The Human and Social Factors of Technological Innovations

Risks And Resources Analysis Model

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ABSTRACT

The theoretical article is devoted to the human and social factors of innovations. This is due to the fact that innovation is an increasing and inevitable trend of our time, with deep impacts on society, on nature and on individuals. At the same time, innovations are related to the area of large economic risks and have quite pronounced contradictions, including in the psychological context. The article reveals the basics of studying the psychological context of innovation and the main risks associated with such a context, drawing attention to the need of developing conceptual approaches to better understand this phenomenon, as well as proper policy frameworks that address innovation under these emerging views. As a result, the author's model for the analysis of risks and innovation resources is presented. The model includes three levels of analysis: the macro level (socio-cultural and institutional factors), the meso level (company level), and the micro level (a person as a subject, creator and/or consumer of innovations). This approach allows us not to make too sharp distinctions between the social, psychological and economic factors of innovation.

Keywords: Attitude to Technological Innovations; the Impact of Innovation on Personality; Risks and Resources of Innovations.

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INTRODUCTION

At the beginning of the 20th century, Josef Schumpeter proposed the concept of "technological innovation". Innovation may be defined as exploiting new ideas leading to the creation of a new product, process or service (Schumpeter, 2004). The term "innovation," originating in Ancient Greece, has changed its meaning (and translation) several times over the centuries: from changes in order as a political phenomenon, to Reformation, from heresy to economics. As Godin rightly noted, "the discourse on technological innovation espouses a semantic that has deep roots in history". (Godin, 2021 p. 11). Clearly, changes in language and vocabulary indicate changes in values.

Innovation, as precisely defined by the OECD, involves implementing new or substantially enhanced goods, services, processes, marketing strategies, or business/organizational methods. Although definitions vary, the OECD's formulation is particularly comprehensive, capturing the essential nature of economically beneficial new activities. The scope of what constitutes innovation under this definition is cataloged annually in the Global Innovation Index.

The concepts of technology, technological innovation, and STI policies are so intertwined that they also require definitions. To avoid a lengthy terminological debate, in this article we will adhere to the definitions (taken in short) of the Russian Federal State Statistics Service (Rosstat). *Technology* is defined as the application of scientific knowledge to practical purposes or applications. Technology utilizes scientific principles and applies them to change the human environment. Technology can also use scientific principles to advance industry or other human-made endeavors. *Innovative technologies* represent a comprehensive set of methods and tools. They enable the introduction of innovations—improved products, goods, or services. They are aimed at increasing product quality or the efficiency of personnel or factories. *Innovative activity* is the transformation of ideas (usually the results of scientific research and development or other scientific and technological achievements) into technologically new or improved products or services introduced to the market, or into new or improved technological processes or methods of producing (transferring) services used in practical activities. *Innovative goods, works, and services* are goods, works, and services that are new or have undergone varying degrees of technological (or biological) change within the last three years.

Marketing innovations are the implementation of new or significantly improved marketing methods, encompassing significant changes in product design and packaging, the use of new sales and presentation methods for products (services), their presentation and promotion in markets, and the development of new pricing strategies. They are aimed at more fully satisfying consumer needs, opening up new markets, and expanding the consumer base for products and services in order to increase sales. *Organizational innovations* are defined as the implementation of a new method in conducting business, organizing the workplace, or managing external relations. These innovations are aimed at improving organizational efficiency by reducing administrative and transaction costs, increasing employee satisfaction with the organization of the workplace (working time) and thereby increasing productivity, gaining access to assets unavailable in the market, or reducing supply costs. An organization does not necessarily have to be the first to implement these organizational innovations. It does not matter whether the innovations were developed by your organization or by others.

First of all, we are talking about technological innovations. Technological innovation is underpinned in technology, which is driven by inventions of new things and are transformed into usable innovations in markets to satisfy (Coccia, 2021). It is not just the invention of a new idea that is important. It is actually "bringing it to market", putting into practice and exploiting it in a manner that leads to new products, services or systems that add value or improve quality. Competition through innovation, Schumpeter argued, is the driving force of economical development.

The importance of innovation is increasing and increasing significantly. In the current economic scenario, innovativeness has become a major factor in influencing strategic planning of companies, public institutions, governments—it has been noted that the generally positive belief in innovation nowadays leaves deep marks in our collective imaginary, at the same time influencing and legitimizing decision-making and public policy design (Global Innovation Index, 2024).

Today we interact daily with the artifacts, infrastructures and systems around us. Megacities, complex transportation systems and the intertwined chains of production-circulation-consumption of goods and services are just a few examples of arrangements of which technology is a fundamental constituent element. However, although surrounded by these elements, we rarely think about the presence of such values in the constitution of the technological dimension of our world.

Of course, the social and psychological reflection of innovation has been taking place for two decades. For example, these are the ideas of broaden the role of the social sciences in technological governance (Macnaghten *et al.*, 2005), also acknowledgement of the importance of privacy in technological and digital innovation (van den Hoven, 2013). If philosophy is the attempt "to understand how things in the broadest possible sense of the term hang together in the broadest possible sense of the term", as Sellars (1962) put it, philosophy should not ignore technology.

The idea that technology is not neutral and actively shapes our values and lives is central to the philosophy of technology, from its early stages of development to modern discussions (Heidegger, 2025). The philosophers of technology (Verbeek, 2021; Ihde, 2022) develop this idea by exploring how technological artifacts not only serve us, but also actively influence our understanding of the world, our actions, and our identity (Leite *et al.*, 2024).Thus, the philosophy of technology emphasizes that technology is not neutral, but actively shapes our being and values. And these relationships are two-way.

We can also give an example of a multidimensional approach to evaluating innovation, which further highlights the value of the human factor (Owen *et al.*, 2021). If, as many people claim, innovation is all around us, we still fail to grasp its exact meaning. This is due to the fact that technologies are developing much faster than society or scientists (psychologists, sociologists) can reflect on, analyze, assess risks and resources. Cultural parameters, not on a global or national level, but on an organizational or group level, may have the greatest influence on an individual's perception of the concept of innovation. The concept of innovation develops within the micro context in which the individual is embedded (Frogeri *et al.*, 2021; Patrakov et al., 2022). Stylized versions of the idea of innovation influence both technophobic and, most commonly, technophilic views.

Given this importance of the idea of innovation, the critical study of the human factor of innovation, the role of humans as creators of products, the influence of the social and cultural environment, as well as the psychology of the consumer plays a significant role both in the development of innovation and in its psychological reflection.

Mobilizing and integrating a diverse set of academic literature, this paper aims is to review the publications on the Problems of the Human and Social Factors in Technological Innovations and to propose a multidimensional and consistent model for analyzing the risks and resources of innovation, taking into the human and social factors.

The first section of the paper provides a very brief contextual overview related to the ever-growing presence and perceived relevance of technology and innovation in the contemporary world. The second section focuses on the psychological dimension of technological innovation (or, rather, how technological change affects psychological aspects in modern societies). The core element of risk as a source of psychological implications of innovation is further developed in the third section of this paper. The fourth section explores how these implications relate to public policies, particularly science, technology and innovation (STI) policies. This is followed by a brief section of concluding remarks and model for analyzing the risks and resources of innovations. We believe that the value of this model will lie in the fact that it can be applied in the practice of analyzing specific innovations, in the practice of real startups.

1. INNOVATION IN OUR TIME

Modern society is characterized by an increasingly accelerating rate of scientific and technological progress and the massive introduction of innovations in all spheres of economic activity. The change in the technological order associated with the fourth industrial revolution and Industry 4.0 requires enterprises, organizations, and states to form long-term competitive advantages and carry out digital and technological transformation.

The Web 1.0 era provided the development of infrastructure for transmitting information and for providing global connectivity, impacting the economy, culture, science. The Web 2.0 era was characterized by much more interactivity: people have started communicating with each other on the Internet, interacting with other people, collaborating with them, and creating, sharing and consuming content themselves. This period was dominated by social media and various web-based applications. This type of behavior was called "Resident behavior", which referred to people leaving social footprints on the Internet.

The next stage is Web 3.0; this phase is in the process of being formed. It has elements like the internet of Things (IoT), Big Data, Artificial Intelligence (AI), Virtual Reality (VR), smart e-devices (phones, watches, e-homes). Most professionals predict that the physical (real) and virtual worlds will converge and will probably merge at some point; and this new connected world will be a part of our everyday lives. And it is not going to happen in the distant future, but it is happening right now, in our present.

So, the technological development that began in the 18th century, accelerated in the 19th, advanced in the 20th, and introduced advanced automation in 21st century, has come to such level that the human society was no longer able to properly follow technological innovations. The current times and the very near future are characterized by a significantly larger number of innovations and their diversity, even if their actual potential for promoting the change heralded by the positively biased innovation narrative has often disappointed (Winner, 2018).

The *Global Innovation Index 2023* (GII, 2023) gauges global innovation trends in the context of an economically uncertain environment. It unveils the rankings of the most innovative economies worldwide among 132 economies and identifies the top 100 science and technology innovation clusters. More than two thirds of the indicators in this rating include digital indicators. As countries and businesses focus on advancing in the innovation index, they will be forced to implement digital technologies. The next significant index in the context of our research is the Network Readiness Index including factors such as: technological component, human factor, management skills, Influence, each of the listed components also has a digital identification.

In the list of the most spoken about technological trends, more than half include digital technologies: unmanned taxi, portable devices measuring health status, e-houses (where artificial intelligence controls all household chores), neuro-interfaces (devices that directly connect your brain with a computer), personal adviser (a self-learning software—an artificial intelligence helping to make everyday decisions basing on a large data array), robot-surgeon, a humanlike robot-assistant, remote doctors (diagnostics and getting medical advice online), domestic 3D printers (to print any complex 3-dimentional objects), clothes made of "smart" nano-materials that can change its properties depending on the weather), portable devices of additional reality (for instance, glasses or lenses), implantable electronic microchips and mechanical devices (that can expand our intellectual and physical abilities), psychopharmacological remedies increasing brain power ("pills of genius"), robot-judges (following laws rigorously), implantable health sensors and many other.

From the above list of innovations, we can see that a significant portion of include digitalization and are also aimed at assisting humans and their needs, which actualizes the value of the concept of the "human factor of innovations." Separately, the research on social robots should be noted, which are the subject of close psychological and economic reflection. (Obaigbena *et al.*, 2024)

These are examples that offer us a glimpse of the profound changes – and associated risks – we are currently facing. Giddens (1990) used the image of the "Juggernaut of Modernity" to address the overwhelming effects of technical change over modern societies, one that provides unparalleled power and myriad possibilities, but which also often escapes our control. Convergingly, Beck's (1992) notion of "risk society" posits that technological progress, while a central aspect of modernization, generates new, systemic risks that are often unforeseen and frequently misinterpreted, thus often eluding traditional mechanisms of control and responsibility. Unlike pre-modern societies, where risks were primarily external and natural, contemporary societies produce self-inflicted hazards with global sensible effects.

This seemingly dichotomic nature of technology generates very distinct interpretations of the role of technology in society, leading to conceptual academic debates as well as very practical, policy issues. Competing narratives are shaped around different, yet incomplete, aspects of the complex dynamics surrounding technology, which tends to lead to equally incomplete, partial and fractured policy responses to sociotechnical challenges.

Behind the artifacts, infrastructures, and ideas that often ignored by politicians and businesses, and go unnoticed by the public, lie complex histories. As a result, we tend to understand technology as a product of strict technical decisions, which it certainly is not. And we fail to perceive fundamental elements that are part of the technology-society relationship. These elements shape the way we live, how we relate to each other, to the environment and to technology itself. And in a world full of things that we perceive as neutral, we often fail to realize how technological change and innovation operates, producing, for example, forms of control, surveillance, oppression or exclusion.

Moreover, the characteristics of things are rarely perceived as resulting from political dynamics and the explanation regarding the specificities of the configuration of artifacts and systems is usually referred to as "technical choices". This naturalizes the idea that technological development follows a single path, previously determined by the relevance of such choices. "Well, things are the way they are, and that's it. Why would they be different...?". There is an unshakable trust in "the one best way", the advancement of technology based on the fundamental values of efficiency, productivity, control, etc. which has oriented technological change and the development of innovations in modern times.

This very powerful idea also permeates our social imaginary, being profoundly embedded in the way we perceive sociotechnical dimensions and how we act in attempt to shape them and to regulate their outcomes, including through public policies.

Winner (2018) refers to innovation as the "god term" of our time. As he puts it,

> "A popular god term today has become an object of worship in universities, think tanks, corporations, Wall Street brokerage houses, and in the dreams of our social elites. The concept is widely associated with originality, vision, inventiveness, success, wealth, fame, personal virtue, national prosperity, and cultural vitality, and features are widely understood to express the aspirations and accomplishments of twenty-first-century societies at their very best. For many people, this concept has become the source of their deepest spiritual aspirations and yearnings for transcendence. In fact, it is not an exaggeration to say that today's central "god term" has begun to resemble a cult with ecstatic expectations, unquestioning loyalty, rites of veneration, and widely echoing exhortations of groupthink. The god term I have in mind is, of course, 'innovation' (p. 61-62)

This central notion serves as the background for the constitution of an overall positive view of innovation, widespread on our society, common among academics and certainly defining of the rationale from which science, technology and innovation policies are shaped, strikingly similarly although national contexts (and specific local problems) are very diverse.

It also serves as a buffer through which innovation is disconnected from its results, lest them be positive ones. If authors like Beck, Giddens and Winner, among many others, point out the complexity of sociotechnical dynamics, these ideas do not always reverberate. Godin stress the need to surpass what they have called the "pro-innovation bias", the idea that innovation always carry a positive effect to individuals and society. If not altogether ignored, its eventual negative effects are usually downplayed as either necessary, bearable externalities or as a natural consequence of change, to be latter regulated by adequate public policies and/or market mechanisms. Underlining this rationale there are certain psychological elements (which are, in turn, also shaped by them), also generally overlooked in analyses regarding the role of technological innovations in the contemporary world. The following section addresses this theme.

This perspective shifts the focus from "What do people think and feel about the innovation?" (and if the innovation is related to work, then what do employees feel about it) to "How does the impact of our innovation make society feel, and what are the psychological consequences of that?" Let's break down this expanded definition, its manifestations, and its weighty implications. This view defines human factors (social and psycho-

logical risks) as the potential for an innovation to cause harm to human dignity, social cohesion, cultural values, and individual well-being *at a societal level*, which in turn creates a profound sense of unease, moral injury, or existential threat among its creators, users, and the public. These risks manifest in several key ways:

A. SOCIETAL ANXIETY AND CULTURAL BACKLASH:

- Widespread public anxiety about genetic engineering ("playing God"), the potential for unintended consequences in the gene pool, and the emergence of a "genetic class divide." (Peters, 2014).
- Societal-level stress over economic displacement—the fear that robots and AI will make entire professions obsolete, leading to a loss of purpose and identity tied to work (Love, Smith and Dace, 2024).
- A collective sense of loss—the feeling that these platforms, designed to connect us, are actually designed to control people, they are eroding community bonds, shortening attention spans, and damaging the mental health of a generation (Haidt, 2024).

B. EROSION OF TRUST IN INSTITUTIONS:

- The psychological risk here is a collective shift from optimism to cynicism. When innovations from tech companies, financial institutions, or biotech firms are perceived as acting against the public interest, it breeds deep-seated distrust in all forms of authority and progress (Wolf, 2021).

C. ETHICAL DILEMMAS:

- AI features built to increase engagement are contributing to teen anxiety, political polarization, and the spread of misinformation and frauds. Digital innovations started influence cognitive and communicative abilities of children and numerous cases of addiction among audiences (Rohman *et al.*, 2025).
- Data scientists working on facial recognition technology who worry about its use in mass surveillance and the erosion of privacy (Payton, Claypoole, 2023).
- Designers in the gig economy creating systems that use psychological tricks to maximize productivity for drivers or delivery workers, leading to burnout and unsafe practices (Christie, Ward, 2019).

- The implications of ignoring *these* types of psychological risks are far more severe than a failed product launch. Businesses may face reputational catastrophe in the form of consumer boycotts, regulatory scrutiny and etc. The most significant implication is tangible harm: increased rates of depression and anxiety in the society, heightened social conflict, the destabilization of democracies, and increased economic inequality.

- Modern innovation is not just about technology and market fit; it's about socio-technical systems. In this light, managing psychological risks about protecting the society (and business) from the unintended consequences of progress. It is the essential work of ensuring that innovation remains a force for good.

2. THE PSYCHOLOGICAL CONTEXT OF INNOVATION

Each of the set of innovations we mentioned earlier, in the beginning of the former section, includes a set of elements: *Personality* and creative skills of creators, *a team* of specialists who strengthen each other, and *an Analysis* of the human factor of consumers' behavior (social factor, cultural factor, personal factor, technological factor, economical factor, etc.). At the same time, all these elements are in an environment that is characterized by its legal (institutional), ethno-cultural, religious features. Cultural factor is extremely diverse: religion (influence of religion, coverage, impact on people's actions, level of fatalism), history and art (reflect people's values and attitudes), means of communication (language, sign language, time, and punctuality), ethics and etiquette (acceptability, compatibility), living conditions (attitude to work, habits and organization of food, gifts, traditions in clothing and food consumption, features of leisure, housing, etc.), traditions of doing business (Zhou, 2021; Stephan, 2022).

In turn, the "ring" of the organization itself (departments, departments, sectors...) can also be multi-level. To some extent, we can look at this from the standpoint of W. Bronfenbrenner's theory of ecological systems (Bronfenbrenner, 1977). The value of this model may lie in the fact that it can consider a multi-level determination of perception or creation of innovations. Note that on the basis of this theory, another theory was developed that combines technologies and the social environment, which, in our opinion, has significant explanatory potential in the future (Navarro, Tudge, 2023). Its essence considers two environments (digital and pre-digital) as a single one with all the complexities of their perception. We also believe that the unification of the technological and the social in the

human psychological world is the dawn of new research in psychology, which includes and will increasingly include ethical and humanistic issues (Patrakov & Vodopyanova, 2024).

Based on this, let us consider the psychological aspects of innovation in more detail. Here we can distinguish two groups of studies. *The first group* is the methodology and empirics of attitudes towards new technologies (innovations). Fundamental research in the field of attitudes towards technology and global technological risks is based on the constructionist and interactionist paradigms, which are widely recognized in the cultural anthropology: construction of Artefacts by T. J. Pinch and V. Bijker (Pinch & Bijker, 2012); model of "Domestication" by R. Silverstone (Silverstone, 2006); Actor-Network theory of B. Latour (Latour, 1996); The Unified Theory of Acceptance and Use of New Technologies by V. Venkatesh (Venkatesh *et al.*, 2012). The essence of the indicated theories is in the understanding and psychological reflection of the diversity of factors that determine the attitude towards new technologies.

On the basis of these concepts, the authors of the current article have conducted a cross-cultural study on attitudes towards new technologies. The study confirmed the hypothesis that attitudes towards new technologies have cultural and age specifics. The results open up the prospects for discussing cross-cultural specifics of the attitudes towards technological innovations (Patrakov *et al.*, 2022).

Systematizing the listed concepts, Zhuravlev A.L., Nestik T.A (Zhuravlev & Nestik, 2019) proposed to consider the attitude towards new technologies in the following aspects: the cognitive aspect (continuum "techno-optimism – technopessimism"); emotional aspect (continuum "technophilia – technophobia"). Let's take for example social technophilia (excessive enthusiasm for technological innovations in society), which can potentially determine the formation of a stable attachment to technical means and innovations. An example of it is the regular updating of cell phones as soon as new models appear, although this updated functionality may not be in the list of essential demands and even not in the list of "nice-to-have". This "love for technology" has especially developed during the pandemic, which has "spurred" the literally uncontrolled growth of digitalization, associated with a number of psychological problems of an existential nature (Agnihotri & Shanker, 2023; Joshi *et al.*, 2021).

Thus, researchers note that new technologies cannot be considered as something separate from the life activities of subjects and communities. Today in psychological science we have a large number of studies on the risks of the Internet and digital environments for adolescents, raising the topic of not only obvious cyber addiction, but also the

ability to distinguish risks, differentiate them, and manage them (Núñez-Gómez *et al.*, 2021; Piko *et al.*, 2024). It should be noted that today almost all innovations include a digital component. Also, the main purchasers of innovative consumer products are young people who associate themselves with a promising future and are to some extent free from the values of conservatism (Stewart, 2022; Owen, von Schomberg *et al.*, 2021).

For example, examining technophobia and its causes in detail, we noticed that everything is not so simple. Various diagnostic methods assess the attitude towards new consumer technologies (social technophobia, technophilia, techno-rationalism, techno-pessimism). But they do not reveal their causes. For example, why is there a fear of new technologies? Based on research on teachers who showed a high level of technophobia on the Schwartz values scale (n=87), we found out the following: a high level of technophobia among teachers correlates with a high level of expression of "Tradition and Benevolence" ($r = 0.76$ at $p < 0.01$). We then conducted an additional study with focus groups on teachers (2 focus groups of 9 and 11 people), and included the following questions: (1) Why can new technologies (innovations) cause concern for some people? (2) What characterizes teachers who are afraid of new technologies?

The results showed the following: among the reasons why new technologies (innovations) may cause concern for some people, the first place was occupied by a possible contradiction with personal and social values. On the second question—what characterizes teachers who are afraid of new technologies—the most numerous reply was about the fear of a decrease in the quality of teaching. The overwhelming majority of teachers noted that maintaining a high level of professionalism in education was unthinkable without face-to-face communication with students, perceiving the digital environment only as a means, an assistance in success, but nothing more. In general, technopessimism implies not so much denial as a critical attitude towards new technologies; accordingly, it may indirectly indicate a fairly high professional reflexivity of respondents, which is also typical for teachers.

Digitalization entered the life space of both adults and children quickly and on a large scale. The current trends in the digital transformation of the living environment affected the formation not only of the personal sphere of the younger generation, but also of the cognitive one. The study showed that the field independence of both elementary school age students and middle school age students grows with each stage of digitalization, while the field independence of high school age students remains approximately at the same level at all stages of digitalization (Chernykh, 2023). Of course, it is difficult

to say for sure whether digitalization and innovation can be considered with a very clear distinction, since they are very closely intertwined. But the fact that innovations and digitalization change our behavior and cognitive sphere can be said with a high degree of probability.

There arises a necessity for a comprehensive examination and psychological description of the process, not merely of convergence, but of integration and merging of the digital and pre-digital environments. This represents a fundamentally new phenomenon, a novel realm of life activity that still has a high level of uncertainty. The evidence is that computer science is the fastest changing and evolving science, but it has an enormous impact on all other sciences as well. Therefore, today there is a need for a detailed study and psychological description of the process of not just convergence, but integration and merging of digital and pre-digital environments. This is a fundamentally new phenomenon, a new living environment, which is still characterized by a high level of uncertainty—a digital environment included in the promising, but sometimes foggy for science, space of innovation.

The second group of studies relates to the concept of "Augmented Human". In the context of interaction with innovations and digital environments, psychologists discuss a new aspect of personality development—the problem of forming an "extended personality" (Semenov, 2020) and the similar concept: "Augmented Human Intellect". This concept was proposed at the "dawn" of the development of computer technologies (Engelbart, 1962) and has a number of variants: "Extended self" (Belk, 2014), "Extended mind" (MacFarquhar, 2018). All of the listed definitions suggest that a person acquires new properties that go beyond his "natural" capabilities. But let us ask ourselves a question: does a person only acquire new opportunities, "expanded" properties, or are there any losses for humans? This is especially valid for the so-called social professions: teachers, psychologists, specialists in the field of social work and others. Is there a "psychological cost", and what is the price of such an expansion of the personality due to digital and innovative opportunities? Thus, we can see that innovations are very multidimensional, and their result can be very risky or even somewhat contradictory, including in terms of investment and results, for example, in digitalization (Hooi, Chan, 2024), which actualizes the value of risk research and personality.

3. ON THE IMPORTANCE OF RISKS RESEARCH IN THE CONTEXT OF INNOVATIONS

If innovation is intrinsically connected to the idea of change, risk research is essential in understanding the psychological dimensions of innovation, as it helps explain human resistance, acceptance, and adaptation to change. Through an integrative interdisciplinary approach, risk research examines how individuals perceive, evaluate, and respond to potential hazards associated with innovation. Individuals do not assess risks solely based on objective probability but rather through cognitive and emotional processes. Factors such as familiarity, perceived control, trust in institutions, and media representation shape individuals' risk perceptions. This complexity requires elements from different fields to be mobilized in order to promote a reasonable understanding of it.

Risk in its most general form (in economics, psychology and sociology) is consider-ed as a potential possibility of future losses due to a subjective decision or an unforeseen situation. For example, miscalculation is a subjective decision, and a natural disaster is an unforeseen situation (Fraser, Simkins, 2010). But still, there is a wide variety of concepts, approaches, classifications of risk understanding. In line with the *economic approach*, risk is understood as the financial or equivalent to financial damage. It is assumed that the value of risk can be measured, estimated, calculated. This approach is used in business, management, insurance, investment plan (Hardi *et al.*, 2024).

A political science approach to understanding risks is essentially similar to econo-mic approach, but it deals with a political damage and a more complex and often contradictory system of its assessment. In this approach, risk is mainly investigated from the point of view of political goals in the continuums: stability/ instability (social, economic), chaos/order (legality, civil obedience). This approach can be extended to the social policy of the enterprise, territory, including the policy of implementation and support of innovations (Deineka *et al.*, 2020).

In line with *the sociological approach* (Luhmann, 1994), the main subjects of the study of risks are the social situations and social relations that can generate such risks. For example, in the last decade, the phenomenon of attitudes towards new technologies (Nestik *et al.*, 2018) has been widely studied. In line with the study of such attitudes towards new technologies there is, for example, a pronounced social technophobia (fear of the general public to apply any technological innovations). Such technophobia, for example due to the cultural or other peculiarities can be a social risk factor for the introduction of innovations.

There are also quite a lot of studies related to digitalization and organizational change in the context of innovation. (Gurieva *et al.*, 2023; Zabelina, 2023). That is, the value and cultural foundations of such risks should also be taken into account here.

In addition, in general terms modern riskology distinguishes the following risk factors:

- the nature of the task (for example, an innovative task itself will be risky);
- situational influence (for example, the degree of openness of society in general or of individual social groups in particular, the institutional environment, including legislation);
- personal qualities of all participants of the interaction;
- the influence of intergroup interactions.

In addition, other research problems are also highlighted: risk motivation, subjective risk perception, situational risk regulation and etc. Anxiety, uncertainty, fears, optimism and expectations are often feelings that emerge when individuals have to deal with new technologies, and this, of course, tends to be dependent on social and cultural specificities as well. Large-scale transformations often elicit significant public discourse, reflecting broader anxieties about socioeconomic displacement, ethical considerations, and shifts in power structures, all of these aspects that should be taken into consideration as well.

Of course, research into the human factor of innovation is not limited to the approaches listed, but we believe that they all play a decisive role and should be more present in critical approaches to innovation as well as in policy-making strategies in science, technology and innovation policies.

4. REMODELING STI POLICIES BY ADDRESSING PSYCHOLOGICAL ASPECTS OF INNOVATION

The academic landscape of innovation comprises two interrelated domains:

1. **Innovation Studies (IS):** An interdisciplinary field investigating the genesis, diffusion, and utilization of innovation. Its analytical focus is on micro- and meso-level phenomena, including firm and startup behavior, scientific practice, and industrial network dynamics, to answer the question, "How and why do innovations occur?"

2. **Science, Technology, and Innovation Policy (STI Policy):** An applied field dedicated to the strategic guidance of innovation by governmental and institutional actors. It operates primarily at the macro-level, formulating national strategies, programs, fiscal incentives, and regulatory frameworks to address the question, "How can we stimulate innovation to address societal challenges?"

The synergy between these fields is fundamental. Innovation Studies constitutes the epistemological foundation for evidence-based policymaking, while STI Policy provides a context for implementation, offering both a testing ground and a source of new research questions and funding. Risk research may play a crucial role in informing and improving science, technology and innovation policies by providing insights into how individuals and societies perceive, evaluate, and respond to changes brought about by innovation. Innovation inherently involves uncertainty, so understanding the cognitive, emotional, and social dimensions of risk perception might provide an important strategy for decision makers and policy makers involved with STI policies. Innovation Research and STI Policy are fundamentally interdependent. Research generates the foundational understanding of how innovation works, while policy translates this knowledge into actionable strategies.

At both the project level (the focus of Research) and the strategic level (the focus of Policy), human factors are a critical variable. These psychological, sociological, and cultural elements can either facilitate or obstruct success. Therefore, integrating an understanding of these human dimensions is essential—not just to explain past failures, but to craft effective policies that are responsive to real-world social and behavioral dynamics.

A consistent body of literature has been developed around the theme of risks associated with emerging technologies in fields such as nanotechnologies (Invernizzi & Foladori, 2010; Grunwald, 2012), energy (Boudet, 2019; Markard *et al.*, 2020), health (Finch *et al.*, 2006), farming (Regan, 2019) and others. Risks associated with the evolution of Web 3.0 technologies now are arguably at the center of the debate (see Vayadande *et al.*, 2024).

The push for "Responsible Innovation" (Mcnaghten, 2020) and RRI—"Responsible Research and Innovation" (de Saille, 2015) has contributed to placing risk (and through it some of the psychological concerns regarding technology and innovation) in the agenda of STI policies. Important steps have been taken to address relevant policy questions and to improve policy effectiveness through a more comprehensive understanding of the social and psychological elements of technology and innovation.

How technological innovation is socially received (innovation acceptance) is a key aspect of dealing with the emergence of new technologies. By incorporating risk perception analysis into policy development, for instance, governments and regulatory bodies can address these concerns proactively through transparent communication, participatory decision-making, and tailored educational initiatives.

Furthermore, risk research provides empirical evidence to guide the regulation of emerging technologies. A risk-informed policy approach allows for a more balanced framework that mitigates potential negative consequences without hindering technological progress. Risk communication strategies are also an increasingly important element. By understanding how different social groups interpret risks and shape their behavior accordingly, policymakers can craft messages that resonate with specific audiences, reducing the spread and damage done by misinformation and fake news (a key challenge of our times) and fostering public engagement.

Despite their importance, these new elements in STI policymaking are still not able to cover all the necessary aspects to address the complex nature of technological change in society, people's lives and emotions. Indeed, saying this we are contributing to ongoing efforts to address the complex nature of technological change. We see the path proposed by RRI (although not everyone would agree with us) is a reformist approach to the policy model. And although RRI started from a critique of market innovation, its implementation has nevertheless become instrumental and too "technical". Focusing on this issue, A. Mohammadi (2021) proposes to increase awareness and responsibility of both developers and consumers of innovation by integrating the values of responsibility into scientific management systems, recognizing the merits of leading researchers and influential scientists in solving problems of society, the economy, and industry. In contrast, we initially advocate a more constructive approach to solving these problems that also takes into account people's perceptions, emotions and desires—aspects that are deeply affected by the high pace of innovation in the modern world.

5. RISK AND RESOURCES ANALYSIS MODEL

Thus, based on these studies, we have created a basic approach model for analyzing the risks and resources of innovation (Figure 1). The model includes three levels of analysis: the macro level (socio-cultural and institutional factors), the meso level (company level), and the micro level (a person as a subject, creator and/or consumer of innovations). Each

of these levels includes both risks and benefits. The risks comprise economic risks, social risks, and psychological risks (for the person). In turn, the benefits are expressed in the form of economic resources, social resources, and psychological resources.

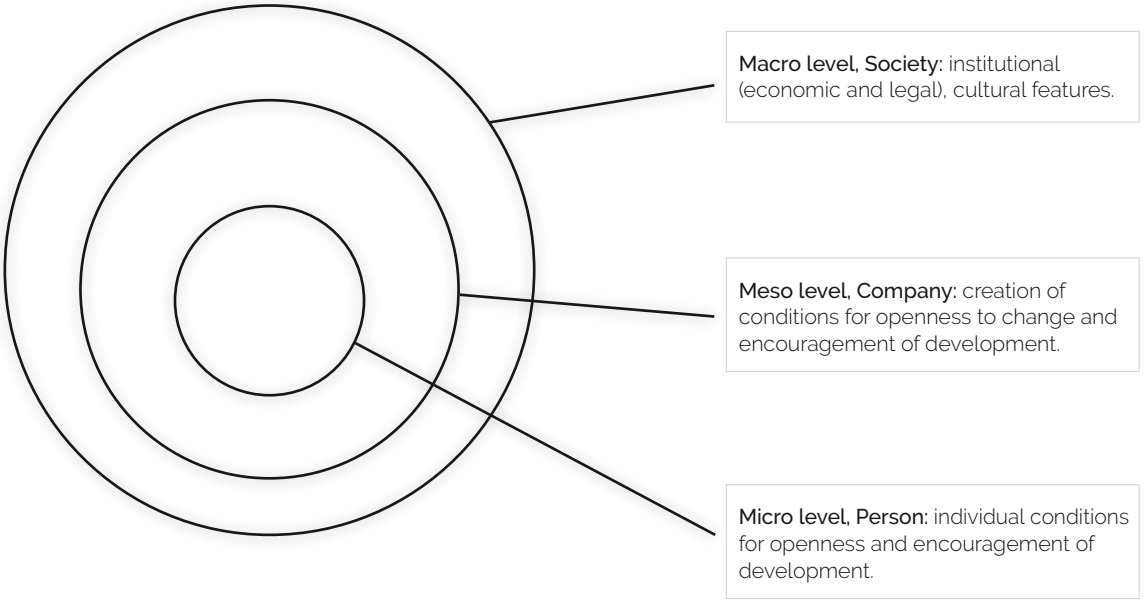

Figure 1. Risk and resources analysis model.
Source: own elaboration.

This figure indicates the following: the outer circle (society) is the environment that determines the main directions of innovation development and conditions. The outer circle includes cultural, economic, and legal features of society (as a rule, this is a country or a state). The second circle includes companies that plan to develop technological innovations. An important resource here is openness to innovation, a developing environment, and objective assessments. We consider the level of personality in two aspects, as a creator and as a consumer of innovations. Each factor can be considered as a risk and a resource depending on the idea of innovation.

This model is presented in more detail in Table 1.

Table 1. Content of Model.

Level	Specificity
Macro level	Culture
	Law
	Economics
Meso level	The purpose of the group
	Vocational roles and functions of the group members
	A way (methods) to solve problems
	Attitude to personality. Interpersonal relationships
	Open Innovation Climate
Micro level (creator of innovation)	A combination of creativity and erudition in the field of professional activity
Micro level The consumer (client)	Willingness/unwillingness to apply technological innovation

Source: own elaboration.

CONCLUDING REMARKS

Innovation is a central element of the way we currently understand our world. It is a topic that has been intensively addressed mostly by economic or social approaches, but less so through a psychological lens. This gap, as we believe, has somewhat been filled by risk research, although it has also been insufficient in covering all of the complex elements surrounding innovation. STI policies should take into account the psychological elements of innovation to a broader extent, placing individuals and society at the core of innovation dynamics, not only as actors that are affected by technological change, but as actors that should be heard in the shaping of innovation processes and dynamics. In this regard, we view our article as a contribution to the study of the psychological component of innovation studies and emphasize the following points.

Since innovations are included in the life of a person and in society as a whole, the need for their multidimensional measurement is obvious. Multidimensionality in our understanding means psychological, economic, social dimension, as well as depth of expression. Note that currently there are various innovation ratings, but there is a deficit of psychological and existential reflection of such innovations.

Innovations are characterized by a high degree of unpredictability, their development is not progressive, therefore, at different stages, the influence of various factors may weaken or increase. In these conditions, for forecasting, it is possible to activate factors from different resources. For example, in conditions of predicted social instability, the project team or simply a group of specialists involved in the implementation of an innovative project must have a high level of objectivity in decision-making, in labor behavior—the absence of deviations, socio-communicative adequacy and a number of other psychological characteristics.

Applicability in training the future innovators, engineers, psychologists, economists for the prevention of 'one-sided' understanding of the innovation process and learning to analyze the whole variety of factors that determine the development of innovation (primarily the human factor).

Dealing with innovations one needs to consider not only general risks but also cultural peculiarities, risks and opportunities connected to them. We cannot talk only about the risks of innovation, it would be more correct to talk about the continuum of 'risk-resource'. This is the main idea of our research. Many factors can be risks and resources depending on the idea of technological innovation.

In our opinion, it is impossible to describe all the factors of technological innovation development, but the proposed model can be considered as universal basic approach for evaluating technological innovation startups, analyzing the causes of success and failure.

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