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Improving industrial R&D practices with social and ethical aspects: Aligning key performance indicators with social and ethical aspects in food technology R&D

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ABSTRACT

Policy makers encourage integrating Social and Ethical Aspects (SEAs) in Research and Development (R&D) for the responsible development and deployment of future and emerging technologies, including Nanotechnology and Life Sciences. However, R&D project leaders in industry generally do not integrate SEAs explicitly in their daily practice. Furthermore, to what extent SEAs improve R&D remains unclear. We carried out a comparative research case study to assess to what extent R&D projects can be measurably improved through the integration of SEAs. We combined recent insights from Science and Technology Studies and Innovation Management to integrate SEAs in industrial R&D in the field of food technology and measured changes in project performance based on Key Performance Indicator (KPI) scores. We used Midstream Modulation with a group of project leaders and measured their projects' performance using a modified version of the Wageningen Innovation Assessment Toolkit.
Results show that the integration of SEAs was not only perceived by participants to be functional and useful, but it also measurably improved KPI scores. We propose that the two methods can be integrated into a Success Factor based Live Innovation Project Scoring and Evaluation tool, which can be functionally deployed in R&D environments.
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1. Introduction

1.1. Research context

Policy makers have spurred innovators to consider Social and Ethical Aspects (SEAs) in Research and Development (R&D) of future and emerging technologies, such as Nanotechnology and Life Sciences, including biotechnology and synthetic biology [1–3]. Innovators are encouraged to include SEAs e.g. through incorporating outsider perspectives from future users [4], social scientists [5], societal pressure groups and professional peers [6]. SEAs relate to sustainable and responsible development, public health and safety, intellectual property rights, public funding, policy and legislation and many others [7,8]. In principle, SEAs form an integral part of all R&D activities [9,10], and influence future and emerging technologies, and particularly innovation in the field of life sciences, including biotechnology [11,12]. However, during the development of such technologies, SEAs are generally not considered explicitly and consciously by the researchers who are closest to such

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development, both in academia [10,53] and industry [58]. They may be unaware of SEAs [53] or have difficulties identifying them [59].

The integration of complex and uncertain [13] SEAs in R&D is recommended from both an innovation perspective and a social perspective. From an innovation perspective, such integration has been shown to have positive effects on R&D projects: it helps researchers clarify and structure their own thinking processes and enhances their decision making processes [14], and it helps them set better research goals and priorities [15]. Researchers participating in SEAs-related social sciences studies recognise the significance SEAs in their R&D practice and appreciate being enabled to actively consider such aspects [10,16]. From a social perspective, integrating SEAs can help society to remain 'in step' with new technology [17]: it may make decision making processes in R&D more democratic [6,18,19], prevent public backlash [3] and make new developments more socially robust [20].

The question rises whether or not integration of SEAs leads to a quantifiable improvement of R&D projects. Improvement of performance can be scored on success factors, or Key Performance Indicators (KPIs) [21–24]. KPIs include e.g. market competition, price, quality, management style and team communication and cooperation [25]. As R&D is an indispensable part of innovation processes, identifying and managing KPIs for R&D projects may be considered essential for successful innovation [26–28]. Nevertheless, the role of SEAs in KPI based R&D project performance has so far not been considered and often remains implicit [29]. SEAs may prove to be valuable in relation to KPIs, particularly for companies that take socially responsible innovation seriously [30].

1.2. Study aim and paper structure

We aim to answer the question: to what extent does the integration of SEAs into corporate R&D projects lead to a measurable improvement of these projects' performance? We answer this question using a case study in R&D in industry. In Section 2 we illustrate how social aspects can be integrated in corporate R&D practices and operationalise the concept of 'improvement' in relation to R&D practices and how we measured such improvements. In Section 3 we display the methodological framework we used to stimulate the active inclusion of social aspects in running projects and measure project performance. The results are presented in Section 4, and their implications for technological forecasting and social change are discussed in Section 5. Section 6 presents our conclusions.

2. Theoretical framework

2.1. Stimulating the integration of social aspects in laboratory practice

The active inclusion of SEAs in R&D projects can be realised with various methods, including real-time technology assessment [32], ethical parallel research [15], moral imagination [33] and sensitisation [34,35]. A new, promising, and potentially transformative [36] approach to include SEAs in R&D is 'Midstream Modulation' (MM), first introduced by Fisher in 2006 [37]. MM methods are clearly described in literature and it has successfully been deployed to actively integrate SEAs in R&D projects in academic nanotechnology [14,38] and biotechnology [16] laboratories, and in industrial research environments [39,40]. Therefore we chose MM for our study. In MM an 'Embedded Humanist' (EH) interacts regularly with researchers at their laboratories for a period of 12 weeks, to incrementally 'broaden' research decisions [41] with social and ethical considerations. The method "*provides evidence of both the possibility and the utility of integrating societal considerations into and during nanoscale engineering research*" [14: 5].

In MM, researchers modulate their R&D decisions into opportunities, considerations, alternatives and outcomes in collaboration with the EH [41]. This renders decision making processes more visible, allowing also the identification of possibilities for enriching these decisions with SEAs [14]. Fisher [38] provided narratives—discussions between researchers and an EH—on how this works in practice. The value of MM lies in allowing researchers to further understand their motivations for technical decisions and broadening those decisions with SEAs. Still, the extent to which MM can be deployed in industry to reach a measurable 'improvement' of R&D project quality based on KPIs, remains to be demonstrated.

2.2. Operationalising improvement

KPIs can be used to score project performance. Looking for KPIs implies investigating which project aspects differentiate between successful and less successful innovation projects. We used a modified version of the Wageningen Innovation Assessment Toolkit (WIAT, [24]) to measure an improvement of R&D projects through the active integration of SEAs in corporate R&D practices. WIAT was developed to help companies with innovation project selection and execution, by providing relevant management information to business development teams in the form of a project benchmark. It has been used successfully in the past to identify KPIs and explain why some innovation projects may be more successful than others [42,43]. WIAT is based on the NewProd innovation assessment tool [44] and the Genesis tool, which added the aspect of team communication [23]. It assesses project performance based on KPIs relating to innovativeness, project newness, upstream and downstream resources, team communication, innovation potential, innovation process quality and market competition. Project participants score performance using a questionnaire with a predetermined set of success factors, items that are combined into KPIs. The performance scores of these projects are used for setting up a database in which innovation projects can be compared, based on previous successful and unsuccessful [45] innovation projects.

However, SEAs relating specifically to R&D in biotechnology are not part of the original WIAT. Internal SEAs such as team communication are part of the original WIAT, but external, (bio or food) technology related aspects pertaining to policy and legislation, environmental health and safety, are originally not included. Additionally, WIAT only to a limited extent takes into account a company's specific criteria for 'successful' innovation: KPIs explaining success of innovation projects vary per company and research context (see e.g. [25]), and also the definition of 'success' of innovation projects is highly context dependent [22,46].

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