gross financial result in individual years of the forecast indicate this.

It should be noted that the above proposal of assumptions for the business model is not binding. It should help direct business plans and be subject to appropriate modifications in the event of changes in the external and internal conditions of the functioning of the business.

## Summary

The WAXO device, developed by scientists from the Maria Curie-Skłodowska University in Lublin, solves the problem of beekeepers' uncertainty regarding the quality of waxes and the wax foundation made from them. This problem is very important, as demonstrated in the research process. Moreover, this problem affects many entities, often causing solid emotions. The number of beekeepers in Poland slightly exceeds 90,000, while it is estimated at about 600,000 in the European Union countries. Therefore, there is actual market demand for the device. This opinion is confirmed by the author's interactions with potential clients. The device's price may be a significant problem in the commercialization process. It will be much higher than expected due to higher production costs. It seems necessary to obtain a subsidy for its purchase by customers, preferably at 50%, as is the case with other beekeeping devices.

To sum up, the diagnosis of the beeswax analysis market and the developed assumptions for the business model for the WAXO device entitle us to formulate a recommendation. The consortium authorities should decide on the entity responsible for the commercialization of the device and create formal and legal conditions enabling this process. Supervising the entity responsible for the production, warranty, and post-warranty service of the device is necessary. The key is constantly enriching the device's design by preparing and implementing a professional graphic design. The selling price of the device and the sale of laboratory services

should be adjusted to market conditions, considering the costs incurred. It is also important to intensify lobbying activities to provide customers with subsidies for purchasing WAXO. Another recommendation is to commission the creation of a website with a store function in polish and english and fully launch the beeswax analysis laboratory. Promotional activities should be undertaken, and cooperation with potential nationwide and foreign distributors should be considered to introduce the device to foreign markets (scaling<sup>8</sup> the business model). In order to popularize the device, it is reasonable to conduct R&D work and to use the device to test other products. Financing international patent protection should be suspended, and the funds allocated for this purpose should be used to develop the device.

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<sup>8</sup> Scalability means the ability to increase the scale of operations, measured by sales revenues, more than proportionally to the increase in costs.



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