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Supporting industrial implementation of R&D results with commercialisation models

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A B S T R A C T
The paper aims to present commercialisation models for advanced technologies and services which can be applied in an R&D organisation. Against the background of the literature review on theoretical and practically verified commercialisation models, and marketing strategies and tools, the authors propose an original model, 7MWwBP, composed of several hybrid submodels. The model is intended to support commercialisation processes carried out at R&D organisations. The model is based on the input criteria (the type of innovation and the character of the innovation related to the market demand scale), and it indicates possible commercialisation paths (sale, licence, provision of a service, or a spin-off) and sets of dedicated marketing tools (BTL). The advantage of the model is that an R&D result (innovation) is its focal point, and the whole commercialisation process depends on it. The model aims to mitigate an empirical and research gap as regards commercialisation models suitable for R&D organisations. Furthermore, the model is distinguished by a holistic approach, which is not common for the commercialisation models described in the literature, as they do not comprehensively consider the relationship between the models and the type and character of a technological solution, commercialisation path, and the marketing tools used for commercialisation of R&D results. All the listed aspects are considered and included in the 7MWwBP model, which makes it suitable for the commercialisation of R&D results originating from research organisations, as presented in and substantiated by the example of an actual commercialisation process concerning R&D results in the field of optomechatronics.

K E Y W O R D S
technology management, prototype production and services, R&D organisation, commercialisation models, marketing tools, commercialisation path

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Introduction

The commercialisation of scientific research results is a widely studied subject by academics and the business community (Maktabi & Pazhakh, 2010; Boehm, 2013; Carayannis et al., 2016; Kozien & Kozien, 2017). The process is accompanied by numerous challenges connected with applying innovations in the industry (Kirchberger & Pohl, 2016; Mazurkiewicz et al., 2021). Commercialising scientific research can be difficult in practice because of the steps required to

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turn basic research into practical results (Fletcher & Bourne, 2012). In the case of scientific research results, it also happens that a market for a product is searched for (technology push). This is significantly different from producing a product designed to fit an established or obvious market (market pull).

Numerous models are developed and used to facilitate commercialisation processes. Although such models are a subject of theoretical investigations and practical applications, there is an empirical and research gap concerning commercialisation models suitable for R&D organisations. Furthermore, the commercialisation models described in the literature do not comprehensively consider mutual connections of the models and (1) the type of a technological solution, (2) its character defined by the market demand scale, (3) customised commercialisation paths depending on the type and character of a technological solution, and (4) a proposed set of the marketing tools to be used for the commercialisation of R&D results.

The proposed model comprehensively covers all the aspects. Its application helps mitigate the relatively high risk pertaining to the development and effective practical implementation of innovations, which is possible because of a holistic approach adopted for the model that considers numerous aspects affecting the commercialisation process. The model is split into submodels, which is particularly useful for researchers interested in the commercialisation of R&D results because, depending on the type of a technological solution (material, technology, system, device or service), a customised path is proposed. The advantage of the model is its focus on the R&D result, which, depending on its type, enables the selection of the most recommended submodel.

Thus, the paper attempts to answer the following research question: "What dedicated commercialisation models, designed with the use of the input criteria, i.e., the type of a technological solution and the character of the innovation related to the envisaged market demand scale, can be used at R&D organisations and what commercialisation paths and marketing tools are the most appropriate for these particular models?".

The paper aims to present an original commercialisation model, 7MWwBP, for advanced technologies and services which can be applied in an R&D organisation. The paper is structured as follows: first, it draws on a literature review and discusses the results in two areas: (1) commercialisation models developed by scholars or applied in practice, focused on commercialisation processes carried out by or with the participation of R&D organisations, with particular attention paid to the possible input criteria, stages of the commercialisation process, and commercialisation paths; and (2) marketing strategies and tools. Against the conducted literature review, the authors present the 7MWwBP commercialisation model suitable for an R&D organisation, which considers the input criteria characteristic for individual commercialisation paths and the marketing tools. The presentation of the model is followed by the example of its practical application with regard to innovations in the field of optomechatronics. The paper is summarised with conclusions indicating possible future model development directions.

1. Literature review

The state-of-the-art analysis comprised two areas: (1) commercialisation models, with a particular focus on models designed for or applied in R&D organisations, and (2) marketing tools and strategies. The literature review concerning the commercialisation models and marketing tools was focused on identifying ideas to support the process of designing commercialisation models for R&D organisations.

As a result, the following dedicated models developed for individual R&D organisations or other scientific communities (Table 1) were selected as a background for designing the original 7MWwBP model for an R&D organisation:

- the model using the TTRI_MP method (Jou & Yuan, 2016) to guide technology development, improve NPD decision-making processes, and support the management of new product development and commercialisation;
- the RIPI's New Technology Development Process from Idea to Market (Bandarian, 2007), supporting the staff of research institutes and universities in effective planning of the commercialisation process of technologies;
- the sustainable innovation academic entrepreneurship process model (Qian et al., 2018) concerning the performance of various functions by representatives of the scientific community in the creation of enterprises based on new technologies;
- the Research and Development–Commercialisation Bridge (R&D-C Bridge) model (Budi & Aldianto, 2020), enabling a detailed analysis of the succeeding stages of the successful commer-

Tab. 1. Examples of commercialisation models developed for individual R&D organisations or other scientific communities

MODEL AND AUTHORS	MAIN CHARACTERISTICS	INPUT CRITERIA	STAGES OF THE COMMERCIALISATION PROCESS	COMMERCIALISATION PATHS
TTRI_MP Method, Jou and Yuan, 2016	Facilitating the process of new technologies development and improving the efficiency of implementation in practice	Technology Readiness Level	1. Market exploration and technology forecasting 2. Idea generation and segmentation 3. Portfolio analysis 4. Technology roadmapping	licence, spin-off
RIPI's New Technology Development Process from Idea to Market, Bandarian, 2007	Supporting researchers in effective planning of the commercialisation process of technologies	-	1. Idea 2. Laboratory self-screen 3. Opportunity recognition & conceptual analysis 4. Categorising opportunity types 5. Technology development (technical activities) 6. Looking for & identifying industrial buyers, commercial entities & eager investors 7. Looking for & providing required conditions for field (applied) tests & certificates 8. Carryout field (applied) tests, verification testing, receiving required certificates & intellectual property protection 9. Developing the business concept of technology (commercial feasibility) 10. Contact & connect to industrial buyers, commercial entities & eager investors for explanation 11. Strategic evaluation of technology for finalising 12. Valuation & pricing 13. Commercialisation plan 14. Convincing the eager for the technology & creating a positive belief regarding the benefits of the technology 15. Technology transference and establishing post-launch review & after establishing supports	sale, licence, services
Sustainable innovation academic entrepreneurship process model, Qian et al., 2018	Involvement of the scientific community in entrepreneurial activities; creation of enterprises, and commercialisation of new technologies	The roles played by researchers in the framework of undertaken entrepreneurial activities	1. Idea generation 2. Developing the experimental prototype 3. Deciding to commercialise 4. Creating the product prototypes 5. Creating the new venture 6. Developing the new venture 7. Producing the product 8. Generating sales	licence, sale, spin-off
Research and Development–Commercialisation Bridge model (R&D-C Bridge), Budi and Aldianto, 2020	Commercialisation model, in conjunction with organisations dealing with technology transfer and with tools needed to execute the process of technology commercialisation	Technology Readiness Level Technology Needs Value (TNV), Integration Readiness Level (IRL), Innovation Readiness Diagram (IRD)	1. Research mapping and selection. 2. Technology/ research assessment for commercialisation decision 3. Commercialisation model decision-making 4. Commercialisation process 5. Commercialisation subject selection 6. Commercialisation advising, facilitation, and linking 7. Commercialisation cooperation and synergy 8. Commercialisation coordination model 9. Commercialisation funding and resources 10. Market analysis 11. Technology introduction process 12. Assessment of commercialisation performance	spin-off
Technology-Product-Market (TPM) Model, Minseo et al., 2019	Analysis of commercialisation steps in the context of the assessment of the target market	-	1. Technology development 2. Product development 3. Market	sale

cialisation process while considering the characteristics of the relationship and integration between the institutions involved in different phases of the commercialisation process; and
- the Technology-Product-Market (TPM) model (Minseo et al., 2019), focusing on analysing the succeeding stages of commercialisation in terms of assessing the target market, which provides the tools needed to see how technology and product developments are perceived by potential consumers.

The selected models are analysed with respect to the following: (1) the aspects which, while developing commercialisation models, may be treated as the input criteria, (2) the stages of the commercialisation process, and (3) the commercialisation paths. These aspects are also covered by the set of the 7MWwBP submodels.

Within the analysed models developed by other scholars, products and technologies are distinguished because they require different approaches (Minseo et al., 2019). Considering this, a type of innovation can be treated as an input criterion. Moreover, TRL was most frequently indicated as a possible factor influencing the model. The authors plan to include this aspect as an input criterion at the stage of further development of the 7MWwBP model. However, at first, based on the experience in the development and commercialisation of innovations at an R&D organisation and with the support of experts in this field, the authors decided to consider the input criteria, such as the type of innovation (consistent with state-of-the-art, but more detailed) and the character of innovation related to the possible market demand scale. All models presented in the paper (Table 1) propose the stages of the commercialisation process, and some of them also propose a commercialisation path (sale, provision of a service, licence, or spin-offs).

The analysed commercialisation models do not comprehensively cover marketing activities that could be taken to commercialise innovations effectively. On the other hand, the importance of developing and applying an appropriate marketing strategy for effective commercialisation is unquestionable, especially in the case of functioning in the market of innovations (Robul et al., 2020). The comprehensive matching of marketing tools and selecting appropriate forms of marketing communication are indispensable parts of managing the commercialisation process. It enables R&D organisations to be in constant contact with their existing and potential customers, which directly impacts the effectiveness of commercialisation processes. Thus, the second area of the state-of-the-art analysis comprises marketing strategies and tools for the purpose of a commercialisation process and covers the following (Table 2):
- segmentation models (Kuipers, 2018), referring to the business-to-business environment;
- a strategy for market segmentation and differentiation (Arsova & Temjanovski, 2019), dedicated to targeting consumers;
- marketing strategies for innovations (Kharchuk et al., 2014), highlighting their comprehensive role for companies;
- modern marketing instruments (Tarasova et al., 2020) while considering two types of marketing

Tab. 2. List of examples of marketing models, strategies and tools

Name	Authors	Entity	Thematic scope
Segmentation models	Kuipers, 2018	Companies within B2B	Recognition of segmentation criteria when the customer is a company
Strategy for market segmentation and differentiation	Arsova and Temjanovski, 2019	Companies	Creating and formulating a marketing strategy for companies
Marketing strategies for innovations	Kharchuk et al., 2014	Companies	Analysing the role of strategic marketing towards the development and commercialisation of innovations
Modern marketing instruments	Tarasova et al., 2020	Companies	Modern marketing instruments for the company's market promotion, considering ATL and BTL marketing communication
Marketing tools	Gvozdetskaya et al., 2016	Universities	Marketing support for the commercialisation process of intellectual property items
Digital marketing tools in the value chain of an innovative product	Robul et al., 2020	Companies	Analysis of marketing and innovation activity at the stages of the value chain and the role of digital marketing in the value chain

communication: ATL-communications (direct) and BTL-communications (indirect);
- marketing tools (Gvozdetskaya et al., 2016) used for marketing support of the commercialisation process of intellectual property items; and
- digital marketing tools in the value chain of an innovative product (Robul et al., 2020).

The presented examples refer to different entities, mainly companies, because they have considerable experience in marketing activities. They were selected because R&D organisations should act similarly to enterprises in the area of commercialising innovations. On the basis of the state-of-the-art analysis, marketing tools are proposed for particular 7MWwBP submodels.

The results of the state-of-the-art analysis were used for the following purposes:
- selecting the input criteria for designing 7MWwBP commercialisation submodels;
- designing the set of 7MWwBP commercialisation submodels;
- the recommendation of commercialisation paths; and
- the recommendation of the sets of marketing tools.

The 7MWwBP model comprises the input criteria determining its submodels, for which commercialisation paths and a set of suggested marketing tools are proposed.

2. Method

The scope of the literature review conducted by the authors first comprised all commercialisation models, with particular attention paid to models developed for or applied in R&D organisations, and, secondly, marketing strategies and tools that may support the effective use of the models. As a result of the state-of-the-art analysis, examples of commercialisation models suitable for the commercialisation of R&D results were selected. Although the authors managed to identify commercialisation models meant for R&D organisations, none of them comprehensively consider the relationship between the models and the type of a technological solution, its character related to the market demand scale, commercialisation path depending on the type and character of innovation, and the marketing tools used for the purpose of commercialisation of R&D results.

The state-of-the-art analysis comprised academic literature (mainly including two databases: ISI Web of Science and Scopus) and grey literature (reports, working papers, government documents, white papers). The search in the first area (commercialisation models) used keywords "commercialisation models", "New Product Development", "New Technology Development"; and in the second (marketing strategies and tools), it used such keywords as "market strategy", "marketing tools" and "market segmentation". In total approx. 120 papers were collected in the first area and about 180 papers in the second. All papers were subject to a two-stage analysis. In the first stage, abstracts were read, and whole papers were roughly reviewed. After this stage, approx. 80 papers from the first area and about 45 papers from the second were selected for in-depth analysis. As regards marketing strategies and tools, this is a very rich area with plenty of publications; however, only a small part of them concerns marketing activities related to commercialisation activities. In the second stage, the publications were analysed with respect to (first area) models and methods used for facilitating commercialisation processes at R&D organisations and other scientific communities and (second area) marketing strategies and tools that may support the commercialisation models. As a result, five examples were selected in each area for inclusion in the paper as a background for presenting a commercialisation model, 7MWwBP, developed by the paper's authors.

Against the background of the state-of-the-art analysis and with the consideration of the authors' experience of participation in research and commercialisation projects, a set of seven submodels was proposed for the implementation of research results and products (7MWwBP) developed at an R&D organisation. The authors assumed that different types of R&D results required different commercialisation paths. At first, real technological solutions of each type (i.e., material, technology, system, device and service) were selected and initial commercialisation models were proposed, considering the findings of other scholars and practitioners. Next, these initial models were verified on several dozen examples of commercialised R&D results, which contributed to the further development of the models.

The authors briefly describe the proposed commercialisation models. A particular emphasis is placed on the input criteria which determine each submodel, as well as on the commercialisation paths and marketing tools suggested as the most appropriate for each submodel. The proposed models are currently used in practice by an R&D organisation, the Łukasiewicz Research Network – Institute for

Sustainable Technologies, for the commercialisation of results of various scientific, R&D and implementation activities. The potential practical application of the models is presented using the example of optomechatronic technologies.

3. Results

Based on the literature review, while considering the specific characteristics of R&D organisations, the authors designed a set of seven marketing and business submodels for the implementation of research results and products (7MWwBP). The submodels were built according to the two input criteria, i.e., the type of solution (innovation) and the character of the solution. The following types of solutions were distinguished (Mazurkiewicz et al., 2015):

- services (e.g., IT, surface engineering);
- materials (e.g., chemical, textile, composites);
- systems (e.g., software, computer systems);
- technologies (e.g., chemical, mechatronic); and
- equipment (e.g., research and testing apparatus).

The second criterion concerned the character of the solution related to the market demand scale (Walasik, 2018):

- unit;
- short series; and,
- mass production.

For each model (Fig. 1), possible commercialisation paths and suggested marketing tools were proposed.

Although individual submodels are customised to the type and character of a technological solution, all of them are characterised by the same approach and include the same elements (the proposed main commercialisation path and main marketing tools). They are unified in one 7MWwBP model to present the whole set of approaches to be applied with regard to the possible types of R&D results. Each researcher interested in commercialisation selects a particular submodel suitable for the R&D result. The awareness of other submodels is very useful, especially if R&D results can be practically implemented with the use of different commercialisation paths, e.g., a direct sale of a device to the market or the provision of services by R&D organisations with the use of this designed and manufactured device.

The developed commercialisation models comprise the Innovation Model, the Niche Model, the Sub-supply Model, the Comprehensive Model, the Market Model, the Infrastructure Model, and the Phase Model. The proposed models were described in detail by Poteralska and Walasik (2021). A short summary is offered below.

M1 — Innovation Model is based on gaining and maintaining the technological advantage. Innova-

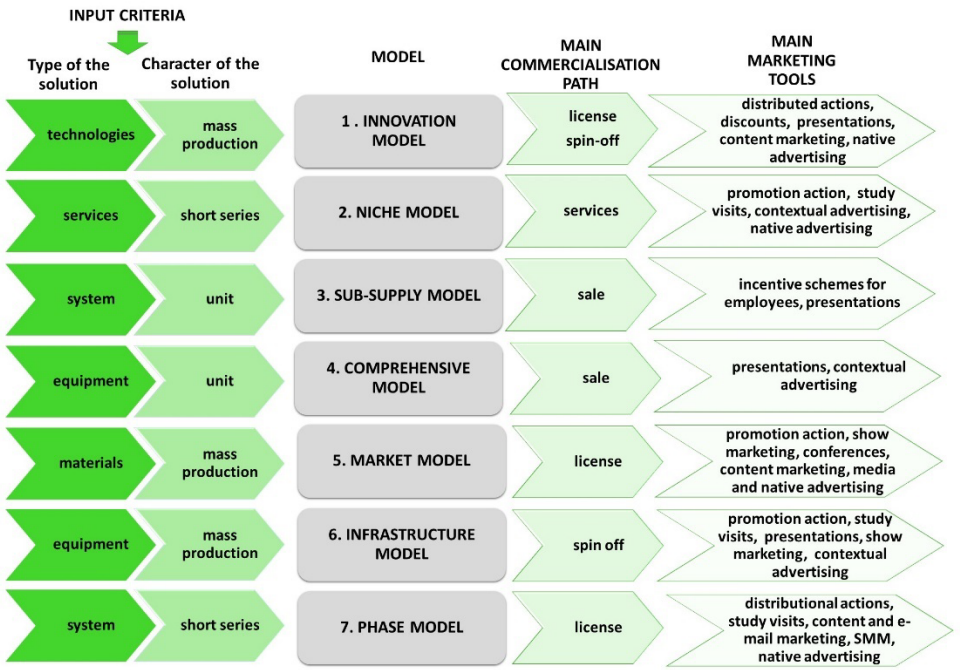

Fig. 1. Commercialisation models for an R&D organisation

tions should be converted into a specific utility for customers and have unique performance characteristics that are absent from products currently available on the market.

M2 — Niche Model is recommended when the results of the ongoing R&D work constitute new ways of conducting processes and solving important problems. It is dedicated to small-scale repeatable services that can be performed within a few days. Entrepreneurs use such services provided by R&D organisations because to perform them by themselves, they would have to engage knowledge and capital that is incomparably greater than the cost of services.

M3 — Sub-supply Model focuses on adapting the offer to the unique needs of the customer. The model is recommended for complex products that require close cooperation with buyers.

M4 — Comprehensive Model is meant for complex products, processes, or technologies. It is dedicated to solutions consisting of many interrelated elements, accompanied by various additional services that are offered both at the time of the purchase and later at the stage of operation.

M5 — Market Model is used when the results of the R&D work aim to solve social, civilisational, and environmental problems. The communication to potential customers should highlight how a solution can contribute to solving the above-mentioned types of problems that are currently relevant to society.

M6 — Infrastructure Model is based on the design and delivery of a complete technology along with new technological capabilities that enable new ventures to be started to provide mass access for potential customers.

M7 — Phase Model is designed for solutions that, after their testing in the laboratory and the semi-production phase, have a chance to be implemented in mass production by launching a new area of activity for an existing company, ensuring that it expands its product portfolio.

Regardless of the type of the commercialisation submodel, based on the literature review and the authors' experience in practical, industrial implementation of R&D results, while concurrently considering the specific conditions under which R&D organisations operate, the following stages of the commercialisation process at an R&D organisation are proposed:

I. generating an idea and developing an R&D solution corresponding to the market demand;

II. applying appropriate suitable implementation submodel (7MWwBP), depending on the result of the R&D work;

III. selecting and implementing marketing activities, depending on the principles of competition applicable to a given market, and including target segments; and

IV. carrying out horizontal activities strengthening the market position of the R&D organisation as an entity developing new products.

The effect of carrying out the commercialisation process based on the indicated points is to implement innovations developed by R&D organisations into economic practice.

For each submodel, a commercialisation path is proposed. Commercialisation may be direct or indirect (Lasambouw et al., 2021; Roszkowska-Mądra & Siemieniuk, 2020). The most common and basic paths of direct commercialisation are the sale of R&D results (direct sale — offering R&D results to economic entities, indirect sale — through intermediaries, e.g., wholesalers), granting a licence to use R&D results, and providing services with the use of R&D results.

Within indirect commercialisation, a spin-off company is set up. It consists in bringing R&D results to a commercialisation company, which is the most difficult commercialisation path, but it can potentially bring the greatest financial benefits.

There is no single best path for commercialisation. Each of them has its advantages and disadvantages, and the choice always depends on the specificity of the technology and its environment and the policy of the R&D organisation. For each submodel, the authors propose the most appropriate commercialisation paths (Table 3).

It should be noted that the current R&D market puts R&D organisations, including research institutes, in the position of companies offering services,

Tab. 3. Commercialisation paths proposed for individual 7MWwBP submodels

Submodel	Sale	License	Service	Spin off
M1	**	****	*	****
M2	***	**	****	*
M3	****	***	*	**
M4	****	***	**	*
M5	***	****	*	**
M6	**	*	***	****
M7	*	****	***	**

and it consistently enforces marketing behaviour in them. Unfortunately, R&D organisations lack marketing skills.

The successful commercialisation of innovations depends on effective marketing strategies (Kharchuk et al., 2014). The use of dedicated marketing tools, which help disseminate the information about R&D results in a non-random and customised manner, contributes to building a science–business relationship and acquiring business partners, which directly results in a more successful science-business knowledge transfer.

Thus, apart from the commercialisation path proposed for each 7MWwBP submodel, in order to allow practical application of the models in the innovation diffusion process, adequate sets of marketing tools are selected for each of them, first, to streamline the process of dissemination of research results obtained at R&D organisations, and then to facilitate commercialisation of these results. In the process of designing these sets of tools, a concept was applied for dividing marketing instruments into ALT (above the line) and BTL (below the line) groups, presented in contemporary publications (Tarasova et al., 2020). Considering the character of technological innovations developed and implemented by R&D organisations, the authors propose, with regard to this group of technological solutions, to apply the BTL activities that are targeted at the deliberately selected audiences. The main advantages of the BTL activities comprise the ability to reach a specific audience, effective and personalised communication, and the measurability of the effects.

For each of the seven submodels, a set of dedicated BTL marketing tools is proposed based on the experience of authors and other scholars in conducting commercialisation processes. BTL tools are divided into three areas (Tarasova et al., 2020) (Table 4):

- sales promotion (Tools 1–4);
- public relations (Tools 5–8); and
- internet advertising (Tools 9–14).

The proposed BTL tools are dedicated to the commercialisation paths indicated in Fig. 1. If the market implementation is successful, it is reasonable to modify the set of the marketing tools used. Furthermore, considering the feedback obtained from the market, it is possible to ensure a more effective commercialisation process by correcting the scope of the marketing activities carried out.

Tab. 4. BTL tools dedicated for 7MWwBP submodels

No.	BTL tools	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7
1.	Promotion action with image-based communication	+	+++	++	++	+++	+++	+
2.	Distributional actions (direct sale)	+++	+	+	++	+	+	+++
3.	Actions focused on the growth of purchases (e.g., discounts for exceeding the volume of purchases)	+++	+	+	+	+	+	++
4.	Incentive schemes for employees	++	++	+++	+	++	++	++
5.	Study visits	++	+++	++	+	+	+++	+++
6.	Presentations – direct meetings	+++	++	+++	+++	+	+++	++
7.	Show marketing (events)	+	+	++	+	+++	+++	+
8.	Conferences	++	+	+	+	+++	+	++
9.	Content marketing (e.g., blogs)	+++	++	++	+	+++	++	+++
10.	E-mail marketing	+	++	+	++	++	+	+++
11.	SMM (social media marketing)	+	+	++	++	+	++	+++
12.	Contextual advertising	++	+++	+	+++	+	+++	+
13.	Media advertising	+	+	+	+	+++	+	++
14.	Native advertising	+++	+++	++	++	+++	+	+++

Legend : +++ recommended tools, ++ advisable tools, + tools of minor importance

Source: Elaborated by the authors (Poteralska & Walasik, 2021).

4. Good practice

The proposed submodels are used to support commercialisation processes at R&D organisations and increase their effectiveness by applying a structured approach and proposing specific steps, depending on the type and character of a technological solution. Moreover, the application of the submodels better focuses R&D organisations on the market, which is of key importance as the insufficient market-oriented approach and insufficient management, marketing, and commercialisation skills, mostly on the technology provider's part, are stressed as one of the important technology transfer barriers (Derakhshani, 1983; Harder & Benke, 2005; Mazurkiewicz & Poteralska, 2019). Strengthening the marketing orientation in an R&D organisation also facilitates its recognition as an organisation oriented towards the commercialisation of R&D results. The application of the models may also act as a boost for an R&D organisation's revenue from the sale or licensing of technologies, provision of services, or practical, industrial implementation of products with high commercial potential.

The models are applied in practice in the processes of technological innovation development and commercialisation at the Łukasiewicz Research Network – Institute for Sustainable Technologies. An example of an effective technology transfer, considering the proposed stages of the commercialisation process for R&D organisations, is the optical inspection system on production lines, which aims to increase the production efficiency and quality of products. The creation of this innovation in the form of know-how (design methodology) was a result of R&D activity (technology push); however, a reverse situation was also observed, namely, the shaping of R&D activities in the directions for which there is demand from companies (market pull) (Stage I of the commercialisation process). For the R&D result, based on the input criteria (type and character of the innovation), one out of seven submodels was suggested, i.e., the Sub-supply Model. This submodel is used when the offer is adapted to the unique needs of the recipient (Stage II of the commercialisation process).

Innovations dedicated to the metal and automotive industry, thanks to dissemination among similar companies, found more customers. Market segmentation, on the other hand, identified new industries in which the innovation was applied, among others in the tobacco industry (Stage III of the commercialisation process).

Undertaken image activities aimed to create a brand of an R&D organisation, showing successful implementations of R&D results, direct marketing, and presentations of success stories resulted in the start of cooperation with new entities and encouraged to implement the system on their production lines, in this case representing the food industry. An important element of Stage IV of the commercialisation process was to inform the existing and potential partners and business entities about the activities conducted in the area of creating a generation of new systems that are constantly being developed and whose operating ranges are continuously extended with new functionalities, e.g., the use of real-time systems, deep learning methods, or new sensors and illuminators from the entire optical radiation range, which resulted in the development of vision systems designed for the glass industry in accordance with the "zero waste" philosophy.

Conclusions

Increasing market pressure to develop innovations poses challenges to R&D organisations and other actors interested in technology transfer, consisting not only of focusing on innovation creation but, above all, on a comprehensive approach to the commercialisation process. In the case of a new technology or R&D results, several important decisions should be taken, including how to protect intellectual property, how to finance various stages of the innovation development process, or, finally, how to introduce new technology to the market, which the proposed models are intended to support.

The use of the proposed set of seven 7MWwBP submodels allows for individual treatment of each research result and product developed by an R&D organisation for the purpose of its commercialisation. The proposed submodels are general and flexible at the same time. They should not be treated as rigid, absolute procedural guidelines but as a proposal that facilitates the introduction of marketing orientation in an R&D organisation, affecting activities aimed at the commercialisation of R&D results. In comparison to the models described in the literature, it comprehensively considers the relationship between the models and the type and character of a technological solution, commercialisation path and a set of the marketing tools proposed for the effective commer-

cialisation of R&D results. The possibility to apply this customised approach to all types of R&D results developed at R&D organisations is, in the authors' opinion, the most important strength of the proposed model. The application of the model can be beneficial for researchers not only at the stage of planning and undertaking the commercialisation of an existing technological solution, but it also can be used at the stage of designing a new one while considering the potential future commercialisation path as early as at the stage of the idea generation.

As previously mentioned, a comprehensive approach is needed, and such is proposed within the model. However, there are still some aspects that are not covered. One of the most important limitations is the lack of market analyses incorporated with the proposed model. They are of key importance for effective commercialisation, and at present, they must be carried out independently of the model.

Another limitation comprises a lack of additional input criteria enabling a more detailed approach to R&D results concerning different aspects of the readiness level. Thus, the proposed future areas of the model development comprise, among others, the inclusion of additional input criteria. Such criteria have already been indicated as a result of the state-of-the-art analysis, and they comprise input criteria relating to Technology Readiness Level – TRL (Budi, Aldianto, 2020; Jou & Yuan, 2016), other (apart from TRL) indicators used for market-related technology assessment: Technology Needs Value (TNV), Integration Readiness Level (IRL), Innovation Readiness Diagram (IRD) (Budi & Aldianto, 2020), and the roles played by researchers in the framework of the undertaken entrepreneurial activities (Qian et al., 2018).

The authors wish to continue the development of the models. The set of marketing tools will be modified if the market conditions or the character of an R&D result change. Selected marketing tools should be more correlated with market segmentation. The need for a closer interrelation arises because a successful segmentation process is one of the key elements impacting the effectiveness of the process of commercialisation of R&D results. Market segmentation refers to the classification of potential customers of innovative solutions according to their needs and requirements. Therefore, market segmentation helps an R&D organisation identify the direction in which it should develop. Its segment-oriented marketing activities help to develop a technology in a specific and thoughtful direction. These aspects of market segmentation are planned to be strengthened during the future stages of the model development.

Another element related to market segmentation, which the authors believe may be crucial for the proper conduct of the commercialisation process, is the identification of industrial sectors that are vulnerable to technological changes and, thus, are also more eager to introduce innovations. The identification of these sectors may result in a need to verify the models already applied in practice, and it may be a factor contributing to changes in the proposed or planned commercialisation paths, depending on the specific characteristics of the sectors selected in the course of the market segmentation process.

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Literature

Arsova, M., & Temjanovski, R. (2019). Strategy for market segmentation and differentiation: contemporary marketing practice. *Journal of Economics*, *4*(1), 27-35. doi: 10.46763/JOE227.1

Bandarian, R. (2007). From Idea to Market in RIPI: An Agile Frame for NTD Process. *Journal of Technology Management & Innovation, 2*(1), 25-41.

Boehm, D. N. (2013). Science-to-Business collaborations: A science-to-business marketing perspective on scientific knowledge commercialization. *Industrial Marketing Management, 4*(42), 564-579. doi: 10.1016/j.indmarman.2012.12.001

Budi, A. A., & Aldianto, L. (2020). Research and Development – Commercialization Bridge: A Refined Model. *The Asian Journal of Technology Management, 1*(13), 47-62. doi: 10.12695/ajtm.2020.13.1.4

Carayannis, E. G., Cherepovitsyn, A. Y., & Ilinova, A. A. (2016). Technology commercialization in entrepreneurial universities: the US and Russian experience. *The Journal of Technology Transfer, 41*, 1135-1147. doi: 10.1007/S10961-015-9406-Y

Derakhshani, S. (1983). Factors affecting success in international transfers of technology; a Synthesis, and a Test of a New Contingency Model.

The Developing Economies: the Journal of the Institute of Developing Economies, 21, 27-47. doi: 10.1111/j.1746-1049.1984.tb00650.x.

Fletcher, A. C., & Bourne, P. E. (2012). Ten Simple Rules To Commercialize Scientific Research. *PLoS Comput Biol, 8*(9), e1002712. doi: 10.1371/journal.pcbi.1002712

Gvozdetskaya, I. V., Golovushkin, I. A., Maykova, S. E., & Okunev, D. V. (2016). System Analysis of Marketing Tools for Commercialization of Intellectual Property Items at a National Research University. *Indian Journal of Science and Technology, 9*(12). doi: 10.17485/ijst/2016/v9i12/89527

Harder, B. T., & Benke, R. (2005). *Transportation Technology Transfer: Successes, Challenges, and Needs. A Synthesis of Highway Practice.* NCHRP Synthesis 355. Washington D.C.

Jou, G.-T., & Yuan, B. J. C. (2016). Utilizing a Novel Approach at the Fuzzy Front-End of New Product Development: A Case Study in a Flexible Fabric Supercapacitor. *Sustainability*, *8*(8), 1-18. doi: 10.3390/su8080740

Kharchuk, V., Kendzor, I., & Petryshyn, N. (2014). The analyses of marketing strategies for innovations, *Econtechmod: An International Quarterly Journal, 1*(1), 49-54.

Kirchberger, M. A., & Pohl, L. (2016). Technology commercialization: A literature review of success factors and antecedents across different contexts. *The Journal of Technology Transfer, 41*, 1077-1112. doi: 10.1007/s10961-016-9486-3

Kozien, E., & Kozien A. (2017). Commercialization of Scientific research results and transfer knowledge and technologies to economy as determinants of development of universities and enterprises in Poland – legal and economic perspective. *Conference Paper – 26th International Scientific Conference on Economic and Social Development – "Builgind Resilient Society"*. Zagreb, Croatia, 8-9 Dec 2017.

Kuipers, S. M. (2018). Business to business market segmentation. *11th IBA Bachelor Thesis Conference, University of Twente.* Retrieved from http://purl.utwente.nl/essays/75334

Lasambouw, C., Sutjiredjeki, E., & Nuryati, N. (2021). The Requirement of Business Model in Commercialization Research Products of Higher Education Institutions (HEIS): Case study in Indonesia. Advances in Social Science. *Education and Humanities Research, 544*, 392-395. doi: 10.2991/assehr.k.210424.075

Maktabi, H., & Pazhakh, A. (2009). *Recognition of Elements in Research Results Commercialization and Prioritizing them Using AHP Technique*. International Conference on Business and Economic Research (ICBER 2010) Proceeding 2010-064, Conference Master Resources.

Mazurkiewicz, A., & Poteralska, B. (2019). Identifying and Overcoming Technology Transfer Barriers at R&D Organisations. In P. Liargovas, & A. Kakouris (Eds.), *Proceedings of the 14th European Conference on Innovation and Entrepreneurship, ECIE 2019* (pp. 637-647). Reading, UK: Academic Conferences and Publishing International Limited.

Mazurkiewicz, A., Belina, B., Poteralska, B., Giesko, T., & Karsznia, W. (2015). Universal methodology for the innovative technologies assessment. In R. P. Dameri, & L. Beltrametti (Eds.), *Proceedings of the 10th European Conference on Innovation and Entrepreneurship*, (pp. 458-467). Reading, UK: Academic Conferences and Publishing International Limited.

Mazurkiewicz, A., Giesko, T., Poteralska, B., & Hua Tan, K. (2021). Crossing the Chasm: Overcoming Technology Transfer Barriers Resulting from Changing Technical Requirements in the Process of Innovation Development in R&D Organisations*, Technology Analysis & Strategic Management* (early access). doi: 10.1080/09537325.2021.1950673

Minseo, K., Hyesu, P., Yeong-wha, S., & Sun-young, P. (2019). Bridging the Gap in the Technology Commercialization Process: Using a Three-Stage Technology–Product–Market Model. *Sustainability*, *11*(22), 1-16. doi: 10.3390/su11226267

Poteralska, B., & Walasik, M. (2021). Commercialisation models for R&D organisations. In Matos et al. (Eds.), *Proceedings of the 16th European Conference on Innovation and Entrepreneurship, ECIE 2021* (pp. 782-790). Reading, UK: Academic Conferences and Publishing International Limited.

Qian, X.-D., Xia, J., Liu, W., & Tsai, S.-B. (2018). An empirical study on sustainable innovation academic entrepreneurship process model. *Sustainability*, *10*(6), 1-15. doi: 10.3390/su10061974

Robul, I. Yu., Li, T., Nagornyi, Y., Khanova, O., & Omelianenko, V. (2020). Digital Marketing Tools In The Value Chain Of An Innovative Product. *International Journal of Scientific & Technology Research, 9*(4), 158-165.

Roszkowska-Mądra, B., & Siemieniuk, Ł. (2020). Identification and evaluation of business support institutions helping with development of academic entrepreneurship in Poland. *Akademia Zarządzania, 4*(3), 167-181.

Tarasova, E. E., Matuzenko, E. V., & Naplekova, Yu. A. (2020). Modern marketing instruments for the company's market promotion. *Journal of Research on Trade. Management and Economic Development*, *1*(13), 7-19.

Walasik, M. (2018). Marketing orientation of scientific-research units as support for the process of commercialization of R&D results. *Marketing Instytucji Naukowych i Badawczych*, *4*(30), 75-90.