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THE EDUCATION AND RESEARCH IN THE QUADRUPLE HELIX AND THE REGIONAL INNOVATION PROSPECTS

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Abstract. Governments endorse R&D promotion policies to correct for potential market failure that is caused by R&D's positive externalities and the discrepancies between the social and private rates of return to R&D. The logical connection of the Quadruple-Helix model with the characteristics of the sectoral specialisation of the economies of the regions in terms of their innovation potential and priority areas for the development of scientific research and innovation will be investigated in this chapter. A special focus will be on the digitalisation acting as a push factor for the processes. The advantages of this approach are with the web-based services and with the established Centre of Excellence could assist SMEs from limited area, but also with the web-based services will grant the SME a number of scenarios they could follow or adjust to their specific needs.

Keywords: quadruple helix; regional innovation factors; triangle with the knowledge economy; innovative types of SMEs

Introduction

Investment in research and development (R&D) is one of the most important factors in enhancing technological progress and economic growth in developed and developing countries, many countries have steadily increased investment in national R&D programs for industrial technologies, fundamental science research, and education, infrastructure, and defence technologies. In addition, governments endorse R&D promotion policies to correct for potential market failure that is caused by R&D's positive externalities and the discrepancies between the social and private rates of return to R&D. In this chapter the crossing points of the Quadruple-Helix model and the outlines of the sectoral specialization of the regional economies with their innovative potential and the priority guidelines for the development of

scientific research and innovations will be outlined (David & Boldrin 2008, p. 109). A special focus will be on the digitalisation acting as a push factor for the processes.

There are a number of obstacles SMEs encounter when trying to apply innovations in their products, services and management:

– Deficiency of a strategic company plan, particularly in innovation planning and development.

– Inappropriate management, which does not tolerate risk taking, failure or anything "out of variance".

– Lack of resources or time for innovation planning, management and execution.

– No processes, models or approaches available for moving ideas into execution.

– Deficiency of education/training on creative problem solving, idea management and innovation management concepts.

These weaknesses could be alleviated by business plan and innovation support management, whether done by independent experts, by special innovation centres or by online web-based tools. These innovations tools, services and guidelines will be useful in strengthening the capacity of SMEs to introduce process and product innovations (Baltov 2021, p. 25). The advantages of this approach are with the web-based services will be available regardless of location. On contrary, the established Centre of Excellence could assist SMEs from limited area, but also with the web-based services will grant the SME several scenarios they could follow or adjust to their specific needs. The web-based services could be applied as a complement to the local Centre of Excellence. The SME could try various scenarios in their business model creation and innovation support using the web-based tools and then to contact the experts to adjust the details, to obtain assistance in product prototyping or to discuss the process or product innovation.

From triple to quadruple helix models

R&D activities and expenditures to a certain level with limited effects (Nishimura, Okamuro 2011). Moreover, a high R&D intensity of a country cannot guarantee better innovative capabilities of universities, industries, and government. Rather, studies show that indirect R&D policies, including "university–industry spillovers, policies that foster human capital and networking/coordination support," have strong relations with innovative R&D outputs. Scholars argue that important knowledge-based innovations, which are key to economic growth, occur when universities, industries, and government R&D institutions interact (i.e., co-operate and exchange knowledge) to find a solution for common problems.

This interaction is known as an innovation process that includes knowledge creation and knowledge transfer. As in the empirical analysis of correlation between R&D indicators quantitative R&D outputs, such as the number of scientific arti-

cles and patent grants, have positive relations with high R&D expenditures, while possible R&D network interactions among institutional actors in a country's R&D network interactions such as 'knowledge transfer' and 'technology cooperation' have strong direct relationship with scientific research level, innovation capacity, and national competitiveness.

This hints that innovation can be created by dynamic interaction among Triple Helix institutional actors: university–industry–government (U–I–G), as these interactions expand knowledge resources and improve the institutional actors' capabilities to create innovative products or technologies (Barnes et al. 2002; Marques et al. 2006; Álvarez et al. 2009). For example, Malaysia can have relatively high firms' innovative capacity (6th) and scientific research level (15th) thanks to the active R&D interactions.

Leydesdorff specified that a system with three sub dynamics can endogenously generate complex dynamics (Ivanova, Leydesdorff 2014), but in the Triple Helix metaphor the emphasis initially remained on integration in terms of institutional relations. Leydesdorff then distinguished between this neo-institutional model of relations, and the neo-evolutionary model of different sub dynamics such as Wealth generation, Novelty production (Ivanova, Leydesdorff 2014). In their research Schütz et al. stressed that at the same time a layperson typology intended to help design participatory processes that facilitate such exchanges and includes the differences in opinions between men and women is possible to apply also (Schütz et al. 2019).

The authors also draw attention to the fact that members of the society played the role of passive recipients of innovations developed and implemented by various research centers for basic, applied and industrial research.

A significant number of studies in the last two decades highlighted the importance of a new approach based on an understanding of the determining role of society and individual lay people in setting priorities in research policies. This perception stems from the understanding that sustainable solutions will be achieved in this way. (Roman, Fellnhofer 2022; Schütz et al. 2019; Belandi et al. 2021).

The integration of the 4th dimension – the social: the point of view of civil society, consumers, the media, the cultural society to the 3-Helix model was first launched by Carayannis & Campbell (Carayannis, Campbell 2009) and is closely linked to the knowledge economy and society.

Models to bridge the triple and quadruple Helixes to the regional challenges

A possible model performed under the field research of the author and in the centre of this this chapter contains a template of business plan, where the abovementioned building blocks are its composite elements (Baltov, M. 2021, p 26). The blocks provide a detailed view of all business success key drivers. Its major

advantages include: This model is concise, but exhaustive. On contrary, traditional business plan descriptions could be very long and difficult to read and understand.

The model is flexible and could be easily tailored to any kind of SME. It will take much shorter to adjust a single page plan (fig. 1).

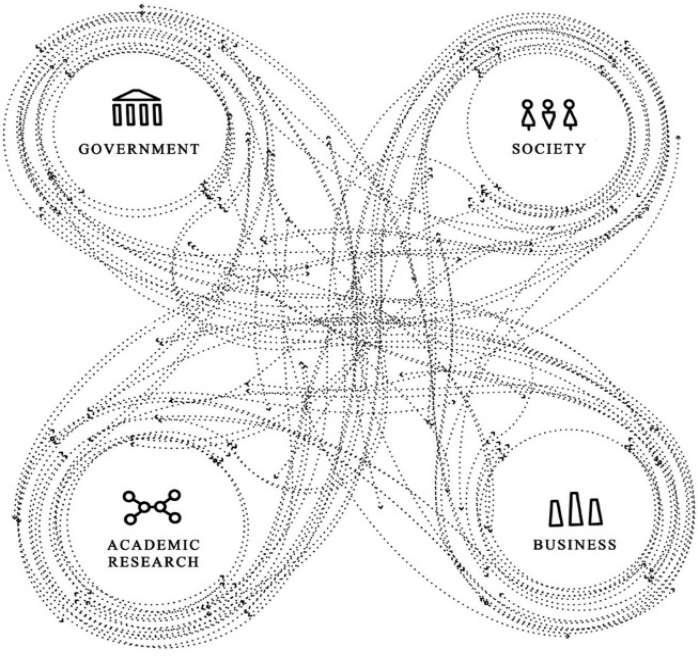

Figure 1. The Quadruple Helix Model adapted by Fraunhofer (2016), originally developed by Carayannis and Campbell (2009). Copyright © 2015 Fraunhofer.
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Key partners are the first important element of the business plan that each SME should determine in order to optimize operations and reduce risks: buyer-supplier relationships, cooperations with competitors, etc. This block requires the company to describe the network of suppliers and partners that make the business model work. The SME should determine their key partners/suppliers as well as the motivations for their partnerships. Key partners refer to those partners SME is not able to work normally without and therefore play important role in business relations. Of course, partnerships are not static and could vary during the business lifecycle since the market circumstances often change.

Given that there are still many unknowns, SMEs would do well to answer some important questions, namely:

– Which partnerships are critical to their business?
– Who are their critical suppliers?
– Which of their suppliers and partners are sourcing their key resources?
– What type of partnerships would suit their needs?

Key activities, similar to the Business Model Canvas, are categorized as Manufacturing, Problem Solving, and Platform/Network (Keane et al. 2018). Production is a core function in the business models of manufacturing firms. The production process covers all activities on the territory of the enterprise, necessary for the preparation of its output in a large enough quantity and at least standard quality. It includes some of the following processes: Technological, Organizational (management), Provision of resources, Transport and Warehouse Management, Marketing, Financial, Technical control of all stages of production.

For many businesses, such as knowledge-intensive business services firms, problem solving is about finding specific solutions to individual customer problems. In these firms, the business models require continuous creation of knowledge and there is sufficient evidence that they function simultaneously as carriers, facilitators and sources of innovation for the firms and for the economy as a whole, by spreading innovative practices and knowledge (den Hertog 2000).

The powerful penetration of digitization in all aspects of business, as well as the presence in the online environment, created prerequisites for the development of business models whose key resource is a platform. Platform businesses are functioning by connecting different groups of users and creating value through interactions between them. Building an ecosystem where to exchange value for all parties involved in is predominant for users than creating own products or services (Baltov 2021, p 26).

Key activities in platform business are multi-sided market, creating value through interaction, monetization model, data management, service provisioning, ecosystem management. The activities performed by SMEs are deeply influenced by value propositions (Gasparin et al. 2022).

However, as the business grows, the company may begin to include unnecessary activities within this block as well. To prevent this, a method referred to as the Minimum Viable Product is proposed (Moogk 2012; Tripathi et al. 2019). The idea is to explore the most basic version of their product or service made through a single cycle of the build, measure and learn loop. Most often, managers believe that for a product to be successful, it must provide maximum value to the customers. While determine the key activities, SMEs should deal with the trade-off between increasing the activities and therefore the expenses and the restrictions of limited resources, so each SME should be selective with customers it chooses (Customer Segments) and the kind of value it provides (Value Proposition).

The Key activities building block creates a bridge between the value propositions and the customer segments' needs. Some typical key activities that are com-

monly practiced by most organizations are listed as research & development, new product / service research, new product development, existing product updates.

Although SMEs rarely possess their own R&D department, it should conduct some typical functions of a research department. Before a new product or service can be produced, the company first has to explore the marketing possibilities, customer target groups, the design of the product, the expected production costs, similar products of the competitors, how long it will take to produce sufficient amounts of the product, etc.

The research stage leading to the product development. Existing products have to be upgraded based on evolving consumer needs or new entrants into the product category in the market. These changes can additionally be focused on product drawbacks that need resolving. The SME managers are responsible for the routing and scheduling of the product, as well as for monitoring and controlling the production process (Baltov 2021, p. 25). The main task of routing is to create a gradual and harmonious provision of work activities by finding the easiest and most economical package of activities. Scheduling, on the other hand, refers to the timing of activities. The purpose of control is to compare planned production with actual one, setting baselines, exploring possible deviations, and correcting them to meet the fixed deadlines.

With the quality checks SMEs should conduct quality checks of their products on regular basis with purpose to assure they are up to the quality standards set by the company. The SME should also keep in touch with innovations and new trends within the industry and ensuring that their product stays in line with these trends.

Production management consists of a number of activities which consider the selection of product and design. The first step of a SME is to select the right product and the right design for the product. This is a critical decision because the combination of the right product (Value Proposition) and the right design (Key Activities) will determine the success or the failure of the SME. Value engineering and analysis are also included in this activity (Moogk 2012; Tripathi et al. 2019).

This is the stage in which every SME must make the important decision of what technology it will use for the purposes of the production process, whether the existing inventory will be sufficient or whether there will be a need for new material assets, what methods of their management will be applied (Department of Energy and Climate Change, 2014).

Being the main one, the production management function must be provided by the other functions in the SME with the necessary, market-adequate information about the expected demand for the product in order to ensure the possibility of correctly determining the production capacity. Any SME that responsibly develops and follows its business plan would not fail to evaluate all these factors, most often by performing a profitability analysis to eliminate problems of the company.

In the contemporary world consumers look for the maximum quality for the lowest price. Hence, each SME should continuously improve the quality of the

product and also reduce costs so their product can remain competitive in the market in terms of price. The inventory control is fundamental to a production driven business because it keeps track of the resources, preventing both overstocking and understocking. The maintenance and replacement of machines for the SMEs managers must constantly monitor machinery and schedule regular maintenance. This activity ensures that there are no unexpected breaks in production.

The marketing specialists are responsible for the growth of the SME by exploring the market possibilities and the value it provides to its customers. Nevertheless, usually SMEs take a relatively small market share; it is a good idea to create a marketing strategy for the company, based on its overall vision and missions (Baltov 2021, p 27). As a next step this strategy should be realized by defining specific objectives based on it.

The SMEs have to be aware of the market the company is operating in including the strengths and weaknesses of the product according to the customer, potential competitors in the market to whom the company may lose market share or weaker competitors from whom company can get market share. The marketing team should work together with the product development team constantly. This is done by analysing market areas for which the SMEs can develop a product to address an unmet need. After the product is developed, the marketing team is also involved in pricing the product.

The SMEs should conduct communication with all stakeholders while going out in the market. This communication varies from press releases to online product reviews, advertisements, e-mails, etc., and the sales support aims to provide the sales team with customer leads, as well as promotional materials for potential customers (Baltov 2021, p. 25). The SME should regularly participate or organize events such as seminars, product launches, exhibitions, etc.

The services for sales and customer play a key role in the purchase and post purchase behaviour and experience of customers. The SME should build a description of constant customers and examine their experience (both positive and negative) with products / services. They fulfil the following responsibilities on behalf of the company. The SME should provide a help desk service to the customers calling in with questions or complaints. Some customer representatives are empowered to solve the problem on the spot by providing a replacement or returning the money. Others may act as gatekeepers who take information and then route it to the relevant departments. The assisting in sales aim at increasing the sales of the organization and may include educating customers on the value propositions the product offers or upselling by telling customers how to upgrade their services for improved quality.

Key resources and values achieved in the regional innovative activities

Key resources are defined as the main financial, intellectual, physical, or human

assets that a SME requires to create a value offering, market, and deliver it to the consumers. It is important to begin with listing the necessary resources to get a clear idea of what final product or service the company needs to create for the customer and which resources are dispensable. Based on the final list of resources, the SME can decide on how much it needs to invest in these key resources to operate a sustainable business. In this Building block, the most important is to come up with an answer to the following questions:

– What key resources do the Value propositions require?
– What key resources are needed for the distribution channels?
– What key resources are needed for the customer relationships?
– What key resources are needed for the revenue streams?

Key resources, such as materials, equipment, skilled labour, and specialists, determine the key benefits of creating a product or service. They are directly related to the number and type of key activities the company is engaged in (Baltov, Pashova 2017). Their quality will affect the sustainability and profitability of the organization. An important aspect is how the change in demand will affect the core resources.

Key resources can be categorized into some broad types. The physical resources are tangible resources that a company uses, and they include equipment, inventory, buildings, manufacturing plants and distribution networks. The Intellectual resources are intangible resources like brand, patents, IP, copyrights, customer lists, customer knowledge and partnerships. The Human resources are the most important assets of an organization. The Financial resource includes cash, lines of credit and the ability to have stock option plans for employees.

Depending on their key resources, SMEs can be categorized (Morgan 2016, p. 1553) into following three types:

– Product Driven Businesses. These are companies that focus all their functions on the creation and sale of a product with unique characteristics and a customer segment. Their key resources are intellectual and human.

– Scope Driven Businesses. These are dedicated to providing a value proposition to a particular customer segment. Such businesses have key resources in their well-developed intelligence about their target customer segment, an established set of processes and in some cases infrastructure such as specialized service centres.

– Infrastructure Driven Businesses. These achieve profitability through leveraging their developed and implemented infrastructure.

A value proposition is a promise of value to be delivered and represents the primary reason a customer to buy from the SME the product or service. In its core, value proposition is a clear statement that: explains how the product solves customers' problems or improves their situation (relevancy); delivers specific benefits (quantified value); tells the ideal customer why they should buy from the company and not from the competition (unique differentiation). The value proposition needs

to be in the language of the customer and should comply to their attitude and intensions (Osterwalder 2004, p. 211). The value proposition should be outlined as the first thing the visitors see on the home page, but also should be visible in all major entry points of the company's website. It is usually a block of text (a headline, sub-headline and one paragraph of text) with a visual (photo, hero shot, graphics):

The Headline (the Attention grabber) explains what the end-benefit the SME is offering is in one short sentence. Can mention the product and/or the customer. A specific explanation of what SME does/offers, for whom and why is it useful. Images communicate and take attention much faster than words. Show the product, the hero shot or an image reinforcing your main message.

The value proposition should be clear and easy to understand: what is the product / service, for whom and how is it useful? In addition, it is a good idea to communicate with the concrete results a customer will get from purchasing and using the offered products and/or services and emphasize how it's different or better than the competitor's offer. It should answer the questions below:

– What product or service is the company selling?
– What is the end-benefit of using it?
– Who is the target customer for this product or service?
– What makes SME's offering unique and different?

The value proposition could be either new product / service or a new disruptive offer or an upgraded one, i.e. added value of existing product. There are various types of value proposition. Some value propositions are based on the newness or novelty factor that they provide. They satisfy a new customer need, either because it was not identified previously, or there was a similar product. This element usually comes into play for technology-intensive products. Better performance is the basis of many product offerings over the years on improved performance versions of the same products. The software and hardware industries are good examples of this type of value propositions.

The contemporary market proclaims the self-expression and individualism of the modern consumer. They expect the products they use to be unique and to express their personality, especially in some specific customer segments (Neykova 2023, p. 620). Providing the option to adjust the product to the consumer's preferences adds value for the customer.

Traditionally customization has resulted in prohibitively expensive products, but today this option provides the opportunity for customers to put their personal stamp on a product while still providing economies of scale. Getting the job done. In this case the product helps a consumer to reach the end goal. This kind of products or services enhances the customer's productivity and helps the customer to focus on more relevant details.

The design of many products is intangible, but important element of their value proposition – clothes, accessories, shoes, etc. Design and brand/status can be

considered jointly because their appeal is quite similar. Just like people will show loyalty to a brand because of its design, people will also show loyalty to a design because of the perceived status the brand name itself lends to the owner or user (Kotler, Armstrong 2013). Ultimately a brand/status intensive product will help the customer look and feel in control, important and part of the mainstream.

Offering the same or similar product at a lower price creates value in many Customer Segments. However, in the contemporary market organizations competing on price, or in some cases, even offering free services, usually have different business models to sustain the organization. In the case of free products / services companies get their revenues by advertising or premium services.

Reducing customers' costs is another way for creating value. For example, hosted services in IT sector are common example of reducing costs by relieving companies of the expenses and time for buying, installing and administrating their own software and hardware. Reduced risks also create value, for example the abovementioned hosted services are with lower risk level with respect to security than software on company's own premises or the one-year service warranty received when buying a used car. In the last example the risk of buying a second-hand vehicle is diminished by the comfort of having the warranty.

Extended access to products and services could create value for the customer. This feature is wide-spread in IT industry, for example with web-based applications and services, accessible fully from any location. Similarly, variations in business models have both led to offering accessibility to unserved customers. Easy to use products/services create additional value to the customer (Beel, Jones & Jones 2016, p. 532). Providing consumers with a product that increases their convenience or is characterized by ease of use is a very strong value proposition and one on which some companies have built empires and legends around.

Customer relationships are defined as relationships established between different customer segments and the company and are extremely important for customer experience maximization and best targeting of the products / services. The Building Block Customer Relationships allows users to describe connections with their customers (Teece 1992, p. 8). Connecting with customer base is important in keeping reputation as a caring organization, to create financial success and sustainability. These relationships are established and maintained with each Customer Segment. In this Building block, the most important is to come up with an answer to the following questions:

– What relationship that the target customer expects you to establish?

– How can you integrate that into your business in terms of cost and format?

– What type of relationships does each of our Customer Segments expect us to establish and maintain with them?

– Atmosphere
– Customer service
– Interactions
– Which customer relationship have we established?
– Preconceived notions about the industry
– How do we get, keep and grow customers?
– How are they integrated with the rest of our business model?
– How costly are they?

Customer Relationships can be broadly categorized in a kind of relationship the company interacts with the customer directly through an employee who provides the human touch by assisting the customer (Keane, Cormican & Sheahan 2018, p 731). Customers have the opportunity to interact with a sales representative while they are making their purchase decision or with a customer services representative for after sales services.

The dedicated personal assistance is characterized by a very close interaction between the customer and the company through a dedicated representative who is assigned a set of clients and is personally responsible for the entire experience the customer has with the company. This kind of relationship takes some time to develop and is characterized by the representative knowing traits of the customer that he uses to customize the customer experience with the company (Neykova 2018, p. 21).

Customers are given resources to help themselves. This model has been getting more and more popular as organizations seek cost cutting measures that will reflect in the prices given to customers. Automated Services are customized self-service relationships where the historical preference of the customer is taken into account to enhance his/ her shopping experience. They are the next level of self-service, and they are usually much more customized that is why can be likened to personal assistance.

Creating communities of clients allows clients to share their experiences and come up with common challenges and solutions. Customers are able to connect with other customers for help. In this way, not only does the company form a personal relationship with its customers, but these bonds are strengthened by the additional relationships' customers form with one another (Richard & Nieuwenhuizen 2006, p. 183).

Customers are able to create value for the company. Companies can obtain benefits from the involvement and participation of customers in the innovation process (Lee, Kim 2016, p. 110). This gives customers greater ownership over the product and service and often results in the creation of product or brand champions in the market. The company interacts with the customer on a transactional basis. Between the company and the customer is established a long-term relationship like the company interacts with the customer on a recurring basis.

Conclusion

In this paper, it was key to seek and discuss the intersections of the Quadruple-Helix model and the contours of sectoral specialization of regional economies with their innovation potential. The importance of deriving the priority directions for the development of scientific research and innovation from society was confirmed and the same were critically discussed. Digitalization gives a strong impetus to these processes, to the creation of new business models, and its impact must be very carefully monitored, studied with a view to its optimal use as a strategic resource. Bringing out the key role of regional intelligent specialization in line with the idea of a digital Europe becomes a strategic motivator for governments and societies to increase investment in supercomputers, find the most suitable solutions for applications of artificial intelligence in business, economy, education and research, and invest in them while ensuring a sufficient level of cyber security and continuous education in digital skills and competencies. One practical pathway is in establishing and performance of the European Digital Innovation Hubs (supposed under the Digital Europe Programme), in order to help companies to improve the activities of their production processes, to improve the products and services they create by using digital technologies. The outlined guidelines can be used to improve business processes in SMEs and to benchmark managers.

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