WORKPLACE INNOVATION

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EDITORIAL

Although workplace innovation (WPI) has in the past largely been neglected by Work and Organizational Psychology (WOP) today it enjoys much greater attention. When we sent out a call for papers for a Special Issue on WPI, we received a large number of high quality papers leading us to publish two volumes of the Special Issue. Six articles made it into Volume 1, 2017 (http://www.eawop.org/archive) and another five articles are now published in this current issue.

Although WPI is in itself not a new concept with origins that can be traced back to the second half of the 20th century in socio-technical design thinking; the concept, with its focus on improving both performance and the quality of working life, is especially important in this day and age. Specifically, we find ourselves in a world on the brink of many technological breakthroughs in, for example, artificial intelligence, machine learning and robotics, that are widely believed to fundamentally change the nature of work and affect the future viability of organizations. Organizations, whether public or private, are increasingly concerned not only with maintaining productivity, but also with becoming more agile and innovative. While some are still putting their faith in technological innovation alone, others realise the limitations of a narrow technological focus to successfully and sustainably navigate the complex social and economic challenges of the 21st century. Indeed, the idea that technological innovation should be complemented with non-technological innovation (i.e., workplace innovation and/or social innovation) has re-emerged and taken hold among practitioners as well as researchers from various disciplines interested in studying the phenomenon.

The five articles included in Volume 2 of this Special Issue represent a multi-disciplinary collection that combines theory, empirical research and practice. As such, the articles draw on a variety of disciplines (e.g., work and organizational psychology, sociology), showcase a range of different types of contributions (e.g., theoretical contributions, empirical papers based on experimental research, case studies, practical intervention tools for WPI) and settings (e.g., various European countries as well as a contribution based on a case study in Guatemala). We hope this collection of articles will stimulate your interest in the topic and your thinking about the application to your own practice.

We open with an interesting theoretical paper, by Tuomo Alasoini examining ways of increasing the effectiveness of work organization development programmes (i.e., WPI programmes) aimed at improving both productivity and the quality of working life. Based on previous work on institutional entrepreneurship and system transitions, the author develops a theoretical framework for analysing the likelihood that work organization development programmes would be successful. Subsequently, he engages in a discussion of how the framework could be used to develop programmes that are more likely to be successful in achieving both improvements in productivity and the quality of working life.

Next, we continue with an excellent piece by Robert van Doorn, Gerjo Kok and Robert Ruiter. The authors identify a prevalent problem in the work on WPI, namely, that the currently available methods for WPI and social innovation implementation lack the level of detail necessary for practitioners to be able to apply them directly in their local contexts. Therefore, they propose a practical tool, namely, the intervention mapping protocol as a potential approach to develop, implement and evaluate sustainable WPI interventions in organizations. Intervention mapping is especially suited for WPI implementation as it takes a systemic view and relies on the active participation of all stakeholders. The authors clearly outline the different steps of the mapping protocol and provide actionable recommendations on how to use it in practice. They conclude with a discussion of the benefits of using a systematic approach to create lasting change in both performance and quality of working life in organizations.

We follow with a fascinating case study by Liv Starheim, Peter Hasle, Per Langaa Jensen, and Birgitte Juul Diekmann. The authors describe an intervention aimed at improving the psychosocial environment in six Danish hospital wards. They developed value-stream mapping combining workflow analysis from the Lean methodology with well-being improvement activities. One key feature of this method is that it aims to improve communication by enhancing relational coordination and, therefore, employees are actively involved in all the different stages of the process. The authors find that this enabled employees to identify and implement work process improvements, which had positive effects on both employee well-being and productivity. However, they caution that external facilitator assistance is most likely necessary for the successful implementation of the intervention.

The next paper by Alvaro Figueredo and Rashedur Chowdhury presents an engaging case study in Guatemala that exemplifies a combination of workplace innovation and community-based entrepreneurship. Specifically, the authors present the case of Ecofiltro and its founder, Philip Wilson, who pursued the goal of providing 1 million families in Guatemalan rural areas with clean water by 2020. The authors outline how a visionary leader used a new business model to implement workplace innovations and involve local community leaders in spreading the usage of a water filter, thereby, enabling poor families to have access to clean water. The main conclusion the authors draw is that community-based entrepreneurial ventures can achieve societal impact and solve local problems by co-opting a wide network of stakeholders to work towards a common goal.

Lastly, Katharina Lochner, Achim Preuss, and Richard Justenhoven present three interesting studies aimed at developing an online creativity test. They argue that selecting creative employees as well as developing creativity in one's employees is crucial for workplace innovation. Nonetheless, the existing creativity tests tend to be paper-and-pencil based rendering them time-consuming, expensive and less than objective. To this end, they developed and tested an online creativity test that uses a fully automated scoring algorithm, optimised for unsupervised settings and that can be applied across borders as it is language-independent.

We offer you best wishes for the upcoming year. We look forward to seeing you at the EAWOP Congress in Turin, in May 2019. Join us on Friday, May 31, 2019 at the EAWOP Congress for a full day dedicated to exploring possible collaborations and identifying potential learning opportunities between academics and practitioners in WOP.

– Diana Rus

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Promoting workplace innovations: Reconsidering the role of development programmes from a neo-institutional perspective

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Abstract

Europe has a long history of programmes to develop the organization of work and promote workplace innovation. Nevertheless, questions concerning the potential of such programmes to act as agents of change and the possibility of change through programmes in general have remained the subject of scant research and discussion. This paper presents a framework for analysing the possibility of working life change supported by work organization development programmes. The paper builds new bridges between research on working life change, workplace innovations, work organization development programmes and neo-institutional theory, and draws implications for how to build better programmes based on such bridging.

Introduction

Many European countries, spearheaded by the Nordic countries and Germany, have conducted programmes to develop the organization of work and promote workplace innovations in recent years. The concept of workplace innovation refers to collaboratively constructed changes in a company's organizational, management or other work-related practices that lead to simultaneous improvements in productivity and quality of working life, which, in turn, also often support other types of innovation (Alasoini, 2011). Our stock of knowledge on such programmes and their outcomes is based primarily on two kinds of studies. The first group comprises a number of comprehensive analyses of development programmes and underlying strategies conducted in individual countries (e.g., Alasoini, 2015; Arnkil, 2004; Brulin & Svensson, 2012; Cole, 1989; Fricke 2003; Gustavsen, Finne & Oscarsson, 2001; Qvale, 2002; Riegler, 2008). The second group of studies includes (mainly) descriptive presentations and comparisons of programmes and strategies implemented in different countries (e.g., Alasoini, 2009; Brödner & Latniak, 2003; Business Decisions

Limited, 2000; Den Hertog & Schröder, 1989; Eeckelaert et al., 2012; Gustavsen, 2007; Naschold, 1994). The latter group of studies has been, for the most part, conducted for the purpose of either highlighting the existing examples as showcases to be emulated by European, national or regional policy-makers, or for criticising the lack of activity by policy-makers in this area.

Nevertheless, at the same time, questions concerning the potential of such programmes to act as agents of change and the possibility of working life change through such programmes in general have remained the subject of scant academic research and policy discussion thus far. To better understand both the factors that are favourable to the occurrence of workplace innovations that enhance organizational performance and quality of working life and the dynamics and structures that can act as obstacles to the creation and dissemination of such innovations, we need a conceptual framework applicable to practice. By making use of a neo-institutional perspective and the idea of development programmes as (potential) institutional entrepreneurs, this paper tries to construct such a framework.

Neo-institutionalism is an approach that focuses on developing a sociological view of institutions. This approach starts with the assumption that institutions operate and interact with each other in an environment in which the main goal of an institution is survival and the establishment of legitimacy. This quest for survival, in turn, often serves as a powerful motive to resort to conformist behaviour, to maintain the status quo and to resist (potentially radical) changes. However, alongside an emphasis on the difficulty of change and obstacles to the diffusion of innovations, neo-institutional theory and research have sought to find explanations for why changes do occur. The neo-institutionalist literature has tried to identify factors that create the conditions that would enable certain organizations to adopt innovative solutions and, thereby, lead to diversity between organizations (e.g., Battilana, Leca & Boxenbaum, 2009; Beckert, 2010; Dacin, Goodstein & Scott, 2002; Garud, Hardy & Maguire, 2007; Greenwood & Hinings, 1996; Oliver, 1992; Weik, 2011). Hence, neo-institutionalism could provide an interesting framework for examining the possibility of working life change through work organization programmes.

To date, even the most comprehensive and ambitious analyses of work organization development programmes and strategies (see above) have not made much use of

this branch of research. Building new bridges between two previously distinctive discourses, i.e., research on working life change, workplace innovations and work organization development programmes, on the one hand, and neo-institutional theory, on the other hand, can be considered the main scientific contribution of this paper. Drawing implications for how to build better development programmes based on such bridging can be considered the main practical contribution of this paper.

This paper starts with a description of the concept of work organization development programme. This is followed by a presentation of a framework for analysing the possibility of working life change supported by work organization development programmes. Thereafter, I will make suggestions on how to make use of the framework in the design of programmes.

What are work organization development programmes?

Development programmes have been a widely used "soft" form of regulation to promote working life reform in different countries. A „work organization development programme" is understood here to mean three things: first, development is guided by a shared framework that applies to several work organizations simultaneously; second, the content of the framework has been accepted by management and staff of the work organizations in question and other major stakeholder groups, such as policy-makers, social partners, and researchers, consultants and other experts; and third, the involved work organizations engage in exchange of information, interaction and cooperation (Alasoini, 2008). This definition is quite broad, and programmes may differ significantly from one another with regard to these key features. Programmes may also differ from each other in many other respects (e.g., Gustavsen, 2006).

The purpose of work organization development programmes is to promote desired lines of development in working life, such as improvements in productivity and quality of working life, and to produce innovations that renew working life, in a planned, systematic and organised manner based on broad cooperation between different types of actors. As such, work organization development programmes' main aim is not geared towards micro-level (company- or organization-level) changes. Such micro-level changes can also be achieved through individual development projects.

The minimum targets of any work organizational development programme would be clearly distinguishable positive externalities in the form of new ideas, knowledge and network relations, which can act as sources of insight, inspiration and encouragement among a larger number of work organizations and which can lead to cumulative innovations among them. Cumulative innovations can, at best, lead to broader macro-level changes that manifest themselves as new approaches or practices on the industry, sector, region or even the national level.

Different stakeholders have different roles in work organization development programmes. These roles can be examined using the triple helix concept, which is derived from innovation research (Etzkowitz & Leydesdorff, 2000). This concept refers to the view that the most effective way to generate new innovative solutions is based on learning and the enrichment of knowledge through cooperation between industry, universities and government.

The triple helix concept primarily describes the industrial environment, with a focus on technological innovations. However, in the case of workplace innovations, a broader framework comprising more parties and more interactive relationships is usually needed. The expanded triple helix model that is characteristic of work organization development differs from the traditional, narrower model in at least four ways (Ramstad, 2008).

First, the expanded model includes not only companies but also public-sector workplaces and non-governmental organizations (NGOs). Indeed, the public sector may, in some cases, be ahead of the private sector in adopting new organizational and human resource management practices.

Second, in addition to universities and research institutes, the expanded model includes other educational institutions and intermediate organizations, such as consultancies and development agencies. Workplace innovations are context-dependent, and their promotion depends on external experts that can commit to long-term cooperative relations with businesses and can communicate effectively with management and personnel on the basis of shared tacit knowledge.

Third, the expanded triple helix concept includes labour market organizations as well as public authorities. The potential for promoting workplace innovations is crucially

dependent on how institutionalised industrial relations are and how capable labour market organizations are to engage in open dialogue.

Finally, whereas the traditional triple helix model discusses three types of relationships, the expanded model addresses the importance of a more varied range of relationships.

Framework for analysing the possibility of working life change

In this paper, I present a theoretical framework for analysing the possibility of working life change supported by work organization development programmes in three consecutive steps. Each of them draws on different aspects of the neo-institutionalist approach. First, I conceptualise working life as an institutionalised entity. Second, I combine these concepts and insights with studies on institutional entrepreneurship. Third, I apply the multi-level perspective to transitions.

Working life as an institutionalised entity

The American historian Thomas Hughes (1994) has conceptualised technological progress as the development of "technological systems" instead of that of individual technologies. In his thinking, these systems comprise a number of intertwining and complex cultural, social and technological phenomena whose mutual interaction aims at particular outcomes, such as energy production, road traffic or health care. By utilizing this framework, it is also possible to examine working life (at the national, regional, sectoral or industry level) as an entity that comprises a number of "technological systems". These systems concern, for example, how work is led, managed and organised; how decisions about the terms and conditions of employment are made; how employees' skills and competences at work are developed; how employees' health is protected; and how their well-being at work is promoted.

Different institutions, organizations and professions play an important role in the development of technological systems. Technological systems are relatively open to changes in the early stages of their development but become increasingly institutionalised as they mature (i.e., as they grow and become more complex), making it increasingly difficult to reform them. Hughes (1994) describes "a

technological momentum" phase, after which, the system starts to function like a material determinant of social reality, i.e., the system is going to take on a life of its own. Technological momentum does not mean that any leeway for different solutions, for example, at the individual workstation, workplace, company or company-to-company network level within a system disappears. It simply means that it is easier to experiment with and introduce new practices at the level of individual work organizations than to break institutionalised practices at the level of the whole industry.

It is possible to draw three main conclusions from the above framework regarding the potential to reform working life. First, working life and all technological systems that influence it become increasingly institutionalised as they mature and begin to function like any material phenomenon. For example, in most advanced industrial nations, especially the post-WWII era represented a period of strong institutionalization of working life in the form of stricter labour legislation, expanded regulation through collective bargaining and increasingly bureaucratic management systems and forms of work organization in accordance with the needs and logic of Fordist mass production. Second, a highly institutionalised working life and its technological systems enable very different manifestations. The lower the level of the unit in question, the greater the leeway (see above). The third conclusion concerns the potential to change working life. The more mature the system, the more difficult it is to change the system from the bottom up. It is difficult to change a mature and institutionalised system from the level of an individual work organization or any individual actor/project.

Work organization development programmes as (potential) institutional entrepreneurs

To bring about a change in a highly institutionalised working life and its technological systems, there are two major strategic options available.

The first of these is to build as large a coalition as possible, including key institutions and organizations, in support of change. A large coalition is in many cases necessary but not sufficient for success. As Leonardi and Barley (2010) note, the institutional dynamics of mature systems typically strive to maintain the status quo rather than to change it (or at least avoid radical change). Sociological research has distinguished

different mechanisms of institutional isomorphism based on the collective rationality that encourages institutional actors (e.g., companies, public institutions, labour market organizations, research units, educational units, and professional or other expert networks) to act in a consistent manner and to rule out alternative manners (e.g., DiMaggio & Powell, 1983; Meyer & Rowan, 1977).

The second strategy is to construct a new competing solution to the existing technological system. This requires a paradigmatic rethinking. For example, in the case of working life change, a radical paradigmatic rethinking could entail a whole new conception of a "working life of the future" represented by the emerging "gig/ sharing economy" (e.g., Grossman & Woyke, 2015; Sundararajan, 2016) concerning, how work is organised, how the terms and conditions of employment are determined and how individuals' economic livelihood is safeguarded.

Work organization development programmes can be seen as means to reform working life that optimally combine both strategic options, i.e., the building of broad coalitions and the search for new paradigmatic solutions. Coalition building is essentially a political task. The programme owners must have the capacity to attract various stakeholders, for example, by creating new trust and cooperative relations or by developing existing relations. The search for new paradigmatic alternatives is primarily an explorative task. The programme owners must have the capacity to launch processes, in which research can play an important role, for finding new insights and workable solutions to meet future challenges.

Programmes that are able to effectively perform both the political task and the explorative task can be described as "institutional entrepreneurs". The concept of institutional entrepreneur refers to change agents who initiate changes that break with the prevailing institutional logic within a given context by actively participating in the implementation of these changes through the active mobilization of resources (Battilana et al., 2009; Garud et al., 2007; Weik, 2011). In the case of work organization development programmes, this means an ability to attract a large number of various stakeholders to join forces in the search for new paradigmatic alternatives to existing established managerial, organizational or other work–related practices.

Work organization development programmes represent a collective or distributed agency that typically comprises many kinds of actors (the expanded triple helix

model). To succeed in this role, a programme must solve, or at least avoid, what in the social research literature has been called the "paradox of embedded agency" (Battilana et al., 2009; Garud et al., 2007; Weik, 2011). This paradox refers to the tension between institutional determinants and agency. In other words, how can programmes, which typically include the parties that also play a key role in the prevailing technological systems, become change agents who are capable and – more importantly – motivated to initiate changes that break with the institutional logic of these systems and to actively participate in the implementation of these changes?

The next two sub-sections will refine the conceptual field in which working life changes take place as well as position work organization development programmes within this field.

The multi-level perspective on working life change

Working life and its different systems form a complex entity. The multi-level perspective (MLP) on sociotechnical transitions is a middle-range theory (Merton, 1968) that has been developed for analysing the change dynamics of such complex systems. So far, the MLP has been used mostly to analyse changes in infrastructure systems, such as energy, transport or food production, but conceptually, it could be applied to almost any type of complex social system (Weber & Rohracher, 2012). The MLP combines elements of different approaches (Geels, 2010), taking a fresh look at the "paradox of embedded agency".

By applying the MLP to working life change, the different systems that characterize different aspects of working life can be conceptualised as sociotechnical regimes. Under normal conditions, sociotechnical regimes provide strong structuration characterized by stabilized rules and established social networks, which make it difficult to deviate from mainstream practice. Sociotechnical transitions refer to changes from one sociotechnical regime to another. Characteristics of such transitions are a long time-span, non-linearity, an interplay between social and technological phenomena and processes at different levels, and the need for system innovations and broad acceptance among key actors (Geels, 2004; Geels & Schot, 2007; Smith et al., 2005).

According to the MLP, sociotechnical transitions occur through interaction between new niche-innovations, external pressures that landscape changes bring to bear on existing regimes and internal tensions within the regimes. When applied to working life change, niche-innovations refer to workplace innovations that question certain routines adopted by key actors of sociotechnical regimes, concerning, for example, how work is managed and organised. The sociotechnical landscape forms an exogenous environment in which economic, technological, political, social, cultural, demographic, etc. changes beyond the direct influence of regime actors or niche innovation actors take place.

In contrast to sociotechnical regimes, niche-innovations experience weak structuration characterized by poorly articulated structures and small and precarious social networks. Competition between niche-innovations and institutionalised mainstream practices that are supported by the prevailing sociotechnical regimes is based not only on the features of the niche-innovations and mainstream practices but also on the features of the institutional environments in which they operate. For this reason, it is difficult even for the most promising niche-innovations to develop into mainstream practices without simultaneous and favourable landscape changes and/or the simultaneous opening up of the prevailing regimes to change. According to Geels and Schot (2007, p. 406), the regimes are never fully impervious to change but can be described under normal conditions as "dynamically stable".

The MLP has been used in innovation studies both as a tool for understanding the dynamics of sociotechnical transitions and for managing such transitions. The rich literature on the subject developed over the past 20 years provides many detailed conceptualizations and models of the dynamics at and between the three different levels (i.e., niche-innovations, regimes and landscape) as well as tools for managing these dynamics (e.g., Van den Bosch, 2010). Here, I limit my review of how the MLP can help us to better understand the possibility of working life change supported by work organization development programmes.

Geels and Schot distinguish five alternative transition pathways of sociotechnical regimes (Table 1).

Table 1
Typology of Transition Pathways (adapted from Geels & Schot, 2007)

	Reproduction	Reconfiguration	Transformation	Substitution	De-alignment and Re-alignment
External landscape pressure for change	No	Low	Moderate	Much	Much
Availability of radical niche-innovation	Yes or no	Yes	No	Yes	Not in the beginning, but multiple competing innovators emerge
Possibility of break-through for such innovation	Little chance	Existing symbiotic innovations are adpoted by the regime	No	An existing innovation breaks through	One of the emerging innovations breaks through after experimentation and competition
Regime transition pathway	Incremental change within existing trajectory	Substantial change in architecture	Cumulative adjustments and reorientation towards new trajectory	Replacement of the old regime with the new one	Erosion of the old regime, emerging of a new regime after a period of time
Key actors in transition	Regime actors	Regime actors and suppliers of the component niche-innovations	Regime actors and outside pressure in-groups	Suppliers of the niche-innovation	Suppliers of the emerging niche-innovations

The first of these is **reproduction**. In the absence of any external landscape pressure to change, the regime reproduces itself only through incremental changes despite the availability of advanced radical niche-innovations.

The second line of development can be described as **reconfiguration**. This pathway differs from the previous pathway in that the available niche-innovations are in a symbiotic relation to the prevailing regime, which facilitates their adoption by the regime. However, the adoption requires changes in the regime architecture.

In **transformation**, a gradual but permanent change in the landscape, in the absence of an available advanced niche-innovation, forces the regime to renew itself. Change happens slowly, but, as it matures, it leads to a distinctly new kind of development path. Although no single promising niche-innovation exists in transformation,

the regime may nonetheless be inspired, albeit in a watered-down form, by niche-innovations that are still in their germ form.

In **substitution**, the regime faces strong external landscape pressure in a situation in which radical niche-regimes are available. Consequently, a new kind of regime replaces the former.

The fifth potential pathway is **de-alignment and re-alignment**. It differs from the previous pathway in that radical niche-regimes do not initially exist, but they develop through experimentation and competition. The former regime gradually collapses, and the new regime is able to emerge only after a period of experimentation and competition.

Positioning work organization development programmes in the framework

The multi-level perspective helps to deepen our understanding of why the modification of practices in working life is so difficult to achieve through the actions of individual work organizations, other individual actors or even networks of these actors alone. According to the framework, even the most promising workplace (niche-) innovations do not easily break through and diffuse among a larger number of work organizations without favourable framework conditions created by tensions within the regimes or supporting changes in the external landscape.

As changes in the external landscape are, by definition, beyond the direct influence of actors, two possible policy approaches remain through which regime-level change can be promoted (Kivimaa & Kern, 2016). The first approach is to destabilize the dominant regime. Regime destabilization can take place, for example, through regulatory changes and control policies, questioning the cognitive and normative basis of its guiding rules, reducing support for dominant regime technologies and practices, or bringing about changes in supportive social networks and replacement of key actors. The second approach is to help niche-innovations to develop into competing regimes. Critical fields of action concerning niche development include developing the contents of the niche-innovations, clarifying the expectations and visions related to them, building social networks and enrolling more actors in support of such innovations, and organizing supportive learning processes.

Work organization development programmes usually resort mainly to "soft" forms of regulation, ranging from indirect means such as providing general frameworks, recommendations and "good practice" guides to more direct means such as project funding. Many of these means are more suitable to niche-innovation support than regime destabilization. However, depending on the type of transition pathway, programmes can play a variety of roles and operate with a variety of policy mixes.

Reproduction and reconfiguration do not necessarily require the support of an in-depth search for new solutions from the programmes, because radical niche-innovations already exist (reconfiguration) or are not needed (reproduction) and the external landscape is fairly stable and thus predictable. This means that programmes can be very development-oriented, focusing on the dissemination of already existing solutions in a larger number of work organizations and helping them to find workable tailored applications of these solutions to their own needs. However, reconfiguration requires more active network building to support successful change compared with reproduction.

In transformation, new development paths that lead towards a totally new trajectory must be actively sought. This emphasizes the role of research and other forms of exploration. Successful transformation also requires a significant investment in the construction of networks and cooperative relations.

In substitution, an existing niche-innovation develops into a competing niche-regime and replaces the old regime. Programmes can accelerate this process both by regime destabilization and through activities that help to disseminate the adoption of new practices.

In de-alignment and re-alignment, in contrast, new niche-innovations compete with each other in the event of the dissolution of the old regime. Here, programmes can play a versatile role by supporting experimentation with potential new solutions through both research and development in cooperation with the underlying networks of these solutions.

Summary of the framework

This section has conceptualised working life as an institutionalised entity and work organization development programmes as potential change agents by framing them as

institutional entrepreneurs. Based on this framework, the potential of a programme to fulfil the role of an institutional entrepreneur is influenced by the combined effect of factors at three levels: the availability of perfectible workplace (niche-) innovations, the degree of structuration of the sociotechnical regime underlying prevailing workplace practices and the state of the external landscape. A typology of five different pathways for working life change was constructed and various potential roles that programmes can take within these pathways were distinguished. Next, this article deepens the discussion on this topic by providing a framework for analysing external programme effects in greater detail.

Programme effects as institutionally framed

According to many evaluation studies that have been conducted in different countries, work organization development programmes have often been successful in producing significant improvements in productivity and quality of working life in individual work organizations that have participated in publicly supported development projects (e.g., Gustavsen, Hofmaier, Ekman Philips & Wikman, 1996; Keuken, 2010; Lee & Lee, 2008; Oeij, De Vroome, Bolland, Gründemann & Van Teeffelen, 2014; Ramstad, 2014). However, although the success rate of demonstration (pilot) projects in such programmes is generally good, the experiences of many programmes indicate that the "good practices" that these projects create spread poorly (e.g., Arnkil, 2004; Brulin & Svensson, 2012; Fricke, 2003; Gustavsen, 2008; Qvale, 2002; Riegler, 2008; Steiber & Alänge, 2013). There are many factors, which may explain this paradoxical situation faced by most work organization programmes. Table 2 summarizes key reasons for this poor dissemination by comparing the divergent conditions for project success between piloting workplaces and "second wave" adopters.

Table 2
Conditions for Project Success: Piloting Workplaces Versus "Second Wave" Adopters (adapted from Alasoini, 2006)

	Piloting workplaces	Second wave adopters
Resources to implement the project	Exceptional resources provided by the programme in terms of funding and expertise	Depends on the financial situation and the extent of management commitment of the adopter
Opportunities for tailor-made solutions within the project	Extensive target-specific tailoring possible	Depends on resources given to the project and the development expertise of internal or external change agents
Development level of the workplace	Progressive workplace that often has experience with both self-motivated development and cooperation with external experts in development	Typically, a follower or a laggard that has less experience with self-motivated development and cooperation with external experts in development
Commitment of participants to implement the project	High legitimacy and transparency of the project and high level of commitment from participants to implement the project as well as possible	"Programme boost", which would enhance legitimacy, transparency and high level of commitment from participants, is lacking
Motivation of the participants to rate the project as successful	Hawthorne effect possible: participants improve their performance and/or give positive evaluations of the project because they have received special attention	Hawthorne effect missing: depends very much on realization of the process (how?) and context (why?) dimensions of innovation

However, the legitimacy of publicly supported development programmes cannot be derived primarily from the success of individual demonstration projects. Rather, it must be justified by a variety of positive externalities produced by the intervention. Work organization development programmes in various countries have generated new and wide–spread knowledge, given rise to new cooperative networks and increased awareness of the possibility of alternative solutions, which, in turn, has contributed to increased public awareness and discourse on working life reform. Gustavsen (2003; 2004) speaks of the need for such programmes to work as mechanisms that can be used to catalyse social movements aimed at making working life more democratic. The challenge is thus to generate parallel and interacting processes of change in a great number of work organizations. In Gustavsen's view, the growth or strengthening of such a movement can, in itself, be considered an indication of a programme's success.

By making use of the MLP, it is possible to build a more structured framework for analysing external effects of work organization development programmes at various levels (Figure 1). Besides changes at the level of individual work organizations, programmes should be able to contribute to increased awareness, knowledge spillovers and the emergence of new cooperative networks around perfectible workplace innovations. This is close to what van den Bosch (2010) calls "broadening of niche–innovation". Gustavsen's characterization of programmes as mechanisms for social movements implies that programmes should be able to produce, in addition to this, mutually supportive cumulative innovations that embody as new practices in a larger number of work organizations than those directly involved in programme–supported activities. Using MLP terminology, this process can be called "scaling–up of niche–innovation" (Van den Bosch, 2010).

Figure 1. External effects of different levels of work organization development programmes
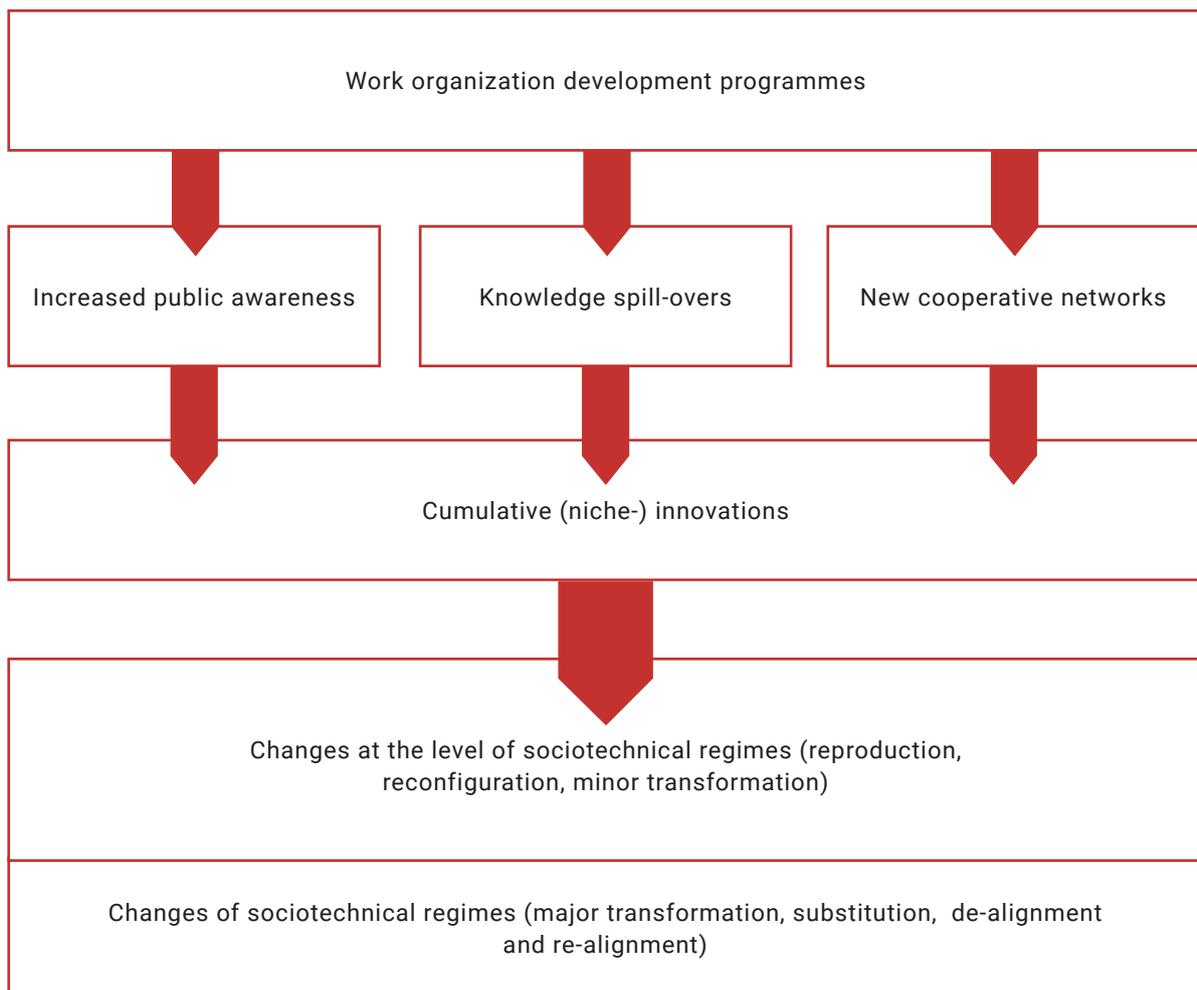
At best, programme impacts occur as changes at the level of regimes or even changes of regimes at the national, regional, sectoral or industry level. Changes at the level of regimes refer to reproduction and reconfiguration pathways, whereas changes of regimes refer to substitution and de-alignment and re-alignment. Transformation represents some kind of middle ground between these two types of change. Changes at the level of regimes refer to change dynamics that largely proceed along predictable trajectories and do not undermine the legitimacy of and power relations between regime actors. Changes of regimes, in contrast, mean more radical changes of trajectories and within the group of key regime actors. "Changes" refer here to processes of adoption or breakthrough of new workplace innovations that can manifest themselves, for example, as new kinds of doctrines in management and work organization, new ways of working, new paradigmatic approaches in workplace health promotion or new kinds of normative expectations concerning employees' opportunities to exert influence at work.

The ability of programmes to produce changes at the level of regimes or changes of the regimes themselves is affected not only by the characteristics of the programmes per se but, according to the MLP, also by external pressure brought to bear on regimes by landscape changes and internal tensions within regimes. The possibility of breakthrough for programme-supported niche-innovations is dependent, among others, on economic, operational, social and other benefits produced by these niche-innovations and the extent to which these niche-innovations support or instead call into question the premises of the prevailing regimes.

Neo-institutional theory and research have developed insights that help us to better understand the change dynamics of regimes. DiMaggio and Powell (1983) have identified three mechanisms of institutional isomorphism that can act as significant converging forces for work organizations and thus prevent a wider breakthrough of niche-innovations and the evolution of such innovations into new mainstream practices (Table 3). Underlying this view is a belief that organizational life is driven not only by economic rationality but also by powerful tendencies to strengthen the organization's political and institutional legitimacy and to demonstrate its social fitness.

Table 3
Three Mechanisms of Institutional Isomorphism and Key Actors (adapted from DiMaggio & Powell, 1983 and Paauwe, 2004)

Mechanism	Source	Key Actors
Coercive institutional isomorphism	Results from both formal and informal pressures exerted on work organizations by other organizations upon which they are dependent and by cultural expectations of the society within which work organizations function.	Governments, labour market organizations and work councils
Mimetic institutional isomorphism	Results from a standard response to uncertainty and the following of trends and hypes which, when applied, demonstrate that the work organizations in question are at least trying to improve their operation.	Competitors and other companies and workplaces
Normative institutional isomorphism	Results from the professionalization of occupations as part of their collective struggle to define the conditions and methods of their work and to establish a cognitive base and legitimation for their occupational autonomy.	Educational and training institutes and professional and occupational associations and networks

It is interesting that the same institutions of the expanded triple helix model that are seen as key promoters of workplace innovation may, under certain circumstances, also act as significant impediments to workplace innovation activities. This inherently contradictory relationship of the various actors towards the development of workplace innovations is rarely explicitly recognized in evaluation studies and other analyses of work organization development programmes.

Although governments and labour market organizations may be active funders and promoters of workplace innovations in work organization development programmes, the labour legislation and collective agreements supported by these actors may include stipulations that seriously discourage innovative behaviour in working life (an example of coercive institutional isomorphism). Work organizations within the same industry may be important sources of learning for each other, but in certain cases, rather than promoting the emergence of novel, unique and innovative solutions, this learning may result in the spread of increasingly consolidated industry–wide "best practices" (an example of mimetic institutional isomorphism). Universities and other educational institutes may enhance the skills and competences of company managers

and other key occupational groups in different functional areas, which may ultimately have the effect of increasing the normative pressure among these groups to think alike and decreasing the incidence of deviant behaviour (an example of normative institutional isomorphism).

To conclude, this section has constructed a framework for distinguishing programme effects at different levels. Depending on the ambition level of a programme, the MLP provides various evidence-based principles and techniques, which can be directly applied to work organization development programmes in an effort to overcome the effects of institutional isomorphism.

Discussion and conclusion

This paper had two main objectives. First, the paper sought to build new bridges between research on working life change, workplace innovations and work organization development programmes and neo-institutional theory. A framework for analysing the possibility of working life change supported by work organization development programmes was constructed. Second, the paper sought to draw implications for how to build better programmes based on the framework. In more general terms, the paper can be considered an attempt to demonstrate how sociological theorizing can contribute to practice.

Four major theory-based contributions that have practical relevance for designers and implementers of work organization development programmes can be distinguished.

First, the paper further develops the MLP on transitions and the typology of transition pathways and applies this framework to outline the possibility of working life change supported by work organization programmes. As shown above, the possibility of change should be analysed as a dynamic interplay of niche-innovations, sociotechnical regimes and the sociotechnical landscape. To build development programmes that have the ability to bring about cumulative workplace innovations in a large number of work organizations or changes at the level of regimes or even changes of regimes, a realistic analysis of the existing sociotechnical regime, landscape and the most promising niche-innovations is needed. Programme designers and implementers must also have an understanding of how to make use of this information for niche development and/or regime destabilization. For this purpose, the studies on both the

MLP and institutional entrepreneurship can be of great help. They have produced, for example, conceptualizations of types of landscape change and coordinating components of regimes, tools for strategic niche management, lists of distinctive characteristics of transition experiments and models of the process of institutional entrepreneurship (e.g., Battilana et al., 2009; Geels, 2004; Geels & Schot, 2007; Van den Bosch, 2010).

Second, the paper directs attention to the fact that the positive results of individual pilot or demonstration projects in publicly supported development programmes are often achieved in an environment that is artificial in many respects (Table 2). Unawareness of the artificial nature of demonstration projects can lead to unrealistic expectations and undefined and under-resourced strategies in terms of diffusion of innovations. Programme designers and implementers should take this artificiality as their starting point and work out strategies to narrow the chasm between the conditions faced by piloting workplaces and "second wave" adopters. There are different strategic options available for programme designers and implementers to achieve this. For example, they can produce more convincing evidence-based argumentation through rigorous analyses of demonstration projects in terms of "what works under which conditions and why". Another option is to try to bridge the social and cultural gap between the creation and reception stages of new practices by enriching knowledge from demonstration projects. A third option is to use learning networks in which the generation of new practices results from co-creation by several actors (e.g., Alasoini, 2011; Gustavsen et al., 2001; Steiber & Alänge, 2013).

The third practical contribution concerns the breakdown of external effects of work organization development programmes. Figure 1 makes a distinction between six different effects. The breakdown can be used as a tool for setting programme goals and as a benchmark for monitoring and assessing the overall success and social effectiveness of programmes at different stages of their life cycle. Using this kind of theoretical framing forces programme designers and implementers to take a stand on crucial matters concerning, for example, the target level of the programme and the means and milestones to achieve the objectives.

Finally, by drawing on the idea of institutional isomorphism that stems from neo-institutional theory, the paper highlights the inherently contradictory relationship

of the various actors involved in the expanded triple helix cooperation towards the promotion of workplace innovations and working life reform in general – an issue rarely seriously discussed in the context of work organization development efforts.

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Combining a person-centered and ecological approach to develop, implement, evaluate and sustain workplace innovation in organizations: Intervention mapping

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Abstract

Workplace innovation (WPI) aims to strengthen both an organization's performance
and the employees' quality of work life by improving the work environment in an
organization. This contribution proposes the intervention mapping (IM) protocol to
develop, implement, and evaluate and sustain WPI in an organization. IM combines
person-centred and ecological (multilevel) views to involve individuals who function
on diverse levels within an organization. The protocol applies theory-based change
strategies to establish concrete and effective individual and environmental changes
that are tailored to the local context of the organization.

Introduction

Workplace innovation (WPI) is a fairly recent notion that stands for implementing
sustainable improvements in the work environment to benefit both organizational
results and employee quality of work life (Pot, 2011). In this paper we introduce the
systematic protocol of Intervention Mapping approach (IM: Bartholomew et al., 2016),
that has been applied to improve health in communities and in organizations.

We think it is also quite suited to develop and implement a change programme to establish a lasting WPI.

Establishing lasting WPI is much needed in knowledge-centred economies to maintain the welfare and security of a gradually declining workforce due to an ageing population (Oeij, Dhondt, Kraan, Vergeer, & Pot, 2012). To increase labour productivity for example, WPI promotes employee skills and competencies. The ideal is to involve employees in reorganizing and designing the work environment. These ideas on WPI have been made publically available via several documents under the auspices of the European Commission (Dhondt & Totterdill, 2014). Some European countries have attempted to develop WPI programmes (Pot, 2011), but a sustainable implementation of workplace innovation still lags behind in many European organizations. The main reason is that attempted changes encounter many unforeseen obstacles and prove less effective than intended.

We believe that IM may help to prevent these obstacles as the protocol advocates a practical approach given that WPI research findings often do not provide concrete advice on how to implement changes (Oeij, De Looze, Have, Van Rhijn, & Kuijt-Evers, 2012). For example, employee well-being has often been related to firm performance or product innovation, but such an association does not tell us whether employee well-being is the cause or the consequence of firm performance or product innovation (Kesselring, Blasy, & Scopetta, August, 2014). This implies that research findings cannot provide hands-on solutions for WPI and the actual methods to accomplish them.

Moreover, the available methods for workplace and social innovation only provide a general description of the potential change processes (Pot & Koningsveld, 2009) and, typically, lack the detail necessary for practitioners to apply them directly in the local context. Importantly, the choice of appropriate change methods and their implementation is only possible as part of a thorough intervention development process. Such a process has to create a realistic and effective change programme to which all individuals involved are committed.

In this respect, the IM approach is a promising protocol to successfully develop, design, implement, evaluate, and sustain workplace innovation in an organization (Bartholomew et al., 2016).

IM: individual and environmental change

The IM protocol emerged in the 1990s from a general discontent with the reliance on fragmented scientific knowledge that often resulted in ineffective health interventions (Bartholomew, Parcel, & Kok, 1998). To date, IM has been applied successfully to develop and implement interventions to minimize health risks such as HIV, smoking, and to promote healthy behaviour through physical fitness programmes and more balanced nutrition (Wisenthal & Krupa, 2014). IM interventionists are often health and social psychologists who are well-versed in translating theoretical methods of behavioural change into concrete, practical applications that are tailored to the context.

IM views individuals as embedded in an ecological environment (van Doorn, Kok, & Ruiter, 2015) and IM interventionists realize that intervention plans may change and that the development process must remain flexible and allow for iterative loops to update earlier design decisions. See Figure 1 for a representation of IM's view on individuals as embedded in ecological levels.

Figure 1. Schematic representation of the ecological view and the positions of individuals
(Adapted from Kok, Gottlieb, Commers, & Smerecnik, 2008).
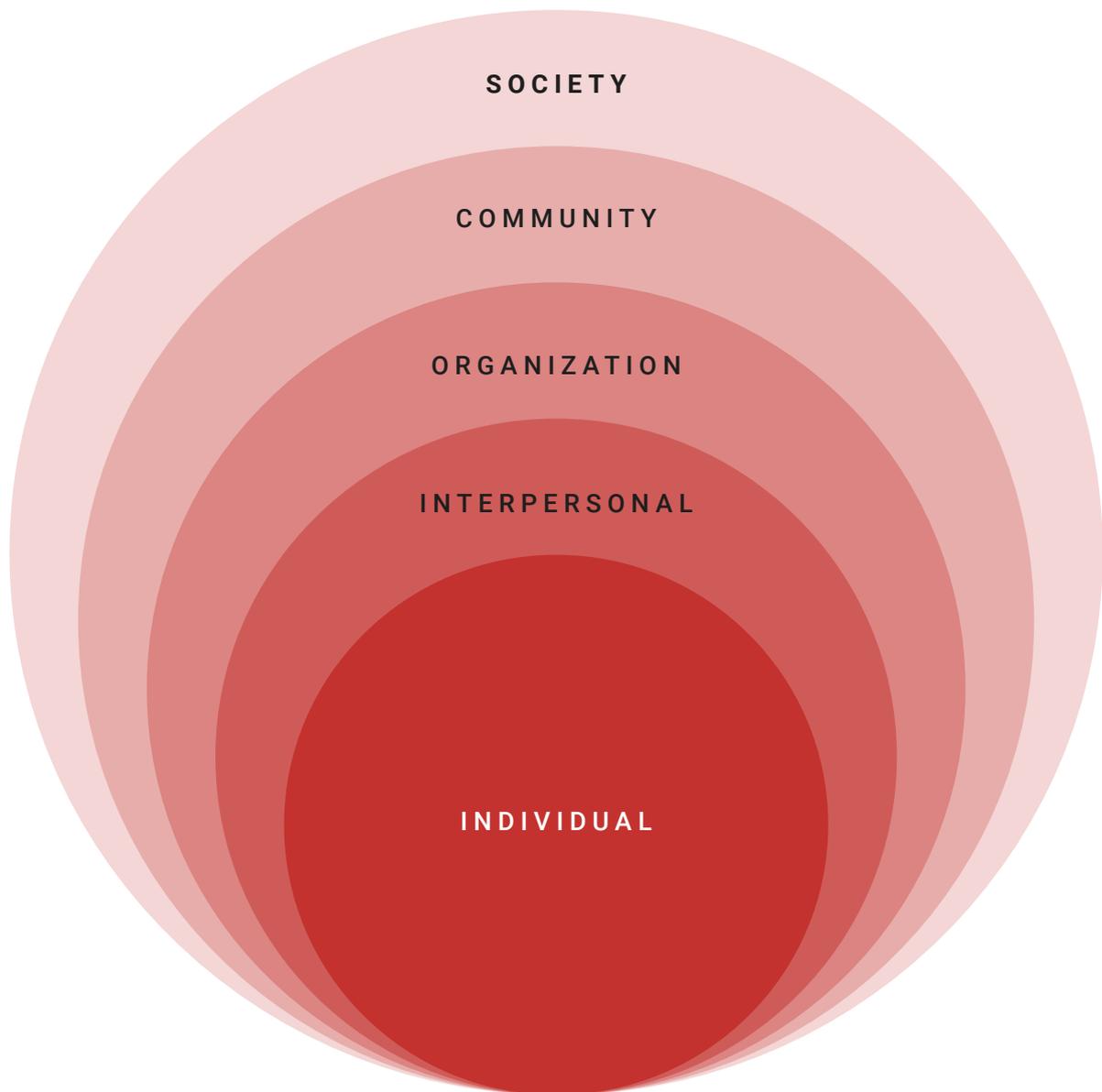
Note: The individual employee may be viewed as embedded in an environment with a number of inter-connected organizational levels and even ecological levels that extend beyond the organization. Individual and organizational changes required to establish WPI are accomplished by involving and targeting individuals who function on these diverse and connected ecological levels.
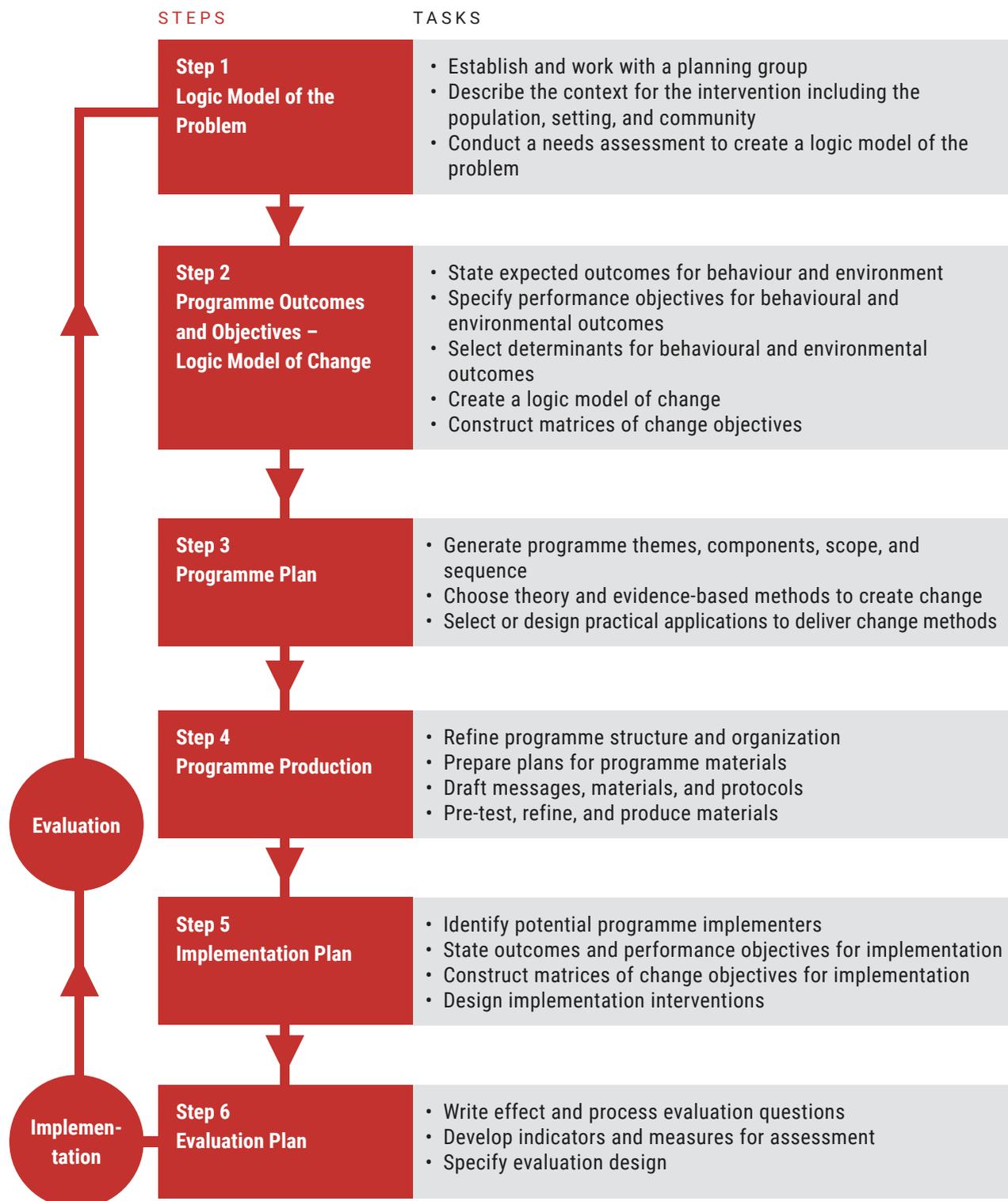
Participation of individuals

An IM change programme to accomplish WPI involves both employees and management in developing the intervention, and also targets these various stakeholders during the actual change process. Interventionists establish participation in programme development by inviting representatives from diverse ecological levels to participate in the planning group. These levels may reside inside but also outside the organization. Representatives from within the organization may be employees on the work floor but also individuals from Human Resources (HR) and upper management. Individuals from outside the firm may be representatives of labour unions and local government. This approach ensures that all participating stakeholders can integrate their knowledge, experience, and creativity. It also ensures a realistic view on the expected scope of the solution in the local setting, and warrants commitment to the change programme at all environmental levels (Kok et al., 2008).

Individuals embedded in the above-mentioned environmental levels may also be the targets of the change programme. Indeed, to establish sustainable WPI, an IM change programme will target employees on the work floor. However, any change on a lower environmental level requires support from higher levels (van Doorn, Massar, & Kok, 2018). Such support may entail motivating the employees as well as supporting them in realizing potential alterations of procedures or even infrastructures. A complete intervention programme will describe in detail the (testable) change strategies to accomplish both individual and environmental changes in the organization.

IM Development Steps

Once the decision is made to implement WPI, the six steps of the protocol are followed in programme development. See Table 1 for an overview. The required activities per programme development step imply that the interventionists are proactive in preventing the effects of the intended changes from being hampered by local environmental influences. Note, in addition, that every development step needs to be well-documented, so that design decisions are detailed and transparent. Such a rigorous documentation also facilitates the common practice in IM to return to previous development steps to verify or even update earlier design decisions to accommodate recent insights.

Table 1

Intervention Mapping Steps in Terms of Required Activities and Products (adapted from Bartholomew et al., 2016).

STEPS	TASKS
Step 1 **Logic Model of the Problem**	• Establish and work with a planning group • Describe the context for the intervention including the population, setting, and community • Conduct a needs assessment to create a logic model of the problem
Step 2 **Programme Outcomes and Objectives – Logic Model of Change**	• State expected outcomes for behaviour and environment • Specify performance objectives for behavioural and environmental outcomes • Select determinants for behavioural and environmental outcomes • Create a logic model of change • Construct matrices of change objectives
Step 3 **Programme Plan**	• Generate programme themes, components, scope, and sequence • Choose theory and evidence-based methods to create change • Select or design practical applications to deliver change methods
Step 4 **Programme Production**	• Refine programme structure and organization • Prepare plans for programme materials • Draft messages, materials, and protocols • Pre-test, refine, and produce materials
Step 5 **Implementation Plan**	• Identify potential programme implementers • State outcomes and performance objectives for implementation • Construct matrices of change objectives for implementation • Design implementation interventions
Step 6 **Evaluation Plan**	• Write effect and process evaluation questions • Develop indicators and measures for assessment • Specify evaluation design

Evaluation

Implementation

Note: The arrows signify the linear and iterative nature of the design process.

Step 1. Create the logic model of the problem.

First, the assembled planning group identifies the main issues or problems in the organization that must be solved to make sustainable WPI possible. The group identifies the context in which the intervention will take place, and distinguish individual and environmental factors that contribute to the problems. Established theories may be used but are complemented by local data gathering via talks and interviews with employees on several levels within the organization. The goal is to create a so-called logic model of the problem that describes in detail all factors that contribute to the problem. The model intends to be realistic and interventionists include only those factors that can be changed. For example, one factor may be that employees on the work floor do not talk about what WPI may mean for them and the organization. Part of the change programme may entail stimulating employees in voicing their opinion on WPI.

The logic model of the problem is complemented and refined by an overview of the available resources such as approval of the intervention and financial support by management. Such a basis is essential to warrant the development of a realistic and effective change programme. During IM's Step 1, it should become apparent which parts of the general philosophy of WPI can be fulfilled and which parts may not be attainable. For example, the analysis may reveal that the need for improving quality of work life is substantial but that limited financial resources and other senior management support may not allow large-sale changes of the organization's infrastructure.

The final logic model incorporates only changeable factors for a realistic framing of the problem.

Step 2. Formulate programme outcomes and change objectives per ecological level.

In Step 2, the factors contributing to the identified problem(s) are now used to define two concrete types of objectives. Performance objectives specify the required employee performance (e.g., employees voice their opinion) and change objectives detail what must be changed (e.g., employees gain and express confidence to voice their opinion) to reach the formulated performance objective. Change objectives may also pertain

to environmental changes. Below we show that, to be effective, these changes also require targeting individuals at higher levels within the organization.

IM's person-centred, ecological view prescribes that a change objective is reached by changing the so-called determinants of behaviour. Examples are beliefs, attitudes, perceived norms, self-efficacy, but also knowledge and skills (Kok, Gottlieb, et al., 2015). Self-efficacy (confidence in one's performance ability) is, in our example, the determinant that is targeted to promote voicing behaviour of employees on the work floor. Such a change is ineffective if it is not supported by individuals who function at higher levels in the organization, such as supervisors and senior management.

During the second development step, the interventionists create matrices of change objectives. Each matrix is a tabulated overview per ecological level of performance objectives (rows) and determinants (columns) that must be targeted to accomplish the change objective (cells). Change objectives are used to create concrete and tailored change applications in Step 3. Note that the present example (Table 2) is necessarily simple. It is not uncommon to target a number of determinants and change objectives for a single performance objective, such as self-efficacy in combination with skills and outcome expectations (Kok, Gottlieb, et al., 2015). A matrix typically specifies a number of distinct performance objectives.

Change objectives pertaining to employees on the work floor cannot be realized in isolation and require support from individuals on alternate environmental levels. This means that these individuals become part of the change plan and that a separate matrix is created to specify performance objectives, determinants and change objectives for supervisors, as well as for upper management. This may even extend to individuals outside the organization. The change programme by the end of Step 2 describes which change objectives (targeting individuals on several levels) must be reached to fulfil the intended programme outcomes (WPI).

The intervention plan is represented by the logic model of change (see Figure 2 for details).

Table 2
Example of a Matrix of Change Objectives.

General behavioural outcome at the employee level	Determinants of behavioural change		
	Determinant 1: self-efficacy	Determinant 2	etc.
Performance objective 1: Employees voice their opinion on WPI	Change objective 1.1: Employees express their confidence in voicing their opinion	Change objective 2.1	etc.
Performance objective 2	Change objective 1.2	Change objective 2.2	etc.
etc.	etc.	etc.	etc.

Note: The matrix follows the example provided in the text and, for the sake of clarity, shows only one combination of performance objective and determinant to form a change objective at the employee (work floor) level. Typically, the change programme (Step 2) specifies more than one performance objective and also more than one determinant. Hence, a table (per ecological level) may have several rows and columns. A row in a table has more than one cell that each specifies a change objective. At this phase of the intervention development, the change objectives (cells) can be made very concrete without specifying in detail what the objectives will accomplish. However, the IM protocol precludes that programme designers mistakenly adopt these change objectives as being change applications. Change applications will be specified later and need to be based on theoretical change methods that have empirical support.

Figure 2. The Intervention Logic Model (Adapted from Bartholomew et al., 2016)
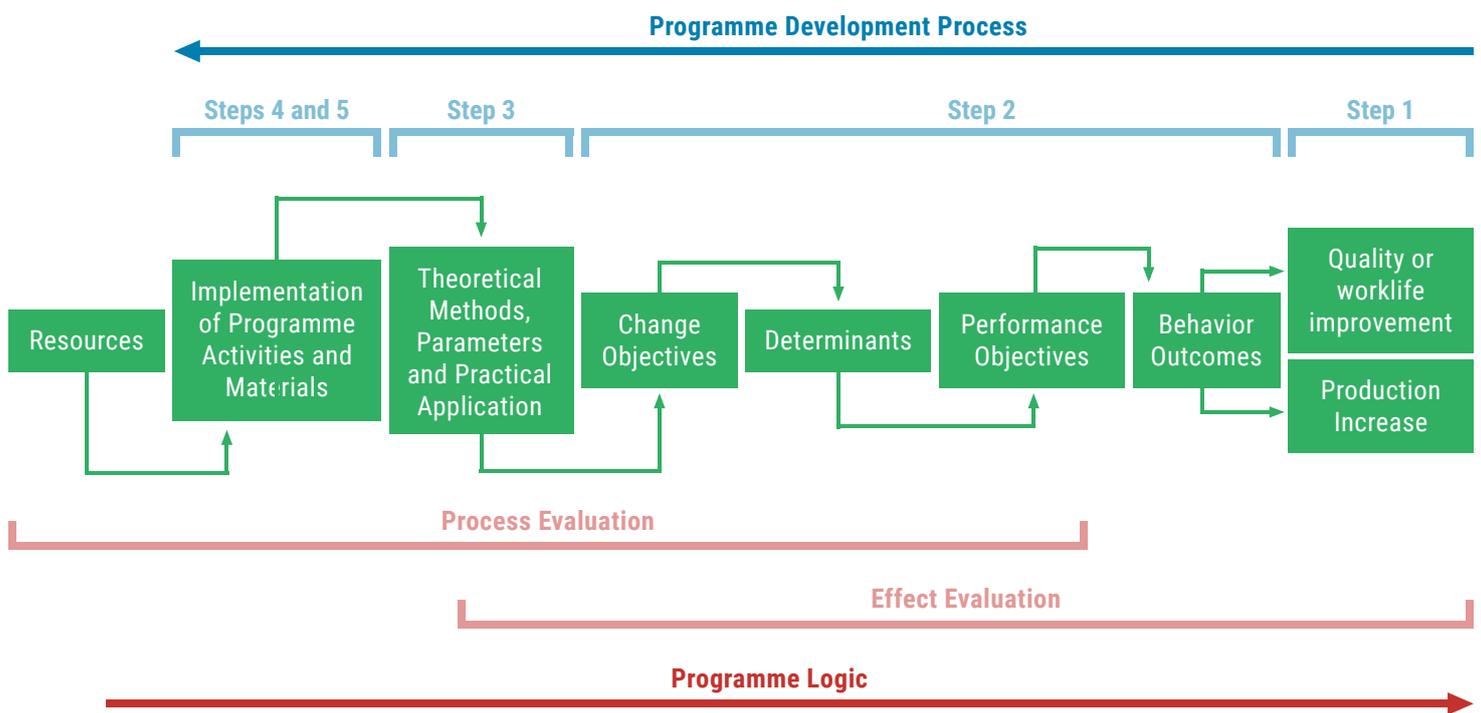
Note: The Intervention Logic Model shows the logic of programme development from right to left along the protocol steps from general outcomes, through performance and change objectives (via determinants) to selecting change methods, translating them into change applications, designing materials and planning how to implement them. The protocol requires programme planners to start at the right side and work through every single development step to prevent omissions that often hamper the effect of interventions in organizations. Following the model from left to right reveals the change logic of the programme from implementing materials toward behavioural and programme outcomes.

Step 3. Programme plan: designing theory-based and tailored change applications.

Step 3 creates concrete change applications to target the behavioural determinants and to reach the change objectives as specified earlier. Concrete change applications are tailored to the local ecological context and are based on theoretical change methods that are selected from the literature. The interventionists selects theoretical change methods based on their support in the literature as well as based (from experience) on how effective they are expected to be in the current change programme. See Table 3 for the outcomes of the development process of Step 3 in our example.

For instance, as shown in Table 3, to motivate employees to become more confident in voicing their ideas on WPI, interventionists may decide to apply a social cognitive theory (Bandura, 2004) based change method, namely, "modelling" to improve employee self-efficacy to voice their opinion. The resulting change application may involve presenting a video of a model employee who is confident and successful in voicing her ideas to her colleagues and supervisor. Such an application must be embedded in the ecological context and this requires that interventionists identify barriers (i.e. parameters) that potentially hamper the effect of the change application, and turn these barriers into effective facilitators.

Barriers and facilitators of change application effectiveness.

A potential barrier, to improving employee self-efficacy in voicing their opinion, could be that the actors in the video who voice their opinions on WPI are not taken seriously as representing typical colleagues. Therefore, an important facilitating factor on the employee level could be that the video shows actors and ideas that are recognized as representing the local context (Bandura, 2004).

Another potential barrier may be that employees will not gain confidence in voicing their opinions if they are not supported by their supervisor. Supervisors may thus be involved as essential facilitators of the change applications targeted at the employee level. However, it is necessary to ensure that these supervisors are able to play a facilitating role. In other words, supervisors are also targets for behavioural change. Interventionists may have anticipated this from the start or have to return to Step 1 to alter the logic model and then identify change objectives for the supervisors in

Table 3

Intervention Mapping Procedure and Required Contents (per Column) in Step 3 of the Protocol to Translate Change Objectives into Theory-based and Tailored and Effective Change Applications (Adapted from Kok, Gurabardhi, Gottlieb, & Zijlstra, 2015).

Determinant and change objective	Theoretical change method	Parameters: barriers and facilitators	Change application
Outcome expectations: Upper management is informed about and will endorse the need for WPI and believes that its implementation and management can be done effectively and has benefits in the long run.	Sense making via persuasive communication (Elaboration Likelihood Model): Guiding individuals toward the adoption of an idea, attitude, or action by using arguments or other means.	Central processing of arguments about health statistics and causal theories on organization benefits. Messages need to be relevant and not too different from the beliefs of the manager, and are repeated to promote continuous change.	A number of presentations by interventionists and health promotion organizations with information on the importance of WPI and the advantage of the IM protocol to implement and maintain it effectively. Show, explain and discuss past and potential IM success.
Beliefs: Supervisors are convinced that feedback provision helps employees to form and maintain confidence in voicing their opinion on WPI.	Belief selection (Theory of Planned Behaviour): Using messages designed to strengthen positive beliefs, weaken negative beliefs, and introduce new beliefs.	Requires investigation of the current beliefs of the supervisors. Resulting action plans must have reachable goals and time schedules, and must be tailored to the target group.	Managers exchange their beliefs and discuss under supervision how feedback can be given. The goal is to come to a concrete action plan to: Train feedback provision, implement, and evaluate.
Self-Efficacy: Employees express confidence in voicing their opinion on WPI.	Modelling (Social cognitive theory): Providing an appropriate model and being reinforced for the desired action.	The employee must identify with the models, must be able and is reinforced to apply the portrayed behaviour effectively in her personal job context.	Employees watch a video in which model employees successfully voice their opinion on WPI and receive appropriate feedback from supervisor and colleagues. The portrayed situation contains recognizable individuals and situations and emphasizes the commitment of supervisor and senior management.

Note: Rows specify the organizational level.

Step 2 and match them with fitting determinants. Interventionists subsequently work through Step 3 and select appropriate theoretical change methods, and translate them into tailored change applications (Kok, Gottlieb, Panne, & Smerecnik, 2012).

For example (see Table 3), it may be necessary that supervisors are stimulated to select the suited belief (determinant) that employees can be motivated to voice their opinion if they receive suitable feedback (Reasoned Action Approach: Fishbein & Ajzen, 2010). The theoretical change method belief selection may be translated in a change application that involves a supervised group discussion. The discussion should lead to a concrete plan to acquire the skills (determinant) to motivate employees to voice their ideas, and to give them motivating feedback (supervisor performance objective) on their WPI opinions (Dysvik & Kuvaas, 2012).

Moreover, support from senior management is a strong facilitator of all change applications on the lower ecological levels. However, the absence of this support may also bar the anticipated effects of change applications. By being part of the intervention planning group as well as a target in the change programme, top management should already be stimulated to endorse the need for workplace innovation and to promote a positive organizational climate (Dysvik & Kuvaas, 2012). From the start, interventionists should also target the organization's human resource department and upper management and inform and update them about WPI and how its implementation and sustainable management can be done (cost-) effectively with lasting employee and organizational benefits. For example, the theoretical change method sense making may entail persuasive communication (Elaboration Likelihood Model: Petty, Barden, & Wheeler, 2009) to alter outcome expectations (determinant) (see Table 3). The change method sense making is facilitated by repetition. The change application includes a number of presentations and updates by a planning group member (for instance, a management representative) to provide information on the required changes to realize WPI in the local environment (facilitator) and to highlight the advantages of the IM protocol to develop, implement, evaluate and sustain it effectively (Kok et al., 2008). The suggested change application could further be facilitated by involving, from the start, local government, and union representatives and labour inspectorates to provide additional credibility to the benefits of WPI.

Steps 4 and 5. Programme production and implementation.

The change programme plan is now turned into a product plan that specifies the strategies and activities that need to be organized to create deliverable programme materials. The end product of Step 4 comprises a number of refined documents that specify the materials to be used and all the individuals that will be involved in developing these materials (Bartholomew et al., 2016). These products are fully reviewed by the planning group and all members must agree that they are ready to plan the programmes's actual implementation in Step 5. The interventionists subsequently develop concrete logistic plans to implement the product plan in an organized manner. The interventionists select the programme implementers and train them in applying the logic, strategies and materials of the change programme.

Step 6. Evaluation plans development.

Plans are made for programme evaluation as an integral part of the Intervention Mapping process. IM distinguishes the evaluation of the development process including determining the quality of the programme implementation plan, from evaluating the effects of the actual implementation (Bartholomew et al., 2016).

Process evaluation planning is part of the entire change design process and is meant to identify and correct the potential weaknesses and flaws in the design (Biron & Karanika-Murray, 2014). The documentation of the design process and the design decisions are critically reviewed. If decisions are viewed as unsuitable they can still be updated and this may urge the interventionists to return to and check earlier planning products. Also, these concurrent process checks and improvements are documented.

Change programme implementation effects can be proximal or distal. Proximal effects may entail, for example, whether targeting a determinant (self-efficacy) has the expected and immediate increase in motivation to voice one's opinion. This can be reliably measured by a planned query of employees and implementers before and after the implementation (Kok, Zijlstra, & Ruiter, 2014). To capture the distal effect of the change programme on productivity and well-being, summative evaluations are planned on a yearly basis as part of the workplace innovation maintenance process.

Discussion

Intervention Mapping is analogous to route mapping in which a route planner determines where she is now and plans the way to find a destination (van Doorn & Blokland, 2014). Similar to a mapped route, IM planners create visual information aids such as tables and diagrams that function as landmarks on their route. But, the route mapping analogy does not fully describe what the IM development process entails. Unlike a road map, the route toward programme completion must be created during the IM development process and it is common to return to former positions and partly rerun the process. That is why IM landmarks or even large parts of the development landscape must often be adapted by renewed insights during the developmental process (Bartholomew et al., 2016).

The usefulness of the IM protocol to plan sustainable WPI can be more fully understood by realizing that IM allows for the integration of scientific and practical knowledge to create the best possible understanding of the local need for WPI. IM prescribes an intervention developmental process that starts with assembling a multidisciplinary planning group, proceeds with prescribed development steps that include iterative checks of design decisions, and anticipates programme implementation and the evaluation of its effects (Bartholomew et al., 2016). The protocol has been used to evaluate earlier intervention programmes and has shown that change applications are often based on intuition, do not account for potential environmental barriers and are not tailored to what the environment needs (Schaafsma, Stoffelen, Kok, & Curfs, 2013). Therefore, the IM framework can help interventionists to avoid pitfalls that are still common in many interventions and which are listed and explained in the final discussion section.

Lessons learned from IM to avoid common pitfalls in the development and implementation of WPI

The IM protocol is the refined product of more than a decade of experience in intervention design, implementation and evaluation. The protocol is also meant to avoid a number of problems and pitfalls that have tended to hamper or even preclude the effectiveness of many organizational interventions in the past (Bartholomew et al., 2016) and may also weaken the effectiveness of WPI development and implementation.

These factors are compiled into the following recommendations that assume that interventionists take the time to become well-versed in applying the IM protocol to establish WPI:

- **An intervention objective solves an identified problem.** The IM protocol prevents interventionists from starting too early with specifying specific change applications. Interventions that fail to perform a proper analysis of the problem are often unable to produce a causal model that defines the problem and its potential solution. For example, practitioners may mistakenly think that simply informing employees that they should voice their opinions will lead to WPI. Instead, interventionists must be able to perform a proper investigation to chart the problem as it occurs in the context of the entire organization, and create WPI within the boundaries of the commitment and (financial) support by the client.

- **Change programme is both theory-based and practice-oriented.** The IM protocol requires interventionists to become well-versed in selecting theoretical change methods. IM is not meant to create new theories, but intends to apply existing theories, but only if they fulfil three requirements (Bartholomew et al., 2016). First, theories should provide well-described behavioural change methods that clearly indicate cause and effect of the behavioural change. Second, the method should have strong support from scientific research. And third, the planning group should be convinced that the change method is appropriate to be translated into a tailored and effective change application that contributes to establishing WPI.

- **Programme development requires both involvement and commitment of the involved individuals.** From the start, IM involves the basic target groups, organizational management, and perhaps even governmental and union representatives. These groups are represented in the planning group and their involvement and commitment defines the scope of the political and financial support to the programme to establish WPI within the context of the organization. Past interventions that failed to establish full support and commitment often experienced difficulties during programme finalization and implementation. This even applies to the actual implementers of the programme. In fact, the change programme will be ineffective if these implementers lack the proper training and commitment. It is essential that programme planners guard the entire process from training these individuals to the period in which they actually implement the change programme (Durlak, 1998).

- **Change programmes target individuals.** IM prescribes that any change objective
  starts with individuals who may function on diverse levels within the environment. This also applies when establishing WPI in the local context requires alterations of the infrastructure. These changes start with the beliefs and intentions of
  those individuals (for example upper management or even union representatives)
  that can realize the support to establish such a change. IM makes this possible as
  it combines person-oriented with ecological viewpoints and regards individuals as
  embedded in an environment that consists of interrelated levels.

- **Intervention programmes identify barriers to change applications.** Many interventions only target employees on the work floor and thus fail to identify potential (environmental) barriers. Instead, the IM protocol specifies that change plans
  target diverse interrelated levels and that change applications may be affected by
  environmental influences from the same but also from alternate ecological levels.
  Individuals on higher levels (e.g., upper management) may act as facilitators of a
  behavioural change on the work floor but also to support necessary environmental
  changes such as workplace redesign.

- **Interventionists fully document the development process.** IM requires programme
  planners to document the entire planning process. These required documents provide a detailed and active history of the development process, make it possible to
  return and evaluate and, possibly, adapt earlier design decisions. These documents
  also provide the criteria for evaluating the change programme's proximal and distal effects. The documentation should distinguish what will be changed from how
  it is changed (Schaalma & Kok, 2009).

- **Interventionists must plan the evaluation of both the programme development
  process and of the programme's effect.** The two types of evaluation provide invaluable information and are required to gain a complete overview of the effectiveness of an intervention programme. Evaluations should bring clarity as to why an
  intervention to establish WPI is or is not effective (Coffeng et al., 2012).

To conclude, Intervention Mapping is a promising protocol to develop, implement,
evaluate and sustain effective WPI. The approach establishes individual and
environmental changes via the behavioural change of individuals that function
on diverse interconnected levels within an ecological environment. Experienced
interventionists instigate and supervise the development process according to
protocol. They form a participatory planning group, perform a problem assessment

and resource analysis, and plan, implement and evaluate evidence and theory-based change applications tailored to the organizational context (van Doorn et al., 2015; van Doorn et al., 2018).

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Integrating Lean and employee involvement in developing the work process and well-being in a hospital setting

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Abstract

This paper describes an intervention project on how to integrate psychosocial risk control and Lean methods. Six Danish hospital wards participated in an intervention study aimed at developing a work innovation tool, combining the workflow analysis in Lean with well-being improvement activities. The methodology builds on value stream mapping (VSM) and aims to improve communication by enhancing relational coordination. Groups of employees carry out VSM of selected processes, follow up with the collection of data on these processes, and develop suitable solutions for them. The evaluation shows that VSM provides new insights, which help employees identify and implement improvements and that these improvements most often have a positive effect on both well-being and production. Employee participation is crucial, but external facilitator assistance to the wards is needed for proper implementation.

Introduction

Hospitals in Denmark and most other countries are under severe economic pressure, due to increasing demands from patients, new expensive treatment possibilities, and limited public budgets. This, in turn, demands increased productivity on the part of staff. Hence, staff experience constant pressure to deliver more, make faster decisions, and coordinate with an increasing number of other professions and units, both in and outside the hospital (Gittell, 2009). This development may have adverse consequences for the staff, such as increased work overload, stress, and burnout, given that they feel hampered in delivering the required quality of care to patients (See an overview in Westgaard & Winkel, 2011).

Since the early 2000s, lean management (Liker, 2004) has become one of the most important tools employed by hospital management in their effort to meet the requirements for productivity increases. In general, the productivity results of lean are mixed (D'Andreamatteo, Ianni, Lega, & Sargiacomo, 2015; Hasle, Edwards, & Nielsen, 2016; Prætorius, Hasle, Edwards, & Nielsen, 2015), the consequences from an employee's perspective are debatable (Hasle et al. 2012), and there is very little research on lean in hospitals (See an example in Ulhassan, Westerlund, Thor, Sandahl, & Schwarz, 2014). Importantly, lean has been criticized for leading to increased work pressure (Harrison, 1994; Landsbergis, Cahill, & Schnall, 1999). However, more recent research developments are painting another picture. Reviews are showing that lean in simple manufacturing work may have a negative impact, but not necessarily in more complex work (Brännmark & Håkansson, 2012; Hasle et al., 2012). Especially in hospitals, several studies indicate that the impact often is more positive than negative (Dellve, Williamsson, Strömgren, Holden, & Eriksson, 2015; Ulhassan et al., 2014). Therefore, one could argue that the effects of lean may depend on how it is applied in practice and to what extent the employees are involved (Hasle, 2014; Holden, Eriksson, Andreasson, Williamsson, & Dellve, 2015).

Employee participation is emphasized in the lean philosophy, yet it may not always be stressed in practice (Hasle, 2014; Womack, 1996). Importantly, previous research suggests that it may have positive effects for the employees (Bamber et al. 2014; Cullinane et al. 2014). As the work pressure in hospitals originates largely from productivity demands, to date, it is not clear whether lean can be used not only to

improve productivity, but also to ease pressure on staff via a focus on participation and, thereby, develop local possibilities for workplace innovation. In this article, we pursue an answer to this question.

Our starting point is Value Stream Mapping (VSM), which is a key tool in lean (Rother & Shook, 2009) and which has proven useful in the context of hospitals (Henrique et al., 2015). VSM is a participatory tool for mapping flow and for the identification of value adding and non-value adding activities, which, subsequently, can be used for process improvements (Rother & Shook, 2009). Insights into the work process can potentially also be used to identify occupational health and safety risks and possibilities for improvements (Jarebrant et al., 2016). We developed a participatory methodology based on VSM aimed at the improvement of the psychosocial work environment (such as control, qualification demands, job demands, social support, feedback, clear job tasks, job security, and reward) (Kristensen, 1999).

We tested the methodology in a qualitative case study in a large university hospital in Denmark. In the following, we present the development and testing of the methodology, discuss how hospital professionals may overcome potential challenges in using the method, and end with a discussion and conclusion regarding the implications for research and practice. As such, we aim to show that a VSM-based methodology focused on employee participation can lead not only to improvements in the psychosocial environment, but also to productivity improvements.

Background

Hospitals can be characterized as professional bureaucracies (Glouberman & Mintzberg, 2001a, 2001b), which are dominated by strong professions – first and foremost, doctors and nurses, but also by other professions such as physiotherapists and lab technicians. The work in hospitals is based on the professions taking their own decisions about proper treatment and care. Hospitals can thus be depicted as organizations in which the professions have a relatively high level of control over and autonomy regarding their own work. Moreover, given that the different professions have typically been in charge of changes in treatment and care (e.g., the introduction of new medicines and technologies), they have, enjoyed relatively high levels of participation in decision-making. However, this professional autonomy and level

of participation is increasingly under pressure. Politicians and management require productivity increases. For instance, there is an increasing focus on improving waiting lists, shortening discharge time, and limiting the professions' control over economic expenditures in line with new public management (Hood, 1995). In addition, individual autonomy is also under pressure as each employee becomes more and more dependent on collaboration with other employees due to the increasing complexity of treatments (Adler, Kwon, & Heckscher, 2008; Gittell, 2009). The consequence of these developments is increased work pressure for employees (Westgaard & Winkel, 2011).

One particularly important problem is the increasing demand for coordination between individuals, professions, and between wards. One way of addressing this issue is through improving relational coordination, which is defined as a mutual reinforcing process of communicating and relating for the purpose of task integration (Gittel 2009). Relational coordination implies that communication is frequent, timely, accurate, and problem-solving, which, in turn, would lead to shared goals, knowledge, mutual respect, and improved quality of communication. Relational coordination has been shown to increase employee well-being, which, in turn, has been linked to improved task performance (Gittell et al. 2008 a; Gitttell et al. 2008 b). Furthermore, the improvements are based upon employee knowledge regarding which part of the communications stream in the organisation needs to be improved.

Employee knowledge and participation have furthermore been described by the original lean authors as crucial (Womack & Jones, 1996; Womack, 1996), and participation is, in many cases, found to be a part of lean practices (Shah & Ward, 2007), although lean implementation can also be dominated by management with adverse effects for employees (Stewart et al., 2009). With the point of departure in participation, the lean philosophy follows the consensus in both human resource management and occupational health and safety (OHS) research that participation is essential both for the employees' well-being and for the successful outcome of organizational processes. The importance of participation has a long tradition in research (Emery & Thorsrud, 1969; Karasek & Theorell, 1990). Later research has also proven that not only is control of one's own work important, but also participation in changes (Saksvik, 2009), and more recent reviews confirm the importance of participation (Egan et al., 2007).

However, participation is not necessarily easy to achieve in practice (Boxall & Winterton, 2015). For instance, management may intend to stay in control. They want to feel secure that the employees will follow the management defined framework and in cases of change, they want to ensure that the management's objectives are achieved (Kotter, 1996). Moreover, employees may also evade participation in order to avoid responsibility or due to a lack of necessary competences. To summarize; employee participation is seen as crucial in both the lean philosophy and in improvement processes regarding the psycho social working environment. Nevertheless, employee participation seems to be more complicated in practice, and there is a general dearth of methods available, to help organizations navigate improvement processes.

So far, we have argued that hospitals are in need of new methods that can be used for the improvement of the psychosocial work environment, and we have found such an opportunity in lean management, in particular in the lean tool VSM, as it can be used to focus on both relational coordination and staff participation and can be compatible with the dominating efficiency agenda in hospitals. In the following, we will show, how this was achieved in five hospital wards.

The intervention study

Our study was conducted in a University hospital in Denmark. The hospital has 690 beds and covers both emergency and elective treatments. It has 4400 employees divided into 25 departments. The hospital has organized the OHS management system in accordance with Danish legislation, with an OHS committee at the central level and OHS groups in each department consisting of an elected OHS representative and a management representative. The OHS committee and groups are supported by an organizational development and OHS unit comprised of five professionals. The hospital implements workplace assessment (the Danish version of risk assessment) every three years. To measure psychosocial factors, the hospital has used a questionnaire following the general guidelines from The Copenhagen Psychosocial Questionnaire. The idea was to use the survey results to make action plans for improvements. However, the experience from this activity has been, at best, mixed. Many departments have found it difficult to transform the survey results into practical changes. Therefore, the hospital has been looking for alternative possibilities for the improvement of psychosocial factors, and accepted our invitation to participate in

the development and testing of an intervention methodology, aimed to address the following research question:

How can a dialogue-based and employee participative intervention design improve the workplace capacity to design improvements addressing work processes and well-being simultaneously?

The design of the intervention is based on the following sources:

- The **literature** on lean, VSM (Jarebrant et al., 2016; Rother & Shook, 2009) and participation (DeJoy et al. 2010; Nielsen, 2013; Van Eerd et al., 2010).

- The **context** of the hospital regarding the general organizational development as well as the particular experience with lean and workplace assessment.

- The **experience** of the consultants and researchers from a large number of former intervention activities, particularly based on the concept of Relational Coordination (Gittel 2008, 2009).

We have named the intervention methodology P-lean (for psychosocial factors intervention with lean). The intervention project was developed as a collaboration between researchers, management, and staff at the university hospital. In the spring of 2013, hospital management, the OHS committee, and the researchers agreed to organize an intervention project, for which the goal was to develop new methods based on lean for improvement of the psychosocial work environment. The intervention project was organized with a project group, a research group, and a steering group. The project group had the responsibility for the activities in the project and consisted of two hospital consultants and four researchers. The research group developed the intervention design and analysed the project results. The steering group comprised representatives from the hospital central cooperative committee, with the Deputy CEO as chair and one of the hospital consultants as secretary.

Methodology

It is a challenge for the design and evaluation of organization level interventions to separate the impact of the intervention programmes from other inside or outside changes to the workplace (Cox et al., 2007; Nielsen, Randall, Holten, & Gonzalez, 2010).

Realist evaluation theory provides a possibility to secure a theory–based design of the intervention (Pawson & Tilley, 1997). In the realistic evaluation, the main question is 'What works for whom, in what circumstances, and how?' Realistic evaluation builds generic theory of changes into complex social intervention programmes considering the context. This is performed through investigation of the change mechanisms in the intervention:

"Intervention works when the resources on offer (material, cognitive, social or emotional) strike a chord with programme subjects. This pathway from resource to reasoning is referred to as the 'programmeme mechanism" (Ray Pawson, 2003, p. 473).

Realistic evaluation theory has been used for the design of intervention programmes (Hasle et al. 2012), and we have, in a similar fashion, built a programme theory based on the desired outcome, followed by the mechanisms that could initiate this outcome, and subsequently the activities, which could activate the mechanisms. These sets of activities, mechanisms and outcomes were subsequently sorted into phases, which were used to schedule the sequence of the intervention. The intervention phases cover the mandatory risk assessment phases, that all workplaces in Denmark must implement at least every third year.

An overview of the result in terms of the project's programme theory that covers activities, mechanisms and outputs is outlined in Table 1.

Table 1
The Programme Theory for the Intervention in the P-Lean Project

Intervention phase	Activity	Change mechanism	Expected outcome
Decision about project start	• Facilitator presents a meaningful programme theory	• Visible problem • Confidence in intervention programme	• Ward committed to participation in the project
Project establishment	• Management of the ward forms a local intervention group (one management rep and 1-2 employee reps). • The group meets facilitator 8–10 times throughout the project • The group identifies project focus and measures in collaboration with facilitator	• Competencies to implement organizational changes available • Relevant knowledge and tools to implement change	• A project group with the capability to implement the project • Mutual goals identified
Identification of priority problems	• Value stream mapping (VSM) workshop with a focus on problematic work processes and consequences	• New insights in flow, relations with colleagues and problem causes	• A list of relevant priority problems • Shared knowledge • Growing mutual respect
Problem analysis	• The workshop group and the facilitators make observations of daily work routines related to problematic work process • 2nd VSM workshop focusing on problem causes	• Comprehension of the causes to prioritise problems based on facts	• Problem causes disintegrated from personalities • Shared platform for development of solutions • Growing mutual respect
Development of solutions	• 3rd VSM workshop focusing on development of solutions • Creation of indicators for measurement of achievements	• Realistic and beneficial solutions	• Relevant solutions for pinpointed problems • Reflections on how to make solutions possible
Action plans	• Project group, supported by facilitator, draws up action plan including goals and indicators for impact • Allocation of resources for the implementation of activities	• A transparent implementation process • A manageable and realistic process with the necessary resources	• An implementable action plan • Commitment to implementation
Implementation and follow up	• Implementation of improved work processes • Whiteboard meetings to follow up on progress • Collection and publishing of data on indicators	• Enthusiasm that this will actually work	• Improved work processes • Improved well-being and job satisfaction

As Table 1 shows, the key mechanisms are the creation of motivational resources based on a shared learning process initiated by the activities. The activities are based on a combination of traditional project management and lean. One of the key aims was to provide concrete and transparent data about the workplace, which on the one hand provide the platform for the development of relevant improvements, and on the other, create confidence in the project. Another important point was to allocate professional facilitators to the activities in the wards to support the application of the methodology. In this respect, there were 2 consultants for the development and OHS unit in the hospital.

The design was tested in a pilot project in a ward specializing in lung diseases and, subsequently, adjusted based on feedback from the pilot test. The intervention in each ward consisted of:

- A small planning group, meeting 8–10 times with their appointed facilitator throughout the project duration of 6 months.

- Three VSM workshops which aimed at improving challenges in the psychosocial work environment for selected work processes. Six to eight employees participated as representatives of all involved staff groups together with the planning group. The workshops were facilitated by internal lean and work environment consultants from the hospital.

- Observations and registrations of the wards' daily work routines between the three VSM workshops.

- Action plan and follow-ups integrated in the structure ward meeting and in the planning group meetings.

Selection of intervention wards

The possibility for participation in the project was announced to all wards in the hospital. The research group had established three criteria for participation: 1) the ward should not experience severe internal conflicts, bullying, or harassment; 2) the ward should not be involved in extensive organizational changes and, 3) the ward should express sufficient engagement in the project and provide the resources in terms of time and representatives for all relevant professions. Seven wards volunteered for the project. However, given that two wards did not fulfil the criteria, the intervention was implemented in five wards covering different specialties (see Table 2).

Table 2
The Five Participating Departments with the Target Ward in Brackets

	Specialty	No of empl.	Professions	Structure
Z	Department of Clinical Physiology (Urology examinations)	**84**	• Doctors • Lab technicians • Physicists • Nurses • Nurse assistants • Secretaries	• Management: A lab technician and a doctor. • The department consists of several wards and the selected ward is directly controlled by the management of the department
B	Department of Nephrology (Bed ward)	**153**	• Doctors • Nurses • Nurse assistants	• Management: A doctor and a nurse. • The department consists of two wards. Each ward is managed by one doctor and a nurse.
O	Department of Medicine (Bed ward)	**277**	• Doctors • Nurses • Nurse assistants • Physio- and occupational therapists • Secretaries	• Management: A doctor and a nurse. • The department consists of five wards. Each ward is managed by one doctor and a nurse.
G	Department of gynaecology and obstetrics (Gynaecological examination)	**335**	• Doctors • Midwives • Nurses • Nurse assistants • Secretaries	• Management: A doctor, a nurse and a midwife. • The department consists of 11 wards and the selected ward has a doctor and midwife as local management
E	Department of Paediatrics (Bed ward)	**237**	• Doctors • Nurses • Nurse assistants • Secretaries	• Management: A doctor and a nurse • The department consists of two wards. Each ward is managed by a doctor and a nurse.

Evaluation methodology

The aim of the evaluation was to test the applicability of the programme theory. The focus was on mechanisms and outcomes in order to learn whether a lean approach can initiate improvement of the psychosocial work environment and, subsequently, how it can be implemented in practice. We used a qualitative case study research design (Yin, 2009), based on a realistic analytical approach (Maxwell, 2012) in order to find out what, respectively, advanced and hampered the process. Where possible, results from changes in quantitative indicators collected by the wards were included in the data material.

Data collection included the following elements.

- Shadowing the facilitators' activities in the wards.

- Collection of written information including results from VSMs workshops, written plans, information materials etc.

- Interviews with members of the project group, workshop group and other employees three months after the last VSM workshop, with thorough notes taken during interviews.

Data analysis

The data from each ward were analysed by extracting elements that supported and hampered the process as well as the outcome of the process. Subsequently, we compared these elements with the programme theory and the intended mechanisms (Pawson & Tilley, 1997) in the intervention design. The findings from each ward were subsequently presented and discussed in the research group and compared across wards in order to identify generalizable results. The analysis evaluated each of the intervention phases in our programme theory for each ward, looking at both drivers and barriers in the process.

Results from the implementation of the intervention

All five departments completed the project with positive results. However, two departments deviated from the intervention design by either reducing VSM workshops (department B) or completely dropping VSM (Department O), given that the department project group decided that interruptions in the medicine dispensing room

were too disruptive and better dealt with without the VSM. An overview of the results for all five departments is depicted in Table 3.

Table 3
Summary of Outcomes from the Five Participating Wards

	The processes selected for VSM	Project activities	Improvements
Z	The good reception of patients	• Three VSM workshops • Descriptions of morning situations • Observations • Registrations • Patient questionnaires	• A redesign of the reception process (including a new position as team coordinator). • Disturbance from other colleagues during morning planning stopped. • Cooperation and climate improved between receptionist and coordinators. • All patients examined, even those not properly prepared on arrival. No patients are rejected and sent back for a new appointment. • Time for four extra examinations daily identified in VSM.
B	Information in shifts and delegation of job tasks in accordance with qualifications	• One whole day VSM workshop • Facilitator observed morning procedures	• Clear morning procedure for reading patients' information • Delegation through qualifications made transparent.
O	Disruptions in medicine dispensing room	• Registration of interruptions in three dispensing rooms	• The importance of informal communication recognized and moved outside the dispensing room. • Film produced by the employees, showing disturbances in the dispensing room.
G	A good balanced workday. The nuchal scan was selected as the process which most often disturbed the balance of the work day	• Three VSM workshops situations • Interview with patients • Registrations of time used for the scanning methodology	• Small solutions regarding towels, PC's, parking, letters to patients, information signs. • Action plan for different scenarios for reorganizing the whole scan procedure, including the demand for resources and competences.
E	Well-structured workday beginning with well-structured meetings	• Three VSM workshops • Facilitator observed and evaluated morning meetings	• Well-structured and well prepared morning meetings. • Job tasks in line with the competencies of the nurses (and doctors). • Reorganizing teams. • Time outs for coordination. • More respectful communication between doctors and nurses. • Small changes such as moving the coffee table, local medical supply depots etc.

An important barrier for the overall intervention that emerged during the analyses was cross-department communication and activities. Several wards identified problems that were directly related to communication with other departments. An example would be the ward for urology examinations in department Z, where lack of information from the emergency ward during the night shift created planning difficulties. In this case, similar to the other wards, the project groups abstained from raising these issues as they expected them to be too sensitive and would limit the chances for a successful outcome.

Below, we will discuss in more detail the results from the bed ward in the Department of Paediatrics (case E in Table 1 and 2), in order to give a better understanding of the process, the activities and the results of the intervention. The ward is one of the three wards in our study, which closely followed the intervention methodology. The two other wards showed a rather parallel process regarding engagement in the project and the resulting outcome.

Department E: The children's ward

The children's ward at the hospital volunteered for the project due to problems with high staff turnover, flawed information flow between shifts, and staff expressing professional insecurity in treating patients.

One of the reasons for the high turnover in the ward is the winter workload. Children tend to become more frequently ill during wintertime. Many children's lung and respiratory problems worsen during that period and the number of patients increases. Moreover, the work in the children's departments demands highly specialized skills. Patients' ages range from 0 to 18 years and the children can be diagnosed with almost any disease. The nurses are forced to expand their knowledge to all forms of possible diagnosis. This is in contrast to other wards where the number of potential diagnoses is more limited.

The high turnover resulted in hiring relatively new and inexperienced nurses, which reported feeling professionally inadequate. This, in turn, was openly expressed by the nurses as being a main problem for their well-being. Communication problems with some of the older doctors also emerged during the first planning meetings, since a small group of doctors did not consult with the nurses nor did they treat the nurses'

observations respectfully. This was a particular problem at the morning meetings where the nurses reported on the development of the patients during the last 24 hours and presented their assessment of the children the doctors should see first. A small group of doctors disturbed the meetings by constantly interrupting the speaking nurse and by not staying on topic during the meetings. Whereas the department doctor attended the second and third VSM workshops and the managing department doctors were introduced to and provided their support to the project, the problem created by this small group of doctors was not otherwise directly addressed in the project.

In the first VSM workshop, the activities of the whole day shift were put up on a big brown paper in the staff's lunch room. For each activity, problems with the work flow were marked with a red 'post it' and the connected challenges in the work environment, for instance, frustration, irritation, and conflict with other staff members were noted on orange 'post it' notes. 'Green post its' were used for possible solutions and made their way onto the brown paper during the discussion of each work activity. However, the facilitator held back from deciding on a specific solution, trying to make room for a more profound analysis of the challenges and an inclusion of opportunities to learn more though data collection and observations of the daily routine.

The first VSM workshop in Ward E revealed that the morning hours from seven to nine were crucial for the whole day. The problems for the day shift started due to the inability of the night shift to provide relevant and precise information in a short and concise way. Therefore, the two–day shift teams of nurses' day shift experienced a rather turbulent sifting through patients in the two teams they split to, after the night shift had left. The teams tended to shift between distributing patients and sharing information in a setting where staff were coming and going, drinking coffee and missing information. Moreover, the whole meeting session sometimes did not stop before a quarter to eight although it started at 7 am. The ward had a subsequent nine o clock meeting that included both nurses and doctors. These meetings were described by the nurses as a horrifying experience. Especially the coordinating nurse had difficulties. She had the task of providing information about patients and updating information on the electronic screen regarding which doctors should be assigned to which patients. However, the meeting was continuously interrupted by some of the

older doctors who raised irrelevant questions, made disrespectful remarks about both staff and patients, and often started disputes among themselves trying to avoid the assignment of too many patients.

The workshop group decided to improve the two morning meetings. The goal was that the initial meeting at 7.00 am should take only 10 minutes and that the meeting with the doctors should be calmer, more respectful, and should focus on the main agenda for the meeting. The facilitator subsequently participated in the morning meetings and recorded observations from the meetings, which were subsequently presented in the next workshop.

At the second workshop, the nurses were really eager to implement some changes. The facilitator introduced the priority matrix that showed how much effort the ward should invest and the expected outcome. Their suggestions included both small and easy improvements as well as some more extensive organizational changes. The workshop group chose four priority improvements from the first workshop, two rather small (moving the coffee table and local medical supply depots) and two more extensive (the structure of the 7 o'clock meeting and using nurses' competencies in delegating patients in the morning). The group also made an action plan regarding who, how, and when changes in the work processes should start. The workshop took place in the common lunch room and the result of the workshop in the form of the brown paper stayed on display in order to make all the project ideas and priorities transparent.

There were approximately six weeks between each of the three workshops. The facilitator often observed the two morning meetings and, gradually, began to ask at the end of the meetings, how those involved evaluated them. Gradually, the morning meeting changed to become more structured, and the nurses, both those responsible for the day and the night shifts began to prepare themselves for these meetings. Still, the turbulence created by the doctors was more difficult to resolve.

Before the third workshop, the planning group received information that two of the older doctors would retire in a few months and that the third one had received a warning from the managing doctor. The workshop group continued working on developing the two morning meetings, discussing the different scenarios they had experienced and how to deal with them. They shifted from sitting down in two groups

to standing in front of the whole group before the electronic screen during the first morning meeting. Regarding the idea of better using the nurses' competencies in patient assignments, they made the assistant chief nurse responsible for this part of the morning meeting, securing a balance between the considerations regarding knowledge of patients, need for education, and the workload for each nurse.

Information to the whole staff about the progress of the project as well as the issues selected for discussion was secured by weekly newsletters from the head nurse.

At the three month follow up, the researchers observed the two morning meetings. The first meeting took place in front of the electronic screen, where the night nurses delivered well-prepared information about the patients. After 10 minutes, the night shift left and the assistant nurse took over assigning patients to the nurses – according to their knowledge of the patients, their diagnosis and the competence development plan. At 7.20 hours, everybody was with their patients and the nurses subsequently returned to the screen and noted the latest information. At a quarter to nine, a new meeting was organized in front of the electronic screen. Two nurses went through the patients together with the doctors for about 10 minutes and then left them to their own delegation of patients.

In the subsequent evaluation, the head nurse, assistant head nurse, the doctor, and three nurses were interviewed about the process and the outcome. All interviewed persons expressed that the project had made the workday much more structured and calm and secured the necessary information for everybody. The previous chaotic and long-winded meetings were over, leaving more resources to concentrate on work with patients and their families. What had surprised them was that their need to organize the day shift in two teams had disappeared. It was possible to meet as a whole group, sharing precise information as well as having spare time to meet for time outs and help each other across the whole department.

The head nurse expressed her interpretation of the outcome of the project by asking the facilitator just before the third workshop:

"Couldn't we expand the project to a period of three years? It is changing so many things and involves the staff in a way that I did not dare to dream of. But we need to keep you as facilitator; we are not able to do this ourselves."

The evaluation interviews showed that the ward undertook a long series of changes on how information was delivered using structured, precise and relevant communication. This led to a more structured way of delegating tasks and following up on one's own tasks. It also increased the capacity to help colleagues when necessary, because they had the necessary overview. The department has made many changes in organizing such as moving the coffee table, meeting space, reception desk, and small medical equipment depots. However, what the evaluation interviews revealed was that they had developed a new way of discussing and solving daily work processes, and, this, in turn, led to more empowerment and mutual help and understanding between the different staff members.

Discussion

Hospitals constitute a typical example of a professional bureaucracy (Glouberman & Mintzberg, 2001a). It is therefore well in line with the problem of professional silos that communication and coordination proved to be the focus points for all the intervention wards. Indeed, when constraints appear in their work, people are inclined to attribute the resulting problems to persons and personalities rather than to the organization of the workplace. It is therefore key to understand and solve these problems to improve social relations in communication and coordination.

This study demonstrates that the P-lean tool – value stream mapping (VSM) – provides new opportunities for hospital wards to identify, understand, and improve their communication processes. The participation of the staff opened the way for a mutual discussion of possible improvements and secured support for the implementation of new procedures and a clarification of roles. Instead of pointing the finger at other people or at the overall structure and lack of resources, it was a relief for those involved that, by focusing on often very small micro processes, the workflow became transparent and it became much easier to find possible solutions.

VSM opens new insights into the processes and the flow connecting the processes, which facilitates a transfer of the problem-framing from one of personal conflicts to one of the organization of work. The involvement part of the VSM process resulted in two main lessons. The first one is that only employees have the necessary in depth, practical knowledge of the process in order to carry out a VSM, which digs sufficiently

deep to create new insights. The second one is that solutions can only be identified, accepted, and implemented in practice if they are meaningful for the employees and if, and when, the solutions integrate both a consideration of patient care and employees' psychosocial work environment.

The study also found that, whereas, the improvement activities regarding the structural and between-wards challenges were addressed in the project and the VSM workshops, they were not solved in the further process. This suggests that the design is able to make incremental changes and improve areas within the wards' own work area, but is not able to spur more radical changes outside the wards, nor change structural work process challenges across the hospital. One of the constraints for the test of the P-lean methodology is, therefore, the lack of experience with cross-departmental issues such as the transfer of patients from one ward to another. All the wards chose to work with their internal problems first as explicitly shown by the ward E case. The employees apparently do not believe that they have sufficient power within the hospital to initiate changes across wards, even though they are able to correctly identify and describe the structural problems in the hospital.

The results indicate that outside assistance is needed for successful achievements. While the ambitions of the design were to create a self-implementable methodology, the wards lacked sufficient competence and outsiders were needed to help create the momentum necessary for progress. Since larger hospitals in Denmark, and probably also in many other industrialized countries have access to internal consultants with expertise in HR, OHS, and/or lean, it should be possible to accommodate this requirement. Especially since the intervention takes place within a limited timeframe.

Conclusion

Value stream mapping has the potential to give the staff at hospitals important insights into their own work as well as the work of their colleagues. It is an insight, which is normally blurred by the daily requirements for immediate response and fast decisions as well as the large number of relations with other staff members. It follows from the literature as well as from the experience of testing P-lean that such a methodology needs strong commitment from management and support for the technical implementation as well as a strong adaptation to each local context.

In this intervention, it proved possible to integrate the productivity and the psychosocial work environment issues. The focus on the cross-professional work flow and creating value for the patients was important in order to avoid a clash between the two. In fact, the direct improvement of work performance had an indirect positive impact on the experience of frustration, irritation, and feelings of insecurity regarding both one's own competencies and the safety of the patients.

Our study highlights that it is the communication process (or relational coordination) which is the key to successful results. The need for coordination in hospitals is huge and P-lean represents one possibility to identify, understand, and improve the day to day practical communication.

The study shows how a participatory and facilitator-supported process can be designed and implemented to make improvements in the work processes, which result in direct improvements of the work processes and indirect improvements of the OHS in the workplace. We hope, that his integration of both improving the work itself and the wellbeing of the staff conducting the work, will inspire more organizational psychologists to design and test more integrative improvement methods.

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Conceptualization of community-based entrepreneurship: A case study of Ecofiltro in Guatemala

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Abstract

Workplace innovation and community-based entrepreneurship (CBE) constitute a powerful combination which, if leveraged, could potentially solve society's most pressing problems. This case study illustrates how an entrepreneur, Philip Wilson combined these two elements to pursue the ambitious goal of taking clean water to one million families in Guatemalan rural areas by 2020, through his organization, Ecofiltro. The research was conducted between 2014 and 2015 in three rural Guatemalan communities. Historical data, observations and semi-structured interviews with Ecofiltro representatives, community leaders and customers were used as data collection methods for this exploratory study. The main objective was to gain a deeper understanding of what made the firm successful in achieving its ambitious goal, whereas other enterprises, mainstream non-government organizations (NGOs) and government institutions fail in solving social, health-related and economic problems. Findings reveal an ingenious workplace innovation led by a visionary leader and a way of organizing which extends Ecofiltro's workforce by drawing from the local community; a simple yet powerful water filter which fits with the local culture.

Introduction

The lack of success of many governments and mainstream non-government organizations (NGOs) in solving developing countries' most pressing problems (see, for example, Chowdhury, 2017) has contributed to the rise of a new type of actor:

The community-based entrepreneur. This individual, like other entrepreneurs, is characterized by her ability to find and create business opportunities and sometimes even innovatively destroy current value-creating initiatives (Schumpeter, 1939). However, her goals concentrate on solving social problems sustainably rather than only pursuing profits.

There are certain contexts which favor the emergence of community-based entrepreneurs more than others; namely, developing countries. Guatemala, which we focus on, is a good example of such a context and there are two main reasons for this. The first reason is that community-based entrepreneurs emerge partly in response to government's and NGOs' inefficient and unsustainable dependence on tax collections and donations, respectively. Second, often well-intended foreign donations generate complacency as well as dependency in the recipient country, thereby reducing the desire to overcome unfavorable circumstance through other initiatives. In Guatemala, the above have fostered a vicious cycle of a paternalistic relationship between recipients and donors, characterized by a sense of victimization and entitlement to receive aid without taking responsibility for finding solutions. This has resulted in NGOs' and the government's poor performance leading to poor social and economic development results.

Interestingly, certain rural communities played a significant role in overcoming the economic and social development stagnation caused by a 36 years long civil war, which officially ended in 1996. Rural communities had received aid from multiple entities including religious ones, thereby enabling the emergence of local leaders and communal organizations. That is why, when a growing number of local and foreign entrepreneurs realized that a shift in focus was needed to provide an effective and sustainable answer to the rural population's basic needs such as clean water, education and nourishment, they found a fertile ground for development.

In the following, we present a case study – the story of how Philip Wilson and his organization, Ecofiltro, tackled the lack of clean water in Guatemalan rural communities. Philip Wilson, Ecofiltro's CEO and a Guatemalan Wharton MBA graduate, found the above to be the ideal conditions to construct a successful business model to solve the clean water problem: Community-based entrepreneurship (CBE), which combines communities' self-organization capabilities with business acumen.

In this article, we show that the success Ecofiltro has achieved has not been straightforward; instead, it has been the result of a painstaking trial and error process in working with the local communities.

Context

As Philip Wilson was driving towards the outskirts of Antigua Guatemala glancing with awe at the stunning landscape, he could not help but think about the huge mission he had set for Ecofiltro: "To reach 1 million rural families with clean water by the year 2020" (Ecofiltro, 2015).

He had embarked on a challenging journey to solve one of the most pressing problems that rural Guatemala has always had: Lack of clean water. Furthermore, this was only one of many interrelated challenges that a 16 million population, with an annual per capita income of just $3,915 is facing. Of the total population, 62.4% are poor and 29.6% live in extreme poverty (UNDP, 2015) and the impact of poverty is striking. For example, low income and illiteracy contribute to 49.8% of children younger than five years old suffering from chronic malnourishment and 2.2% dying from protein-energy malnutrition. Additionally, three per 1,000 children die from diarrheal diseases, related to a lack of appropriate sanitary conditions and contaminated water consumption (WHO, 2015). Approximately 97% of water streams in Guatemala are contaminated with fecal bacteria and 50% of the population in rural areas lack access to clean water (Wilson, 2015a).

Even people living in cities, though, may suffer from gastrointestinal diseases, should they consume water directly from taps. Hence, most families usually purchase bottled water, and higher-income minorities rely upon water-filtration technologies such as ozone filters. The city dwellers, on average, spend almost $200 per year per household on bottled water. For people in rural areas this means collecting water from river streams or wells, and then boiling it over open fires. This means that they may spend from $20 to $40 monthly in wood for combustion, depending on the size of the family and the wood prices. Given this context, it is evident why Philip decided to tackle the challenge of sustainably providing poor communities with clean water.

Case Study: Ecofiltro

This research was conducted as part of a university-industry collaborative endeavor (Sobrero, 2013) between 16 Entrepreneurial Engineering students from a Guatemalan University and Ecofiltro during the second semester of 2014 and the first semester of 2015. In order to gain access to the firm, we proposed an action research (Reason & Bradbury, 2008) project to Philip Wilson so that we could help him accomplish his firm's mission statement:

[Ecofiltro] *"…has a very clear social objective: To reach 1 million rural Guatemalans with clean water by the year 2020…[it] will always use financially sustainable methods to reach this goal and [we] will always remain open to sharing [our] production process and marketing tactics with any outside group that wants to solve the water challenge…"* (Ecofiltro, 2015).

The project's aim was to help Ecofiltro gain an understanding of the most effective way of introducing the filter to new communities. Due to its accelerated growth, Ecofiltro was entering new rural communities and the resulting social, economic, educational and cultural differences were complicating the filter's effective commercialization. We thus offered help in gaining a deeper understanding of rural communities' perceptions (Bauer & Gaskell, 2000), health concerns, and purchase power in order to refine the filter's commercialization process.

Ecofiltro was chosen due to its distinctive approach to solving a pressing social problem. The approach is based on a form of CBE which actively involves community leaders in organizing people. This form of CBE differs from the one proposed by Torri (2009) in two ways. First, for Torri (2009), CBE is a community-generated enterprise created to solve local problems, whereas Ecofiltro is an external enterprise which expands its operations into local communities, helping them solve local problems by making use of community leaders to drive the engagement of the larger community. This constitutes a very novel way to operate an enterprise and a good example of workplace innovation (McMurray, Islam, Sarros, & Pirola-Merlo, 2013). Second, Torri's (2009) CBE is a collaboration run by the community members, whereas Ecofiltro is run by a CEO using an organizational structure similar to a for-profit enterprise.

However, these are precisely the two factors which make Ecofiltro a unique form of community-based enterprise, and reflect our main motivation to understand the success of this workplace innovation in greater depth (McMurray et al., 2013).

Research Methodology

We employed a single case study design (Yin, 2003) which consisted of historical (secondary) data, semi-structured interviews and participant observation in the communities and at Ecofiltro's headquarters. Considering that it was necessary to gain deep knowledge of the field operations despite the time constraints of Ecofiltro personnel and the students, a combination of qualitative methods was used as suggested by Burgess (1984). The interviews were fully transcribed and interpreted using thematic networks to structure unsorted data as suggested by Attride-Stirling (2001). The historical data were gathered from the firm's website, newspapers and magazine publications.

Semi-structured interviews (DiCicco-Bloom & Crabtree, 2006) were conducted with eight field representatives of Ecofiltro who were in charge of promoting the filter in the communities. The CEO, the filter's inventor, and the operations manager were interviewed, as well as the community leaders. These included interviews with two leaders of two communities in the Guatemalan South Coast, and two interviews with two community leaders in The Highlands. By doing this we aimed to capture the cultural differences between the communities as suggested by De Walt, De Walt and Wayland (1998). Additionally, four interviews were conducted with customers from each of the four communities. Participant observation was conducted during two Ecofiltro presentations at The Highlands' communities and two at the South Coast. Table 1 summarizes the data collection.

Table 1
Summary of the Data Collection

Interviewee	Instrument	Number
CEO of Ecofiltro	Semi-structured interview	1
Operations manager of Ecofiltro	Semi-structured interview	1
Inventor of Ecofiltro	Semi-structured interview	1
Field representatives of Ecofiltro	Semi-structured interview	8
South coast community leaders	Semi-structured interview	2
Highlands community leaders	Semi-structured interview	2
South coast community leaders	Semi-structured interview	8
Highlands community leaders	Semi-structured interview	8
South coast community customers	Participant observation	2
Highlands community customers	Participant observation	2

Meta-findings and theory-development

In the next sections, we present our findings as meta-findings integrating the history of Ecofiltro, semi-structured interviews and observations to refine the understanding of the concept of CBE. We define meta-findings as the results of analyses using various sources of information to arrive at a holistic theoretical overview of the focal concept and its implications (c.f., Marcus, 1995).

Key Insights from the History of Ecofiltro

Ecofiltro´s origins can be traced back to the Central American Institute for Industrial Research and Technology (ICAITI in Spanish), founded in 1956 as a regional technology transfer office to support Central American firms. In 1980, ICAITI was commissioned to develop a solution to provide clean water to poor rural areas in Central America. Fernando Mazariegos, a Guatemalan scientist from ICAITI led the project. His team discovered that people purified water using chlorine or by boiling it which, although effective, generated a flavor that people disliked. This led them to look not only for a technical innovation, but for something that people would adopt.

There are a number of potential reasons why the solution to the issue could be found in the filtering stage of the process. First, filtering could prevent water from tasting bad. Second, it had the potential to be a culturally acceptable solution, easier to adopt and diffused, given that historically, indigenous people from Central America had been collecting water using clay pots. Although in recent years, plastic had reduced the use of clay containers, probably as an inexpensive, more robust and light material, ceramic pots were still being widely used for cooking. Third, its production could generate new jobs, because ceramic could be used as a base material for a filtering device, generating additional work for ceramists who made a living out of producing decorative clay handicrafts.

The team experimented with and combined pinewood sawdust with clay to create a ceramic filter. Pinewood sawdust had the advantage of not altering water's taste and had the additional advantage of being transformed into carbon when exposed to high temperatures. Carbon has chemical properties which eliminate odors, colors and flavors from water. Clay, given its malleability, could be shaped into different designs and would offer porosity so that the water could be filtered. The third material used became colloidal silver, which eliminates bacteria. With these three materials, Fernando and his team developed what later on would be named the Ecofiltro (Figure 1).
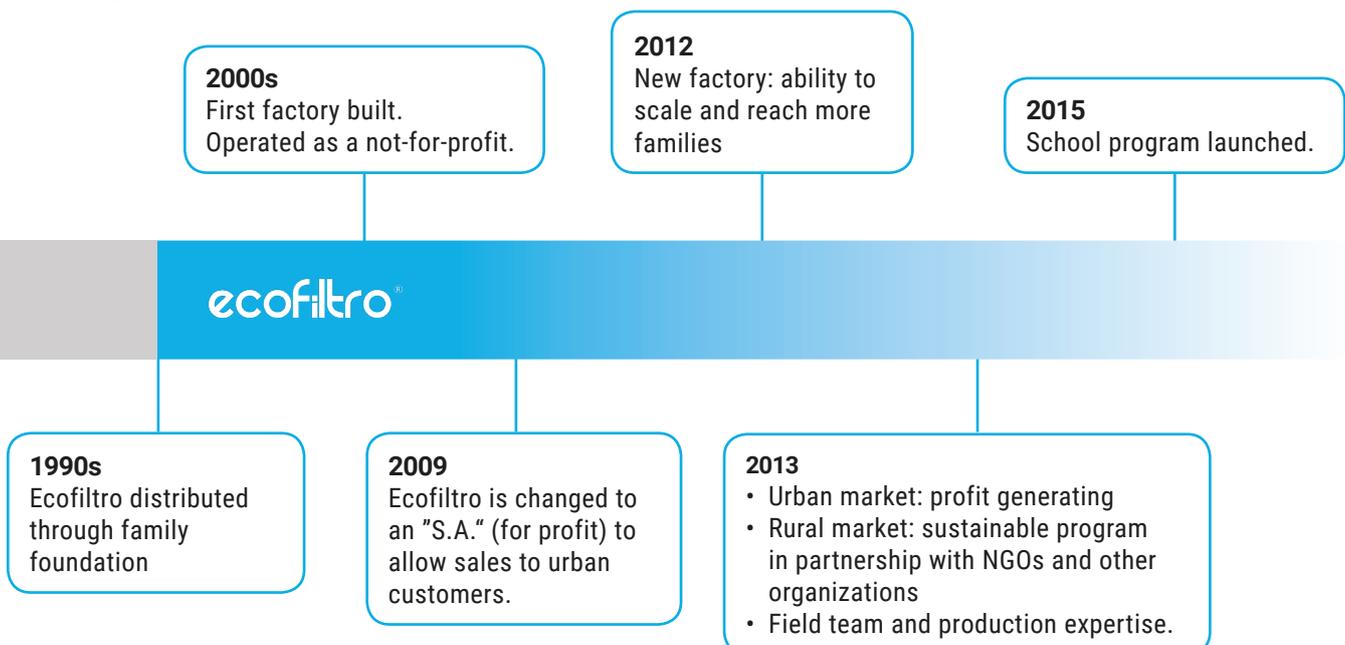
Not long after the first filter was developed in 1980, Fernando presented it at a Latin American Health and Environmental Engineering conference where it received its first award out of more than 30 international honors and recognitions by 2015. The filter has been so successful that, currently, there are more than 59 factories producing it across 37 countries in America, Asia and Africa. ICAITI folded in 1998 and, despite having been able to submit patent applications, Fernando decided to never claim the Intellectual property (IP) as his contribution to humanity. His views have not changed to date, despite the filter's great success. Fernando has humbly shared how pleased he was when a group of Harvard graduates who founded a factory in Uganda told him to 'feel good' about the 2.5 million more people who were going to be added to the long list of those who had already benefited from his invention.

It took almost 30 years for Ecofiltro to transition from a great invention in the early 1980s to become a successful innovation by 2009 (Figure 2). The transition started

Figure 1. Fernando and Ecofiltro

Fotografía:
Rodrigo Vela / © Revista Sala

Figure 2. Ecofiltro's Timeline

2000s
First factory built.
Operated as a not-for-profit.

2012
New factory: ability to
scale and reach more
families

2015
School program launched.

ecofiltro®

1990s
Ecofiltro distributed
through family
foundation

2009
Ecofiltro is changed to
an "S.A." (for profit) to
allow sales to urban
customers.

2013
• Urban market: profit generating
• Rural market: sustainable program
  in partnership with NGOs and other
  organizations
• Field team and production expertise.

when, in the early 1990s,Fernando met Philip's sister, Mrs Dominique Wilson, a nutrionist and social worker who was leading a family-owned foundation called Familia Guatemalteca de las Américas (Americas' Guatemalan Family). She met Fernando by chance while waiting for a meeting at a government office. They started talking and the filter came up during the conversation. She saw its potential and suggested that the foundation and Fernando run an "acceptability" research project to test the likelihood of the filter's diffusion. That is how Fernando – along with other five scientists from Harvard University, Universidad Rafael Landívar from Guatemala, the World Health Organization, the Panamerican Health Organization, the Instituto de Nutrición de Centroamérica y Panamá (Central America and Panama Nutrition Institute (INCAP)) – undertook a two-year study during the early 1990s.

These results showed that those families who had received education about health alongside using the filter had managed to reduce gastrointestinal diseases by 55%. This was encouraging and resulted in Fernando and the NGO setting up an artisanal workshop in the 1990s to produce the filter. In the early 2000s the NGO acquired more land and set up the first factory. This was about the same time that Philip had made up his mind about what his career should concentrate on – helping others.

That is when Philip became more involved and the process of transforming the NGO into a community-based enterprise started. Considering that the aim was for Ecofiltro to become self-sustainable, Philip realized that the filter could also be sold to urban users, not only be brought into rural communities. However, this required Ecofiltro to become a for-profit organization, which they did in 2009. Paradoxiclly, selling to urban families enabled them to reach more rural families; they achieved this by subsidizing the filters for the rural families through the income generated by selling the filters more expensively to urban users. In 2012 they set up a new factory to meet the increasingly high demand.

The Community-based Entrepreneur's Journey

Philip Wilson describes himself as a businessman interested in solving social problems through enterprise models (Wilson, 2015a). We see his approach as CBE, where an entrepreneur takes on big challenges – especially those which have not been solved for decades – and wants to leave a legacy for his community or for the entire nation.

In contrast, a "general" entrepreneur is focused on creating profits for the firm's shareholders. We call this CBE (see, also, Britton, Jackson, Morrow, Scaff, Scott and White, 2014) because communities are at the heart of such entrepreneurial processes and moral causes serve as the main aspect of innovation, rather than simply making profits. More importantly, this approach not only addresses social problems but also solves micro-level problems that are often ignored by typical commercial institutions and NGOs.

CBE is driven by strong moral consciousness which is shared by both the community and entrepreneurs. We cannot separate this moral consciousness of the one party (i.e., the community) from that of the other (i.e., the entrepreneur). When both parties realize that they share similar moral values, their drive for profit and sustainability takes on a different meaning. They see each other as partners – and this partnership is not about profit that benefits a community or an entrepreneur in the short-term. Instead, they engage in collaborative innovative activities through which they make unique, long-term contributions to a society. They are ready to make sacrifices (Chowdhury, Banerjee, & Nagarkoti, 2017) to develop a sustainable product or service. They may even abandon the development of a product or service if they do not find it feasible or if they think that it may harm society in the long run.

In this respect, one of Philip's moral concerns was about how many children's health problems, such as impaired physical development and cognitive abilities, were caused by their lack of access to clean water. Therefore, he thought that, if Guatemala wants to solve its other most pressing economic and social problems, water and malnourishment must be prioritized. During the interviews he recalled how, earlier in his life, despite being a successful entrepreneur in California, the USA and Guatemala, he still felt that something was lacking in his life. Therefore, when he found out that his sister was struggling to promote the Ecofiltro, he took this opportunity to use his business skills for a higher purpose. For Philip, the greatest rewards come from being able to save children who would otherwise die from gastrointestinal diseases as well as enabling the poor to prosper by being healthy. These days, the mission of taking clean water to one million families by 2020 makes him wake up every morning and feel fulfilled, happy and useful (Wilson, 2015).

But how did Philip get to this point? When the Ecofiltro factory still operated as a not-for-profit organization, his sister, Dominique, saw with frustration how small the donations were compared to the huge task at hand. Moreover, they were negatively affected by the cash flow and, therefore, sustainability was at risk. She asked Philip for advice on how to change this. This led Philip to reflect and wonder "Why not set up an organization which has the brain of a business and the heart of a foundation?" (Wilson, 2015a: 3). She was a philanthropist and refused to transform it into "a business"; despite her reluctance, though, she embarked on Philip's idea of transforming the foundation into a CBE. He was confident this was the right decision. In his opinion, real entrepreneurs use resources ethically and efficiently and everything they do must be sustainable otherwise they go bankrupt.

With the metaphor of "an organization which has the brain of a business and the heart of a foundation" (Wilson, 2015a) in mind, Philip organized a CBE where everybody has weekly, monthly and annual goals and clear long-term objectives. It means that everybody in the organization knows that their market consists of those people who have no access to clean water, and that the goal is solving 100% of the problem. "Not 5%, not 6% but 100%!" says Philip, "and that – he stresses – is a businessman mentality". What makes Ecofiltro a CBE is the fact that the sales and collections processes are supported by community leaders who (Wilson, 2015a):

· Organize the community for health talks where the problems with contaminated water are explained and the filter is presented as a solution.

· Share a small percentage of the sales through the periodic collection duties they perform.

Key Successes: Business Model Innovation and Mindset Shift

CBE requires finding new ways of making projects sustainable (see Britton et al., 2014) and, in order to achieve that, a paradigm shift is necessary. In this case, the key was extending the sales force by integrating community leaders and having field representatives who understood the local culture. However, this would not have been so effective in solving the water problem if Philip and his team had not changed the way they saw the people in these communities. They shifted from feeling pity for them, to seeing them as customers with special needs, thereby also restoring

their dignity. This mindset shift led Ecofiltro to provide the special conditions these communities needed to be able to afford, and benefit from, the filter.

Business Model Innovation

Giving away products for free, as government and NGOs tend to do, is not sustainable. Philip realized that they had to go beyond feeling good about helping people, to really solving the root-level problem. This could only be done by identifying the market and by re-conceptualizing poor families as functioning buyers as opposed to charity cases; buyers who are able to purchase products and gain value from using them. For example, when they gave the filter away for free, sometimes they would find the filters being used as flower pots or rubbish bins, suggesting that they had not properly communicated the filter's value to people. In addition, they used to look at the poor person with pity, rather than as a functioning and honorable buyer – a customer. These insights about low adoption and 'pity-based' philanthropy led them to shift their perspective: They evolved to utilizing the Ecofiltro as the main solution to the problem (as opposed to the earlier use of chlorine pills), while shifting to selling it instead of giving it away free. Accordingly, Philip decided to keep the price of filters as low as possible so that his customers could easily afford them. The low pricing could not only improve the lives of the poor health-wise, but also acknowledge that the poor could function as capable and dignified human beings in societies (Sen, 1999; 2010).

There were, however, several challenges to overcome in order to find a solid strategy that could solve the water problem in Central America through a CBE approach. One of them was scalability; that is, being able to exponentially grow the filter sales and delivery, at the lowest possible cost without having to grow excessively in personnel and infrastructure. The initial idea was born to outsource the filter production to local ceramists which would be good for boosting the local economy by using low-cost, local materials, with qualified labor. Unfortunately, the ceramist profession has become less attractive to younger generations and qualified workers were scarce. That is partly why Ecofiltro decided to build their own factory employing their own ceramists.

A second challenge was finding a way to offer the filter at a low cost to poor rural families. The solution to this challenge came when Philip realized that, similar to 601,000 families in urban areas, he had been paying approximately $200 per year for bottled water. This made him decide to start selling the filter at urban homes. However, his wife did not like the look of the filter since it was installed in a plastic receptacle such as those used to store paint. He proposed putting the filter within a beautiful ceramic receptacle and she said that it looked like a piece of art right in the middle of the kitchen (see Figure 3). Then he realized that he had a product that might appeal to people in urban areas who had to filter water or get it bottled anyway, and who might be able and willing to pay more for it than his poor rural customers could. Hence, market segmentation between urban and rural customers, whereby the rural markets could be subsidized by the urban markets, presented an obvious solution that did not require loans from financial institutions. Hence, cross-market subsidies from profits in the urban areas passed to the rural areas became the second crucial solution to the scalability challenge.

The most important aspect of scalability was to avoid – by all means possible – having to hire a growing number of sales representatives which would have been unsustainable. The key insight in solving the problem came from the realization while visiting the communities that there were key individuals – community leaders – who had the power to influence people due to their standing in the community. Henceforth, they developed an incentive program for the community leaders where they could earn a small portion of the payments from the sales of filters. Through this scheme, each field representative can multiply his/her efforts by collaborating with the community leaders. In summary, the community became directly involved in a solution through small monetary incentives, therefore expanding operational capacity for Ecofiltro without introducing high fixed costs for the organization.

Figure 3. Ecofiltro

Mindset Shift

Business model innovation was coupled with a broad mindset shift towards seeing the poor as customers with special needs instead of charity cases. Nonetheless, the low purchase capacity of poor families in developing countries such as Guatemala would still require some innovative thinking in terms of making the filter affordable. Initially, Ecofiltro had provided poorer customers with the opportunity to pay off the filter in a large number of small installments over a longer period of time. However, after interacting with and getting feedback from the communities, they decided to

shift from longer-term small installments to shorter-term higher installments, a rather counterintuitive move which is explained in more detail below.

Philip realized soon enough that since this was an entirely a new approach, traditional managerial methods based on predictability and control had to be adjusted to 'learning by doing'. This means that Ecofiltro had to involve their customers in solving their own problems and adjusting strategy accordingly. He often uses the analogy of how people frequently used to take 25-30-year-long mortgages. Considering 'how poor' his customers were, the most logical initial decision was to provide as many payments as possible to make it easier for them to have clean water. He was wrong. Philip, who works intensively with his customers in the countryside, started being approached by them asking for fewer installments. "We feel that we are going to be in debt with you forever, can we do something to get rid of this debt quicker?" they exclaimed while referring to the 20-24 installments schemes that were offered to them (Wilson, 2015b).

Philip took this on board. However, he was not sure what the right number of installments would be and wanted to investigate this issue further. In this regard, several groups of students from Stanford University's Extreme Affordability Program and the local students conducted research in the communities on the preferred number and amount of payments. Based on the results, Philip decided to set up a flexible five-installment payment system or an upfront one of roughly $33.

Making this adjustment did not pose a big challenge to him since Ecofiltro is used to make mistakes. In a sense, part of their philosophy is that in order to learn "you have to fail a lot and quickly" (Wilson, 2015b:6). He was surprised, however, by the fact that the preferences of the poor in rural areas contradicted the economic logic of long-term payment schemes[1], which are pervasive in developed countries. This insight had important consequences for other players in the field, given that most NGOs who used to give away free filters now also charge a small amount for them. This implies that

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[1] This is a significant finding because microfinance proponents such as Mair et al. (2011) and Yunus and Jolis (1998) argue that microcredits improve the living standard of the poor. However, Chowdhury and Willmott (2018) contradict this argument. The Ecofiltro case indicates that Chowdhury and Willmott (2018) hold a more accurate view: The poor do not desire long-term debt because such debt can lock them into a debt-trap, disempower them and, eventually, decrease their overall living standard (see also Karim, 2011).

Philip's shift in mindset enabled NGOs to shift their mindset as well and see the poor as customers.

Nevertheless, another challenge in the adoption of the filter resulted from more subtle and cultural barriers such as the look of the filter. Initially, Philip had thought that the ceramic filter would be easily accepted given that it solved an acute health issue. However, with amusement, he shares how the first 100 families the organization tried to help were reluctant to drink from a flower pot–like filter, but when they did it the water tasted so good that they embraced this piece of technology. Another subtle and cultural barrier was the manner in which child mortality was seen in the rural areas. The majority of villagers believed that such mortalities are inevitable. For instance, "Out of my eight children only five made it" is a statement that illustrates this. Philip realized that, in order for the filter to be accepted, a mindset shift needed to happen in the rural communities so that child mortality would no longer be seen as something inevitable. Therefore, it was important to raise awareness of the importance of clean water. Accordingly, the student team's research findings suggested that more vivid and graphic representations of contaminated water (rather than traditional presentation) would be more effective so that people understand the severity of the problem. For instance, graphic posters and educational videos depicting bacteria were deployed. Also, some people had a chance to observe bacteria through disposable $0.25 microscopes. Hence, Philip increased the adoption of the filter not only by adjusting the payment system, but also by providing a product that was culturally sensitive and contained simple health information.

Community-Based Entrepreneurship and the Commercialization Process

The first five years of selling the filter (i.e., from 2000 to 2005), as opposed to giving it away for free, revealed something very important. It turned out that a uniform approach across poverty–stricken rural areas was unlikely to work given the wealth disparities even among those who were classified as poor (i.e., living on an income of under $2 per day; see World Bank, 2016). As a result, Ecofiltro segmented the poor rural markets into three levels. Some people were poor but could still pay the whole value of the filter upfront (level 1: poor), others needed a payment plan (level 2: +poor), and others were not able to afford it even with a payment plan (level 3: ++poor). Hence, the latter would still have to be given the filter for free. In contrast, urban customers subsidizing rural families' filters earned $1,000 or more per month.

Sustainability is key and twofold in Ecofiltro's case. First, sustainability means that for its survival Ecofiltro has to be successful. Second, it must provide an effective long–term solution to the water problem for its customers. For example, the filtering unit has to be changed after two years because colloidal silver's performance decays and porosity decreases, thus diminishing the filtering capacity over time. This means that if people do not renew the filtering unit, they cannot have clean water.

Consequently, the segmentation of Ecofiltro's target markets has been the result of a strategy developed to ensure sustainability. Each segment is targeted through different channels. Poor users can buy the filter in hardware stores, +poor need a payment plan based on installments, and ++poor people require donations. The urban markets support all the rural ones by subsidizing their operation and credit system. Profits generated by higher margin products (Figure 4) enable this. This constitutes a new form of workplace innovation from the financial viewpoint: Wealthier urban people subsidizing poorer rural people.

Moreover, urban markets have also opened the opportunity to engage poor families in product and workplace innovation by opening creative spaces for people outside the organization to paint their own filters. In some cases, parents and children have been invited to the factory to customize their products by painting filters together. Through these workplace innovations artists have new sources of income and poor users get personalized stylish products.

Other communities such as graffiti artists (Figure 5) have been involved in similar workplace and product innovation processes which simultaneously increase the product's acceptance and create a social value.

For instance, collaborations between Ecofiltro and graffiti artists opened up opportunities for these artists to generate income; this is particularly valuable in a country such as Guatemala where it is difficult to make a living out of artistic and creative work. There have been successful events where these artists gather and paint filters which were then sold to high-end customers for a premium price. Part of the profits goes to the artists and the rest is used to finance the rural operations. The most interesting aspect is that urban customers are willing to pay a premium for a functional piece of art, which also makes them feel good about themselves knowing that they can support both artists and families in need of clean water.

Ecofiltro remains focused on their main objective despite the attractiveness of other potential markets. For example, some businesses such as hotels have asked Ecofiltro to make smaller versions of the filter for their guest rooms, in order to replace bottled water (Figure 6). Although Ecofiltro fulfilled a few of these special requests, for the time being, they are not planning to cater to this market. The main reason for not doing so is that it would require them to change the production process to be able to produce smaller filters alongside the ones they are already producing, and they feel this would distract them from their main objective. Other markets such as online auctions and sales have also been explored but are still in development given that the rural operations consume most of their resources.

Figure 4. Urban Areas Ecofiltro

Figure 5. Ecofiltros painted by Guatemalan graffiti artists

Figure 6. Ecofiltro for hotel guest rooms

In the rural markets, particularly when it comes to the +poor and ++poor, the successful commercialization of the filter required the involvement of the larger community. These two segments suffer from multiple challenges such as low income, lack of education, and a lack of sanitary infrastructure. In this respect, Ecofiltro field representatives (i.e., full-time employees of the firm) were in charge of identifying community leaders who in turn would gather the whole community for a session on health and the dangers of contaminated water. During such a session, a filter is presented as a solution and people can sign up for an installment payment program. In order to make the payment collection easier community leaders (who are considered entrepreneurs by Ecofiltro) earn a percentage of what they collect. This workplace innovation has increased Ecofiltro's operational effectiveness while keeping their operating infrastructure relatively small. They currently have 10 field representatives and approximately 350 community leaders with whom they work collectively.

Regarding the ++poor segment, Ecofiltro has concluded that, considering the extreme poverty they live in, there is no other approach to solve this problem than the usual give-away of a product. However, nowadays, most organizations charge at least a minimum in order to increase the adoption because this makes families appreciate the filter and increases the likelihood that they will use it appropriately.

A final challenge to overcome concerned the logistics of delivering the filter to rural areas. Given the lack of infrastructure such as roads, in most parts of the country where contaminated water is a problem, it was crucial to establish an effective delivery system. There are many communities that cannot be reached with heavy lorries; therefore, other means such as motorcycles and pick-ups need to be used locally. This is another reason why integrating the communities to find solutions to problems proved to be important.

Inclusion of Schools

One problem Ecofiltro faced was that, oftentimes, only about 50% of the people invited to the health talks showed up; however, a change made in 2015 increased attendance to nearly 100%. This change consisted of engagement with local schools. Ecofiltro made a strategic move which became an effective workplace innovation: Since 2015 they have been providing free filters to public schools (see Figure 2) under

the condition that a school must organize mandatory health talks requesting parents to attend. In some cases, food and beverage firms sponsor filter deliveries in schools as part of their corporate social responsibility (CSR) initiatives. They see this as an opportunity to help and improve their image in rural communities. Given that the school initiative has started to yield positive results, Ecofiltro has decided to shift its strategy and fully integrate it into its sales process. This means that rather than the community leader herself organizing the meeting, she is in charge of contacting schools to collaborate.

Discussion and the Path Ahead

There are several things which are noticeable about Ecofiltro. First, from a business perspective, they have achieved economic success by becoming profitable, therefore sustainable. However, the growth rate of filter delivery is also important. They have grown from delivering a few hundred filters per month as a nonprofit to delivering 50,125 filters in 2014, a number which grew to approximately 64,100 in 2015.

Second, although it is difficult to objectively measure emotional attachment, the empathy and commitment of Ecofiltro´s employees are crucial for its success. Ecofiltro's field representatives do not hesitate to work at the weekends and during holidays because they are fully committed to the organization's mission. Such commitment occurs because some of the employees know from their experience how severe the negative consequences of drinking contaminated water are. For example, some employees have experienced tragedies of losing several family members due to drinking contaminated water. One of them shared a tragedy she witnessed in her hometown; i.e., her village people found out that more than 20 children had died as a result of having drunk contaminated water. This type of experience encourages one of Ecofiltro's marketing managers to run 113 kilometers from Antigua to Lake Atitlan to raise funds to buy filters for schools (see http://www.quepasa.gt/we-ran-for-water-we-ran-for-the-children/). This clearly reflects how Ecofiltro's employees go beyond what is expected from them in their job descriptions.

Third, Ecofiltro garners more and more support from NGOs, renowned universities such as Stanford, MIT and Harvard, entrepreneurs, and multinational as well as local corporations which support their cause. The next big challenge in the region is an expansion into México with a group of young and enthusiastic entrepreneurs.

Conclusion

Ecofiltro is a great example of how a CBE can bring about workplace innovation that mobilizes poor communities to be aware of their wellbeing in a sustainable manner. While the organization solves local problems, it addresses wider issues too. For example, Ecofiltro's product innovation and business model shows that moral values are important for sustainability. The organization was able to make a profit while serving the local people which shows that helping others is the best way to sustain a business (Grant, 2013).

One of the most powerful lessons from this case study is how a firm can share intellectual property and at the same time maintain a model which involves a wide network of stakeholders working towards a common goal and commitment so that empathy and collaboration with communities are transformed into a societal impact.

The Ecofiltro case shows that when a business empowers local communities it encourages workplace innovations. Employees feel motivated to make small changes that can drive a decent profit margin. In other words, to make CBE work, an organization needs well-thought-out workplace design so that primary members of an organization continuously work hard for the business and communities. In a way, it reinforces the moral compassion that keeps an organization focused on solving social problems sustainably. Without integrating moral values within a business model, a social change is difficult to achieve; however, if more businesses adopt CBE, this can help poorer societies and ultimately reduce social ills.

To conclude, this approach can work in other parts of the developing world such as Bangladesh, where NGOs tend to operate using mainstream mechanisms such as microcredits. CBE can empower the poor by providing them with the necessary business ideas and tools. This type of approach can enable the poor to become self-sufficient. More importantly, it can make them feel valued and dignified members of a society and provide them a real opportunity to live a healthy life.

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Detecting who is going to innovate

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Abstract

An important factor for workplace innovation is having creative employees in the workplace. Most tests for assessing creativity are paper-and-pencil-based and require a trained evaluator for scoring. This, in turn, renders scoring time-consuming, expensive, and not entirely objective. The aim of the three studies presented here was to develop an online creativity test that uses a fully automated scoring algorithm, that is optimised for unsupervised settings, and that can be applied internationally by being language-independent. As such, it can be used as a quick and cost-efficient instrument for selection as well as individual and team development purposes.

Introduction

Innovation has become something like a "Holy Grail" for organisations, given that innovative products and services provide a competitive advantage in rapidly changing international markets (Maier, Streicher, Jonas, & Frey, 2007). Moreover, organisations see workplace innovation (WPI) as a factor to help them face the challenge of today's

volatile markets (Kesselring, Blasy, & Scopetta, 2014). Thus, companies, on the one hand, strive to establish an environment that facilitates innovation (Amabile, Conti, Coon, Lazenby, & Herron, 1996) and, on the other hand, try to recruit innovators (i.e., people that are likely to innovate).

But how can one assess during the selection process who will most likely be an innovator? Whether someone will be an innovator is determined by a number of factors, such as cognitive ability (i.e., intelligence), certain personality characteristics, such as openness to experience, and creativity (Farr, Sin, & Tesluk, 2003; Soosay, 2005; Streicher, Maier, Frey, Jonas, & Kerschreiter, 2006). All of these characteristics can be measured by using psychometric tests and questionnaires.

There are different modes of administering such tests and questionnaires: either in paper-and-pencil mode or online (online assessment). Paper-and-pencil mode usually implies that participants are invited for an on-site session during which they fill in the instruments on paper with an administrator being present. For this mode, there are a variety of instruments available that assess the above-mentioned personality characteristics, cognitive abilities, and creativity.

During the past few years, however, online assessment (i.e., tests and questionnaires adiminstered via the internet) is becoming more and more popular with recruiting companies: In a 2012 survey of European companies, 83% of them indicated using online assessment in their recruitment processes (cut-e, 2012). Moreover, a recent article in the Harvard Business Review (Bateson, Wirtz, Burke, & Vaughan, 2013) recommends using unsupervised online assessment as a first stage in the process of employee recruitment.

Thus, it would be desirable to be able to measure applicants' potential to innovate in unsupervised online mode. This mode requires candidates to be able to complete the assessment using a computer and the internet and it usually involves automated scoring and reporting.

There are instruments for measuring cognitive ability and personality in unsupervised online settings using automated scoring. However, to date, creativity tests have mostly required supervised settings and always a trained evaluator. Training evaluators takes time and, even if there are two or more evaluators per test, it will still mean that there

is a certain amount of subjectivity involved. Moreover, evaluation usually takes about ten minutes per test, so evaluating 100 tests will take over 16 hours, assuming there is only one evaluator per test. This is time-consuming and expensive.

Thus, the aim of the three studies presented here was to develop an online creativity test that uses a fully automated scoring algorithm and that is optimised for unsupervised settings. To this end, Study 1 is an exploratory study designed to find and combine parameters that can be used for an automated scoring algorithm. Study 2 evaluates the first part of a scoring algorithm designed on the basis of Study 1 by comparing its results to the rating done by trained evaluators. Finally, Study 3 validates the full scoring algorithm as well as the creativity test designed based on the insights from Studies 1 and 2.

Assessing creativity

Creativity is often equated to divergent thinking. Divergent thinking (Guilford, 1950) generates creative ideas by exploring various possibilities. In contrast to convergent thinking (i.e., a process that focuses on coming up with a single, well-established answer to a problem) in which a series of logical steps are diligently connected in order to reach a goal, divergent thinking (or lateral thinking; De Bono, 1992) is spontaneous. Many possibilities are gone through in as little time as possible and with the least possible evaluation, thereby giving rise to new connections between elements. Options are produced by decomposing the problem into conceptual parts and then recombining them.

In the literature, creativity is often seen as consisting of four different components, fluency, flexibility, and originality (e.g., Jäger, Süß, & Beauducel, 1997) as well as elaboration (Torrance, 1966). Fluency is the number of unique responses within a certain period of time (Guilford, 1967; Torrance, 1966). Flexibility refers to the extent to which the responses relate to a diverse range of categories and perspectives and the use of broad and inclusive cognitive categories (Guilford, 1967; Torrance, 1966). Originality refers to the extent to which responses are novel, infrequent and uncoventional (Guilford, 1967; Torrance, 1966). Elaboration is the amount of detail given in each response (Guilford, 1967, Torrance, 1966).

A well-established and validated instrument for assessing creativity in a supervised setting with trained evaluators is the Torrance Tests of Creative Thinking (TTCT; Torrance, 1974). This instrument is directly based on Guilford's (1950) work. TTCT have the most extensive empirical basis of all measures of creativity so far, and longitudinal studies prove the effectiveness of the underlying concept (Torrance, 1981). In a TTCT the participant has to use a number of given shapes, combine or complete them, and name the result.
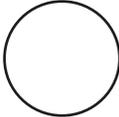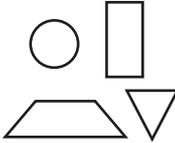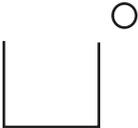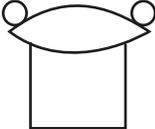
Figure 1 depicts the different types of tasks a TTCT uses and provides examples of more or less creative solutions for the tasks. When comparing the more and less creative solutions for all three types of tasks a few things are worth noting. The more creative solution for the 'Use' task involves using the shape in different sizes. The more creative solution for the 'Complete' task involves using a greater number of shapes in different sizes and orientations. Finally, the more creative 'Complete' task consists of more elements and the title is more complex and unusual.

The test is a paper-and-pencil test, meaning that the participant has to draw the objects. The results are evaluated by previously trained evaluators. In the original version, the raters scored participants on Fluency (number of objects), Flexibility (number of different categories of objects), Originality (number of unique or rare objects), and Elaboration (amount of detail in the objects). In the third edition of the TCCT dating from 1984, "Resistance to Premature Closure" (i.e., going beyond the logical way to complete a figure) and "Abstractness of Titles" (i.e., level of abstractness of the titles given to the objects) were added as rating categories.

Participants have to draw the objects manually. This means that their results are, to a certain extent, dependent on their ability to draw. Moreover, the test requires being evaluated by trained evaluators, making the process time-consuming and not one hundred percent objective. Finally, it is not suitable for unsupervised online administration.

As already mentioned, the purpose of the three studies reported here was to develop a creativity test that that can be administered in an unsupervised online setting and that can be evaluated automatically. Since TTCT is a well-established and validated test, we decided to use this test as a basis for the online test to be developed.

Figure 1. Different types of tasks used in TTCT.

	Starting Shapes	Completed Drawing	
		More Creative	Less Creative
Use	◯	Mickey Mouse	Chain
Combine		King	Face
Complete		A fish on vacation	Pot

Note: Retrieved from https://kathrynwelds.com/2015/07/08/greater-hemispheric-specialization-not-integration-increased-creativity/

In the following sections, the three studies that were conducted to design and validate the test will be described.

Study 1

Study 1 was a pilot study designed to explore whether it is possible to find parameters in the pictures and names that result from an administration of a TTCT type test that can be used to design a scoring algorithm. To this end, a version of the TTCT was administered in paper-and-pencil mode as part of a supervised study. The purpose of the study was to find properties of the drawings and names that determine whether a solution is more or less creative.

Method

Participants

The study was conducted with N = 68 university students (44% female, 56% male) taking part in a competition to find the smartest student in 2014 in Frankfurt, Germany. Participants were undergraduate and graduate students enrolled for various subjects such as economics, engineering, IT, natural sciences, or social sciences at different universities in Germany and Austria. For reasons of data protection, no other biographical data apart from gender was collected.

Procedure

The competition that Study 1 was part of had been launched by a major German recruitment agency, and the prize was, in addition to winning the award as the 'Smartest Student', a cash prize. In order to participate in the competition, they could sign up on a website, and participation was voluntary. After registering, they completed a series of online tests and questionnaires assessing cognitive abilities (numerical, verbal, and abstract-logical reasoning as well as handling of information). Sixty-eight students with the highest test scores were invited to a one-day assessment centre-type challenge in Frankfurt. During the course of the day, participants were asked to complete the 'Objekt-Gestaltung' (OJ; 'Object-design') from the Berlin Intelligence Structure Test (BIS; Jäger, Süß, & Beauducel, 1997) paper-and-pencil test under supervision. After the instruction sequence, candidates had 15 minutes to complete as many pictures as they could within the time given.

There was no ethics commission involved for giving ethical approval for the study. However, participants were told that their participation in this study was voluntary, that it would be anonymous, and that they could withdraw from the study at any time. Afterwards, all tests were scored by two trained experts according to the guidelines given in the TTCT test manual (Torrance, 1975). The same two experts then conducted a qualitative analysis and looked at parameters that could be used to automate the scoring.

Measures

As mentioned above, the test used was 'Objekt-Gestaltung' (OJ; 'Object-design') from the Berlin Intelligence Structure Test (BIS; Jäger, Süß, & Beauducel, 1997). This is a task that originates directly from TTCT (Jäger, Süß, & Beauducel, 1997). The task is to combine circles, rectangles, triangles, and trapezoids into real world objects by drawing them and to name these objects. Participants were free in combining these geometrical figures, using as many or as few of them as they wanted. The only requirement was to use at least one geometrical figure.

The test has to be evaluated by trained evaluators based on guidelines given in the manual. The scores resulting from the test are Fluency (number of options produced), Flexibility (number of different options produced, assessed by categorising the options produced into pre-defined categories and counting the number of different categories present), and Originality (number of unique options produced, assessed by counting the number of options that do not fit into one of the pre-defined categories).

Based on the ideas they had from the BIS (Jäger, Süß, & Beauducel, 1997) and TTCT manuals (Torrance, 1975) (see above, number of shapes used, number of different shapes used, changes in size and orientation, complexity of name), two experts recorded for each picture the following properties:

- **Fluency:** Number of real-world objects drawn and named.

- **Flexibility:** This measure usually refers to the number of different options produced. Based on the reasoning that different options can show in how flexibly the available shapes are used, the following was counted: (1) number of circles, rectangles, triangles, and trapezoids used (this was counted for each shape, so for example in one picture there could be 1 circle, 1 rectangle, 0 triangles, 3 trapezoids); (2) number of circles, rectangles, triangles, and trapezoids changed in size

and/or orientation (this was counted per picture, so if there was a variation of size and/or shape in at least one of the shapes in the picture this picture was given a 1 on this score, if not it received a 0).

· **Originality:** This measure usually refers to the uniqueness of the objects produced. Based on the reasoning that uniqueness can be seen in how the shapes are combined and how frequent or unique the given names are, the following was counted: (1) number of different patterns, i.e., number of different combinations of the shapes used across different drawings; (2) frequency of names given (how frequently the same name appeared across the entire sample, e.g., "house" or "sun").

The two experts divided the pictures to be reviewed between the two of them and did the recordings according to the predefined guidelines described above. After completing their respective share of the pictures, they swapped and reviewed what the respective other expert had recorded. In the event of disagreement, they discussed until they reached agreement.

Results

Fluency.

Candidates had drawn between 6 and 36 pictures (M = 17.9, SD = 6.17).

Flexibility.

The number of circles, rectangles, triangles, and trapezoids that were used per picture ranged from 0 to 48 (some candidates just used one type of shape in a picture, that is why the number of other shapes used in this picture can be 0). Variations (changes in size and/or orientation) of these shapes within a picture ranged from 0 to 1, with 0 meaning the shape was not changed in size or orientation, and 1 meaning the shape was changed in size and/or orientation.

Originality.

There were almost 300 different patterns that candidates had used. The frequency of names ranged from 1 (e.g., "Mexicans from above") to 33 (e.g., "house"). Moreover, there were titles that consisted of one word only, but also titles that consisted of several words, and different lengths of words.

Discussion

The purpose of this pilot study had been to see whether it was possible to find rules for an algorithm to score creativity tests. These rules were meant to crystallise the expert knowledge based on the scoring rules from the manual. Hence, the rules for the algorithm were on the one hand supposed to reflect the scoring rules and on the other hand to be able to create enough variation in scores so that, later on, differentiation between candidates would be possible. Based on the results described above, it was obvious that the highest differentiation was to be achieved using the number of shapes used, the changes in size and/or orientation and the number of different patterns used. Also, the complexity and unusualness of the name given was a potential differentiator.

Based on this reasoning the following rules for the algorithm were defined:

- **Fluency**: Number of real-world objects drawn and named.

- **Flexibility**: As described above, flexibility was assessed using the number of shapes and the variations in size and/or orientation. Therefore, the reasoning was that these properties could be combined into patterns for each image and that based on these properties the algorithm could compare each picture a participant had drawn to the previous ones and assess whether the pattern was different from the others. Thus, flexibility for the algorithm was defined as the number of different patterns.

- **Originality**: As described above, this score focused on the uniqueness and complexity of the pictures drawn and the uniqueness and complexity of the titles given. The uniqueness of the picture was defined as the uniqueness of the combinations of shapes. E.g., combining a circle and a triangle in one picture and combining a square and a rectangle in the next would yield a flexibility score of 1 (since it is two different shapes that are being used), but a uniqueness score of 0 (since both pictures use two shapes without changing them in size and/or orientation). The complexity of the picture was defined as the number and diversity of objects used and the degree of variation of the objects in terms of size, position and rotation. The uniqueness of the title was defined by how unique or rare the title was. The complexity of the title was defined by the number of words used and by the length of each word.

The next step now was to validate the algorithm. This was done using two follow-up studies. Study 2 focused on validating the Originality score since this was the more

complex one, Study 3 on validating the Fluency, Flexibility, and Originality scores, along with validating the entire test designed based on Study 1.

Study 2

The purpose of Study 2 was to validate a scoring algorithm for Originality that had been set up based on the insights from Study 1. For validation, a newly programmed web-based version of the test (called "sparks") was used and the Originality score generated by the algorithm was compared to ratings by trained experts. The study was conducted in a supervised setting in collaboration with a university in Hamburg, Germany.

Method

Participants

Five university students participating in a research project at their university in Hamburg, Germany, had recruited family members, friends, or fellow students for the study. The $N = 65$ participants were between 15 and 60 years old and had various educational backgrounds, ranging from high school to university degree. Due to reasons of anonymity no further biographical data is available.

Procedure

For this study, a new online creativity test, called "sparks" was developed, based on the same principles as 'Objekt-Gestaltung' (OJ; 'Object-design') from the Berlin Intelligence Structure Test (BIS; Jäger, Süß, & Beauducel, 1997). It is described in more detail in the Measures section.

As mentioned above, five university students participating in a research project recruited participants who were invited to a session in which they were in a room with a supervisor (one of the five students). Participants completed the online creativity test sparks while the supervisor was sitting behind them. Whenever they had finished one picture they let the supervisor know. Then the supervisor took a screen shot of the respective drawing and saved it into a file, and the participant went on with the next item.

This was done so that after test completion all the pictures would be available for manual scoring by trained evaluators. The procedure was repeated until time was up (15 minutes). At the same time the scoring algorithm automatically scored participants' responses. The procedure meant that there was an interruption after each object drawn. Thus, it was to be expected that candidates would complete less pictures than they would without the interruption.

As mentioned above participation in the study was anonymous. In order to be able to assign the screen shots taken during the session to the automated score for each participant, the administrators generated a code for each participant, consisting of the initials of the administrator's name and a number that was later on used to match the results in the data base with the screen shots taken during the administration.

Like in Study 1, there was no ethics commission involved for giving ethical approval for the study. However, participants were told that their participation in this study was voluntary, that it would be anonymous, and that they could withdraw from the study at any time.

The five students who had supervised the test administrations were trained to evaluate the test and thus became Expert raters. Each of them received the screen shots of all participants in the study. Each of the Experts then used one excel sheet to rate all objects individually with respect to Originality since this was the most complex one of the scores. A full validation of all scores was already being planned at this stage and thus not considered to be necessary. All five Experts rated all the objects participants had drawn without knowing the other Experts' ratings. Moreover, they did not know the results of the automated scoring when evaluating the drawings.

Measures

The creativity test "sparks" that had been programmed for the study works as follows: there is a drawing area onto which participants can drag four different shapes: square, circle, triangle, and trapezoid. One shape is already present on the drawing area and has to be incorporated into the drawing, and at least one shape needs to be added. Participants can use as many of these shapes for each of their drawings as they want and they can change their size and dimensions. Once they have completed their drawing they need to name it in a text box below the drawing area. Figure 2 depicts two sample items from the test.

Figure 2. Sample items, with a less creative one on the left-hand side and a more creative one on the right-hand side
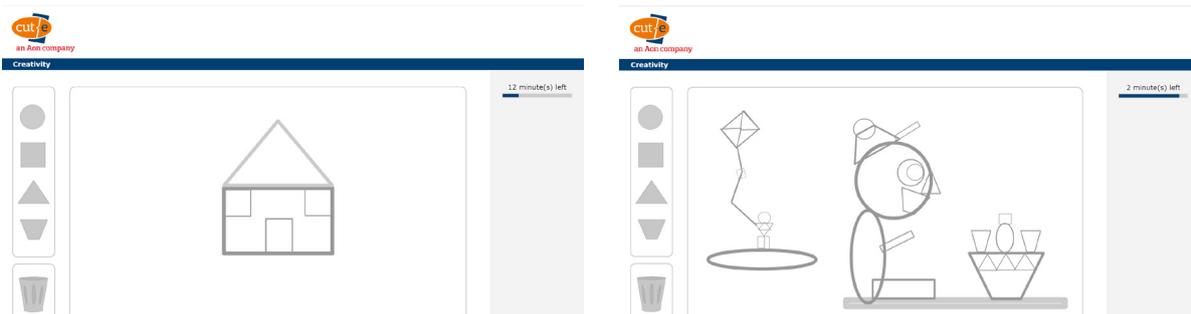
The rating criteria the Experts used were to reflect the logic the algorithm used so that it would be possible to see whether or not the algorithm had really "learned" what it had been programmed on. Thus, Originality was rated based on the following criteria: A drawing and given name was original if the participant:

• used two or more of the available shapes (e.g., at least a circle and a rectangle)

• used them in different sizes or dimensions

• combined them in a way in which they had not done it before or considerably changed the combination compared to something they had drawn before (e.g., used a triangle, rectangle, and circle once to depict a house with the sun next to it and once to depict a rocket flying to Pluto)

• added something that was unique in the category the object was assigned to (e.g., the participant combined rectangles, circles, and triangles into a forest (not unique), but added a few circles and rectangles to symbolise two people, and called it "bliss of love in the forest").

Based on these criteria the administrators assigned between 0 and 100 points to each drawing. The algorithm used the same range. Experts' ratings were averaged and then correlated with the results the automated scoring had yielded. Before doing so, interrater reliability, i.e., agreement among raters, was tested using the intra-class correlation coefficient. As a model, two-way random was chosen since the same raters rated all participants, and the type used was absolute agreement. The ICC was .95, $p<.01$, which can, according to Cichetti (1994), be interpreted as excellent. Thus, an overall rating of the scores for originality was calculated as an average of the five Experts' ratings.

Results

The results obtained by the automated scoring algorithm were compared to those the trained Experts had given.

Table 1 depicts descriptive statistics for the Originality scores each of the Experts (trained evaluators) had given and for the Originality score calculated by the automated scoring algorithm.

Table 2 depicts correlations between the five experts (individually and averaged) and the scoring algorithm. It can be seen that, based on Cohen's (1992) taxonomy, the correlations between the Expert ratings and the scoring algorithm can be classified as high.

Table 1

Descriptive Statistics for Originality as Calculated by the Scoring Algorithm, and as Rated by Trained Evaluators

	M	SD
Scoring algorithm	25.23	25.51
Expert 1	24.04	17.25
Expert 2	24.29	17.38
Expert 3	31.32	17.95
Expert 4	27.89	17.66
Expert 5	30.53	20.04

Note. *N* = 68. Possible range of the score = 0-100.

Table 2

Intercorrelations Between Originality Scores Calculated by the Scoring Algorithm and Rated by the Experts

	(0)	(1)	(2)	(3)	(4)	(5)	(6)
(0) Scoring algorithm	1	.78**	.72**	.57**	.73**	.73**	.77**
(1) Expert 1		1	.92**	.74**	.88**	.84**	.95**
(2) Expert 2			1	.74**	.86**	.78**	.93**
(3) Expert 3				1	.83**	.69**	.87**
(4) Expert 4					1	.82**	.95**
(5) Expert 5						1	.90**
(6) Experts averaged							1

Note. *N* = 68. ** *p* < .01.

Discussion

Intercorrelations between the five Expert ratings indicate that they followed the guidelines. The high intraclass correlation supports this. Thus, interrater reliability can be considered to be excellent, which is to be expected because they rated the drawings based on standardised guidelines from the test manual. However, what is remarkable is that the correlations between the individual and the averaged Expert ratings on the one hand and the score based on the scoring algorithm are rather high. Thus, the parameters for the scoring algorithm that were defined in Study 1 reflect an Expert rating on Originality.

One limitation of this study is that the sample was a convenience sample since the students conducting it had recruited family members and friends. Thus, the question is to what extent the sample can be seen as representative of those who are likely to take the test in a true selection setting. Moreover, in such a sample participants' motivation can be expected to be different from the motivation in a more "neutral" sample.

Another limitation of the study is that participants were interrupted during test administration because the screen shots had to be taken and saved. Thus, it is likely that they drew less pictures than they would have drawn without being interrupted. This, however, is not so much of a problem since the score we focused on in this study was Originality (not Fluency, so the number of pictures drawn). However, it is also possible that the interruptions disrupted participants' concentration and flow. Thus, it could be that their scores on Originality were lower than they would have been had they completed the test without interruptions. However, their true Originality score was not so much the focus here, rather it was the scoring algorithm, and it is unlikely that lessend concentration and focus had an impact on this.

Finally, the study had focused on validating the Originality score only, not the Fluency and Flexibility scores. Thus, an additional study was required to validate the other two scores, along with a construct validation of the newly programmed test. This was the purpose of Study 3.

Study 3

In Study 3, we focused on all three scores (Fluency, Flexibility, and Originality) as well as on the entire creativity test with respect to test-retest reliability, convergent and discriminant validity. Moreover, it was necessary to find out whether the test result depended on the ability to draw because, if so, there would be error variance in the overall score because it would assess another construct along with creativity.

Method

Participants

There were N = 470 participants in the study. Of those 30% were female and 70% were male. They were between 17 and 67 years old (M = 34.00, SD = 11.00) and had predominantly higher education. They all lived in the USA and completed the instrument in English.

In the re-test sample that completed sparks for a second time two weeks after the first test administration there were N = 120 participants. Of those 34% were female and 66% were male. They were between 19 and 57 years old (M = 33.00, SD = 10.50). Educational background was predominantly higher education. Again, they all lived in the US and completed the instrument in English.

Procedure

The study was carried out using Amazon Mechanical Turk (mTurk) in February 2015. mTurk is a platform where people are being paid for completing various kinds of tasks online in front of their home computer, for example for completing tests and questionnaires that are part of a study. Online studies are becoming more and more popular, which raises questions regarding the reliability and interpretability of the results. Studies indicate that participants in these kinds of research designs are motivated and diverse (Lochner, 2016). McGraw, Tew, and Williams (2000) collected data from online experiments across a period of 2 years and came to the conclusion that the data from online experiments are just as interpretable as data from the laboratory. Moreover, when it comes to mTurk, studies indicate that data gathered using this platform are at least as reliable as data collected in conventional ways

and that participants are even slightly more diverse than participants in standard internet studies, making it possible to generalise the results (e.g., Buhrmester, Kwang, & Gosling, 2011). In the present study, in order to establish construct validity, participants first completed the "sparks" creativity test (the same one that had been used in Study 2, completion time: 15 minutes), a test assessing abstract logical reasoning (for testing discriminant validity; completion time: 6 minutes), and a questionnaire for biographical data that included self-assessed drawing ability (in order to establish whether test performance was really independent of the ability to draw). Completing the entire battery took about 30 minutes, and participants were compensated with US$ 5 each for their participation. In order to establish test-retest reliability of the creativity test, participants completed this instrument for a second time two weeks later.

Like in Studies 1 and 2, there was no ethics commission involved for giving ethical approval for the study. However, participants were told that their participation in this study was voluntary, that it would be anonymous, and that they could withdraw from the study at any time.

Measures

Apart from the already described creativity test, we used a measure assessing deductive-logical reasoning, scales lst (cut-e, 2008), a questionnaire assessing demographical data and a self-rating of the ability to draw. The creativity test is described in the Measures Section of Study 2. It was scored using the automated scoring algorithm and an Expert rating. The following sections thus describe the questionnaire assessing biographical data, the test assessing logical reasoning, and the rules the Expert rating of the creativity test was based on.

Biographical data. In the biographical questionnaire, candidates were asked to indicate their age, gender, and education level. Additionally, they were asked to rate their ability to draw on a five-point Likert scale (1=very poor; 5=very good).

Deductive-logical reasoning. The measure assessing deductive-logical reasoning, scales lst (cut-e, 2008) was used to establish discriminant validity. According to Guilford's (1950) theoretical assumptions on creativity as divergent thinking, we would expect moderate correlations between divergent and convergent thinking.

Scales lst (cut-e, 2008) consists of grids of 4x4 or 5x5 cubicles that contain different symbols, each of which must appear only once in each row and each column, like in Sudoku. On the test, incomplete grids are depicted in which one cubicle contains a question mark. The participant has to find the symbol to replace the question mark and select it by clicking on one of the four or five alternatives provided. The test has a split-half reliability of α = .89 (Spearman-Brown corrected; N = 3,216) and a correlation of r = .48, p < .01 (N = 90) with Raven's Advanced Progressive Matrices (APM; Raven, Raven, & Court, 1998).

Figure 3. Screen shot of an item of scales lst.
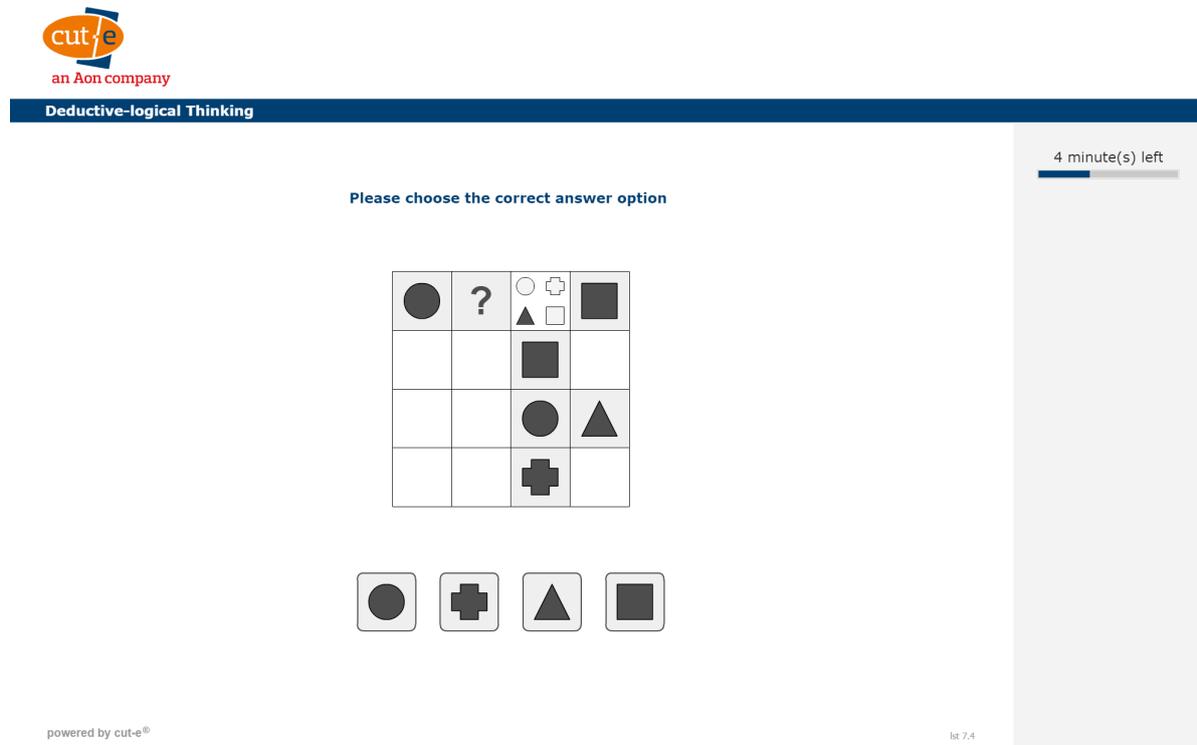
Expert rating of the creativity test. The online platform on which all instruments ran allowed for generating a report for the creativity test that depicts, for each participant, the objects they have drawn along with the names they gave these objects. For those who had completed the creativity test twice, this report was retrieved from the system and two trained evaluators (Experts) rated the objects based on the instructions given in the TTCT manual. Since the Expert rating was to reflect the rating a trained Expert would give using the instructions in the TTCT manual, not the rules the algorithm had been programmed on, the TTCT criteria were used. The hypothesis was that the results would be similar since the algorithm had been based on assumptions regarding the properties of picture and title drawn from the TTCT manual. Moreover, the Experts rated Originality and in addition to Study 2 also Fluency and Flexibility. Thus, the rating criteria the Experts used when rating creativity were as follows:

- **Fluency:** Number of real-world objects drawn and named (like in Study 1).

- **Flexibility:** each object was assigned to one of the categories given in the TTCT manual; for each category represented in their objects participants received one point; if it was not possible to assign an object to a category the participant received an additional point for each non-assignable object (minimum score was 1, with no theoretical maximum here)

- **Originality:** this was a combination (unweighted addition) of two TTCT categories, elaboration, i.e., complexity of the picture, and abstractness of the title, i.e., complexity of title (the possible range for Originality was from 0 up to 30 per picture).

  - elaboration: participants received one point for each non-necessary detail per object (e.g., window in house was one point, chimney on roof of house one more); scores ranged from 0 to 20 per object

  - abstractness of title: participants received 1 point for each word they added to the title of the object; if it was only one word the score was 0; each additional word (except for prepositions and articles) scored 1 point (e.g., dog was 0 points, dangerous dog 1 point, man running away from dangerous dog 3 points); scores ranged from 0 to 10 points

The two Experts rated the pictures independently of each other, their ratings were then combined by averaging them (see below in the Results section).

Results

In this section, we will first focus on the validation of the scoring algorithm by comparing its results to the ratings two trained Experts gave, using the small sample of N = 120. Next, results on test–retest reliability will be reported, also using the same sample of N = 120, and finally the results on construct validity will be presented, using the large sample of N = 470. Table 3 depicts descriptive statistics for the two samples as calculated by the scoring algorithm. Table 4 depicts the ratings on the same three dimensions as given by the Trained Experts.

Table 3
Descriptive Statistics for Fluency, Flexibility, and Originality for the Full Sample, and for the Small Sample at First and Second Test Completion as scored by the Algorithm

	Full sample		Small sample T1		Small sample T2	
	M	*SD*	*M*	*SD*	*M*	*SD*
Fluency	10.07	4.53	9.22	5.40	9.66	5.25
Flexibility	7.26	2.72	6.60	2.54	7.12	2.85
Originality	181.14	85.94	169.67	88.38	183.89	62.67

Note. Full sample: N = 470; small sample T1 (at time 1, first test completion): N = 120; small sample T2 (at time 2, second test completion for test-retest reliability): N = 120.

Table 4
Descriptive Statistics for the Fluency, Flexibility, and Originality for the Small Sample as rated by the Trained Experts (Averaged)

	M	*SD*
Fluency	8.39	4.05
Flexibility	5.98	2.47
Originality	171.74	80.71

Note. N = 120; small sample at T2 (at time 2, second test completion)

Validating the scoring algorithm

In order to compare the scoring algorithm to the Expert ratings an automated reporting function had recorded the drawings and titles so that after test completion they could be downloaded from the data base. As mentioned above these pictures were scored according to the TTCT manual by two trained Experts who did not know the results of the automated scoring.

For assessing interrater reliability, i.e., agreement among the two raters, the intra–class correlation coefficient was calculated. As a model, two-way random was chosen since the same raters rated all participants, and the type used was absolute agreement. The ICC was .80, $p < .01$ for Fluency; .93, $p < .01$ for Flexibility; and .81, $p < .01$ for Originality. According to Cicchetti (1994), this can be interpreted as excellent. Therefore, the two ratings were averaged to have an overall rating of the three scores that could be correlated with the automated score. Table 5 shows the correlations between the automated sparks scoring and the manual scoring by the two Experts.

Table 5
Correlations Between the Three Creativity Scores as Calculated by the Algorithm and as Rated by the Trained Experts Based on the TTCT Manual Using the Data from T2.

	r
Fluency	.99**
Flexibility	.85**
Originality	.88**

Note. *N* = 120. ** *p* < .01.

The results demonstrate that with .99 the automated sparks scoring almost perfectly predicts the expert rating of Fluency. This means that the scoring algorithm detects whether someone has added a shape to the one already given and whether a valid name was given to the object and thus reflects a decision made by a trained rater. The other correlations indicate that the automated scoring reliably reproduces an expert scoring according to the TTCT manual.

Assessing test-retest reliability

Test–retest reliabilities for the automated scoring (N = 120) were .82 for Fluency, .67 for Flexibility, .and 71 for Originality. This can be considered satisfactory.

Construct validation

For establishing discriminant validity, the creativity test scores as calculated by the scoring algorithm were correlated with the test scores of scales lst, the test assessing deductive–logical reasoning. Table 6 depicts the results.

Table 6

Intercorrelations Between the Four Creativity Scores and a Test Assessing Logical Reasoning

	Reasoning test speed	Reasoning test accuracy	Reasoning test performance
Fluency	.33**	- .17**	-.01
Flexibility	.85**	.02	.15**
Originality	- .03	.11*	.15**

Note. N = 470. * p < .05. ** p < .01. Reasoning test speed: Number of items processed. Reasoning test accuracy: Percentage of correct solutions of items processed. Reasoning test performance: Overall performance score on logical reasoning test.

There is no correlation between the Fluency score and the performance score of the reasoning test. The other two creativity scores and the performance score of the reasoning test is r = .15. This can be interpreted as an indicator for the divergent validity of the creativity test. All correlations are highly significant (p < .01), but according to Cohen's (1992) taxonomy this is a small effect, with only about 2% in the variance in Flexibility or Originality, being explained by the reasoning test.

There is a rather high correlation of r = .33 between Fluency in the creativity test and processing speed (number of items processed) in the reasoning test, which is in line with expectations since Fluency (number of pictures generated) may also be interpreted as an indicator for a participant's processing style. Thus, someone who works quickly on one instrument is also likely to work quickly on the other one. There is also a significant negative correlation (r = –.17) between Fluency in the creativity test and accuracy (percentage of correct solutions) in the reasoning test. The effect is small but the direction is to be expected: someone who works quickly is likely to not

be quite as precise as someone who works more slowly. Overall the results suggest discriminant validity of the creativity test.

Finally, candidates' results as scored by the algorithm correlated almost 0 with their ability to draw ($r = -.05$ for Fluency, $r = .07$ for Flexibility, $r = -.01$ for Originality). Thus, performance on the test can be considered to be independent of the ability to draw.

Discussion

The study investigated the validity of the scoring algorithm and the psychometric properties of the test that was developed based on the previous two studies. The scores obtained by the automated scoring algorithm correlate highly with Expert ratings that are based on the TTCT manual instructions (between $r = .85$ and $r = .99$), thus the scoring algorithm can be considered a valid one. Test-retest reliabilities are between .67 and .82 for the three creativity scores and can be considered satisfactory. Intercorrelations with a test assessing logical reasoning are as to be expected: low but positive. Thus, discriminant validity can be shown as well. Finally, results are independent of the ability to draw.

Discussion

This paper describes how, in three studies, an online creativity test was developed that is suitable for unsupervised online assessment and that uses an automated scoring algorithm, so that it is not required to have trained experts to evaluate participants' test results.

The test is based on the well-established and validated concept of Torrance Tests of Creative Thinking (Torrance, 1974). It was adapted to the computer screen using the same logic. In Study 1, parameters that can be used for designing an automated scoring algorithm were explored. The parameters that were found to be promising were for Fluency: number of real-world objects drawn and names; for Flexibility: number
of different patterns used when combining the shapes; for Originality: uniqueness of the picture (uniqueness of the combinations of shapes), complexity of the picture (number and diversity of shapes used, degree of variation of the shapes in terms

of size, position and rotation), uniqueness of the title, and complexity of the title (number of words used and length of each word). In Study 2, this scoring algorithm was validated by comparing the results from this algorithm to Expert ratings. Finally, in Study 3, the final version of the test was validated and showed satisfactory overlap with Expert ratings, test-retest reliability, discriminant validity, and independence of the ability to draw.

Limitations

A limitation of Study 1 and thus, in the definition of the scoring algorithm, is that the development of the algorithm was not theory-driven, but rather based on what was available. When the algorithm was developed, the authors could not find any models or studies on the aspects of the objects created that actually turn them into more or less creative ones. Thus, the method used to develop the algorithm was a machine-learning one to transfer the rating knowledge of experts into an algorithm. However, the subsequent two studies showed that the scoring is valid. Nevertheless, further validation of the scoring is necessary. The first question will be to what extent the algorithm generalises across different samples with different educational or cultural backgrounds. Moreover, there could also be differences in the validity of the algorithm that originate from different levels of experience with using the computer or even from different personality characteristics. For example, candidates who are more experienced in using the computer and who work with graphics a fair bit might use more of the functionalities the test offers than less experienced individuals. If true, the scoring algorithm might underestimate the creativity of those individuals who do not play around with the shapes quite as much.

Another issue of the current algorithm is that it does not check whether the object and its name are really in line. What could ultimately happen is that participants simply pull random shapes onto the drawing area and assign names that have nothing to do with the objects. To account for this, a report option was created in which the assessor can see all the objects and the names assigned to them. Thus, evaluators can manually check for congruence between object and name in case of doubt. Moreover, one could also state that, even if there is no congruence between objects and given names, under certain circumstances the individual acting in such a way can still be considered

creative: In order to get a high score on originality they will still have to come up with various combinations of objects and they will have to come up with many different names. So even if there is no congruence between object and name they will have had a lot of associations and a wide range of different ones.

In general, what is still lacking is proof of the prognostic validity of the instrument. There needs to be a criterion-related validity study in which it is tested whether the instrument predicts creativity. This is currently being planned.

Implications

Sparks assesses creativity and can be used in unsupervised settings. Thus, it can be used to assess an individual's creativity either at the selection or at the development stage. Creativity, in turn, is an important building block of innovation. Hence, if an organisation is looking into recruiting or developing individuals who are likely to be workplace innovators it can use this instrument.

At the selection stage, the recruiting organisation can determine who is creative and therefore might come up with ideas for workplace innovation when being recruited. Since the test is optimised for unsupervised online assessment this can happen at a very early stage in the recruitment process, i.e., before the candidate is even invited to an on-site interview or assessment centre. This means that it can be done quickly, at low cost, and independently of where on the globe the candidate is located.

At the developmental stage, the instrument can be used for assembling and developing teams as well as individuals. In combination with instruments assessing logical reasoning and personality, organizations can assess who in the team is likely to detect structures or processes within the organisation that can be optimised (based on a test assessing analytical abilities), who will come up with creative ideas for this issue (based on sparks), and who will be able to implement and communicate the innovation well (based on personality characteristics such as conscientiousness or social confidence). Thus, teams can be assembled in the best possible way so that they can be innovators in the workplace. Thus, altogether, sparks can help select and develop potential workplace innovators.

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