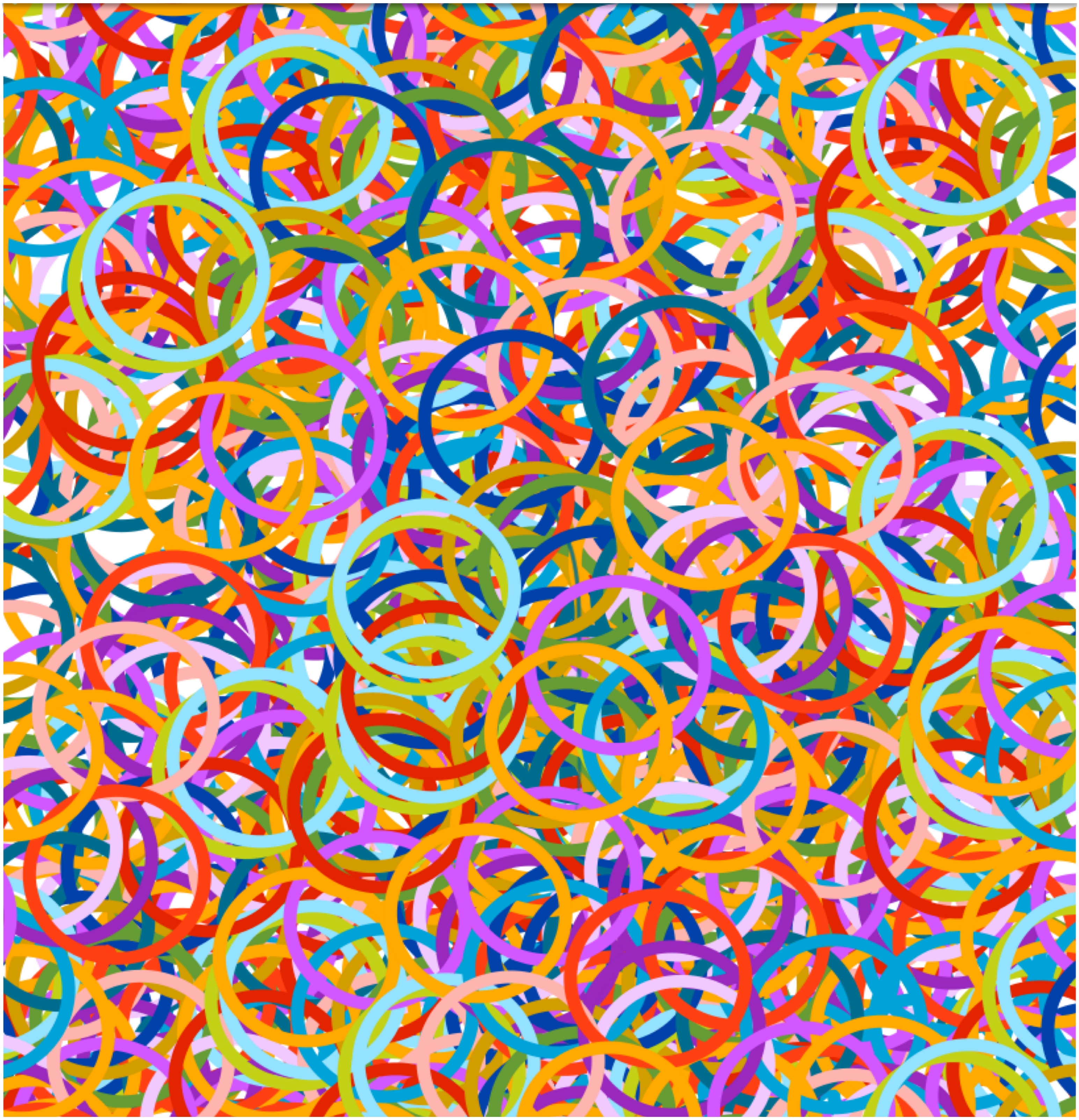
JIM Journal of Innovation Management

The International Journal on Multidisciplinary Approaches on Innovation

Volume 7 Issue 2 | 2019 | open-jim.org



ISSN 2183-0606

FEUP Edições

Volume 7 - Issue 2

Table of Contents

ISSN 2183-0606
http://www.open-jim.org

Editorial Team

ISSN 2183-0606
http://www.open-jim.org

ISSN 2183-0606
http://www.open-jim.org

Editorial Board Members (Technology and Science / Industry)

ISSN 2183-0606
http://www.open-jim.org

Journal of Innovation Management
JIM 7, 2 (2019) 1-6
HANDLE: https://hdl.handle.net/10216/121201
DOI:https://doi.org/10.24840/2183-0606_007.002_0001
SM: Apr/2016 AM: Apr/2018

Towards the science of managing for innovation: the beginning

Anne-Laure Mention
anne-laure.mention@rmit.edu.au | RMIT University, Australia
João José Pinto Ferreira
jjpf@fe.up.pt | INESC Technology and Science, Faculty of Engineering, University of Porto, Portugal
Marko Torkkeli
marko.torkkeli@lut.fi | Lappeenranta University of Technology, Finland

Some might argue that ever so nimble and responsive innovation paradigms can rarely be managed scientifically. We propose a more inclusive perspective. Science of managing for innovation has certain characteristics which we identify through the acronym "ROTRUS"- Real world, Observable, Testable, Replicable, Uncertain and Social. Real world refers to the notion that innovation happens in practical settings, be bound by resources and capabilities. This real world is the context in which the observable events occur. To progress the understanding of formative predictors and their impact on innovation, the innovation events need to be observable. This may be challenging if we are to believe that much of the innovation is driven by heuristics (see e.g. Lopez-Vega, Tell and Vanhaverbeke, 2016; Nisch and Veer, 2018). Observable evidence in our perspective does not mean it needs to be capable of being observed but includes events or phenomenon that were observed. In this sense, managerial heuristics once actioned become observed evidence, such that observable evidence is any evidence that can be or has been experienced by one or many, regardless of whether this can be observed by a third party. Yet, to progress further as science, these observations need to be replicable, and in the least predictable. Here innovation connects with psychology. Decades of psychology research and the recent works (see e.g. psychology of innovation by Cropley and Cropley, 2015 and cognition and innovation by Sund, Galavan and Brusoni, 2018) have shown us one thing – human behaviour is predictable under given conditions, and hence can be manipulated (Ariely, 2009). Given that humans are at the centre of all innovations (be as creator or user), this emphasises the current focus on humans in advancing the science of managing for innovation, both in terms of innovation as a process and an outcome (see Butler and Roberto, 2018; Yang, Wang, Zhou and Jiang, 2018). While this focus on how individual and group cognitive processes is recent and ongoing, it is likely to lead to scientific theories only when it can be repeated and proved or disproved. As evidence builds, science of managing for innovation will become more predictable. Yet, we must remain cautioned that it will never be 100% correct. This is especially the case when events involve social factors. As innovation continues to be more open and collaborative (Bogers, Chesbrough and Moedas, 2018), human social interactions within and between firms are becoming part of business-as-usual, explained in innovation literature through concepts of coopetition and cooperation (Bouncken, Fredrich, Ritala and Kraus, 2018; Mention, 2011). It is imperative in times like these that the focus is on the 'whole' rather than any singular nuances. Perhaps, because such a perspective also considers what is happening across various individual and group psychological levels as well as the interactions at organisational, ecosystem and global-level.

We argue that relying on single case studies or methods that draw on point-in-time beliefs, attitudes and perceptions of select individuals while interesting, pose a challenge for replicability. To move towards the science of managing for innovation, we need to be careful in avoiding pseudoscience and drawing generalised assumptions from information that is still in the proto-science stage (early understanding). Concentrating on single case studies (see recent innovation stories e.g. Manzini, Lazzarotti and Pellegrini, 2017) is like trying to understand complex brain functioning by focusing on select few neurons, when common knowledge tells us that brain functions through connectivity. In innovation management terms, literature is increasingly drawing attention to so-called failed cases (Ciesielska, 2018; von Briel and Recker, 2017) or 'sleeping beauties' (e.g. Dabrowska, Lopez-Vega and Ritala, 2019) in trying to draw prescriptions on the ways of managing for innovation. Yet, in keeping with the brain analogy, ask a neurologist, they will tell you that a focus on 'damaged' cells is less likely to reveal how to manage the brain functionality, compared to a focus on the science of how new connections are formed, stimulated and recognised. Even when there are fully functioning neurons in one area of the brain it bears little importance unless the firing of such neuron triggers interconnected transfer of a series of action potentials down the axon to result in desired reaction (electrical impulse transfer across the nerve in simpler terms). So, when the objective is to understand the formative predictors of innovation, at an individual level the focus needs to be on not only the mental processes but also the deeper neurological events affecting it and the behavioural outcomes arising from such processes. At a group or societal level, this means even when a firm has a 'cognitively present' manager, that individual insight has limited relevance to innovation, unless the cognitive flexibility and adaptability is shared amongst all those tasked to bring innovation to fruition. Science of managing for innovation, in this respect, calls for observation of not only individual-level predictors of innovation process and outcome, but also the interaction mechanisms that translate individual motivations and perceptions into intentions and socially-motivated behaviour.

In the following section, the beginning, we briefly introduce the foundations that can plausibly serve as levels of inquiry. As the reader will notice, some levels are obvious and well-researched where others are not. We do not intend to state this obvious, rather we aim to highlight the interconnectivity across levels and emphasis the need to investigate the interactions across levels to build replicable evidence to advance the science of managing for innovation.

ISSN 2183-0606
http://www.open-jim.org

The Beginning

I think, therefore I am. - René Descartes

Long ago, the ancient Greeks viewed brain as important part of the sacred human body. It was the early works of Pythagorean Alcmeon of Croton in the 6th and 5th centuries BC that we recognised the centrality of the brain and its connections to the mind. Nevertheless, it was not until Descartes in the 17th century famously argued the then illusive link between brain (I think) and mind (I am), that the discourse became disparate from the belief that brain was just an organ that cooled the body (Bear, Connors and Paradiso, 2001). In his famous work, the *Mediations on First Philosophy* (1641), Descartes formed association of mind with that of "a thing that thinks" and body as its "extension" (Descartes 1637/1980, 93). This formative assumption that it is the interactions of brain and mind that affects human behaviour has profoundly influenced the way we understand the world. More recent work in neuroplasticity has suggested that cognition and alterations to cognition through training regimes could affect the brain structure (Green and Bavelier, 2008). From an innovation management perspective, this notion attempts to explain the adaptive capacity of humans to learn new skills and cope with new knowledge sharing environments. However, it complicates the previous simplified depiction of the linear relationship between brain, mind and behaviour, spanning multiple levels of analysis. Our primary objective in this editorial is to re-imagine these levels of analysis as not hierarchical but interconnected stages (Fig. 1) and thus as an important segue towards the science of managing for innovation. The neurological level represents the 'the brain' and the biological factors such as genetic formations, brain chemical messengers and intelligence (Ilardi and Feldman, 2001). The mental level represents the 'the mind' and the behavioral level captures the actions, exchanges and effects of social interactions (Lilienfeld et al., 2016).

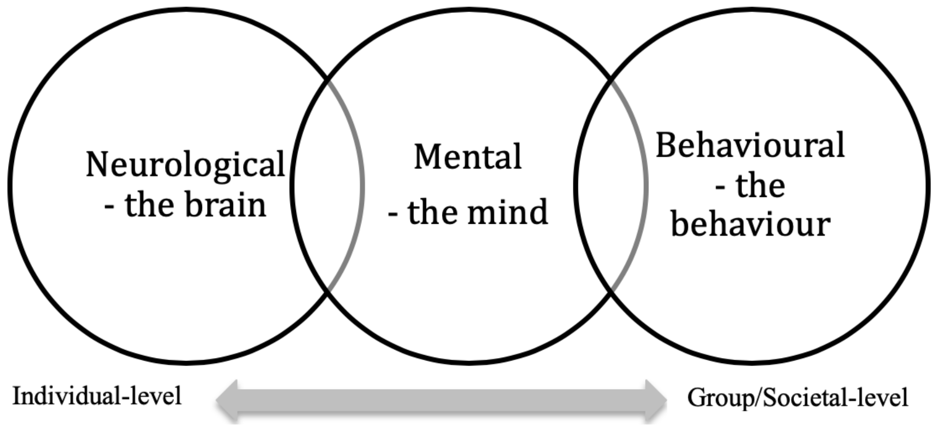


Fig. 1. Levels of analysis for science of managing for innovation (Source: Adapted from Lilienfeld et al., 2018)

The brain being the intelligence center of the body with neurons as its core functional units, implicates cognition, perception, emotions, feelings and sensitivity through transmission of action potential (*firing of the neurons*) (Lilienfeld et al., 2016). While some research points to the relationship between firing of a neuron and behavioural conditioning (Tsai et al., 2009), including

ISSN 2183-0606
http://www.open-jim.org

motivated goal-oriented behaviour (Grace et al., 2007), there is limited understanding on the links between brain activation and cognition (Lauriero-Martinez, Brusoni and Zollo, 2010). Some views in neuroscience exploring effects of social conditions (e.g. social exclusion) on patterns of brain activation through fMRI suggest that there may be significant correlates between what the mind think, what the body feels and how the brain reacts (Eisenberger, Lieberman, and Williams, 2003). This opens a new stream of investigations investigating the neurological effects on innovate on processes and outcomes.

From a management perspective, scholars in recent times have recognised the interplay of these multiple levels of analysis from various vantage points (see e.g. Narayanan, Zane, and Kemmerer 2011). The 'mind' in particular has been studied extensively in management literature (see e.g. Abell, Felin and Foss, 2008; Grisold and Peschl 2017). Much of the research in this stream has focused on knowledge, perceptions, cognition, thinking, emotions and feelings, often keeping to the boundaries of subjective-objective dichotomy. Some focus has been on the human behavioural aspect of innovation management (Salampasis and Mention 2017), albeit largely confined to attitudes (e.g. Antons and Piller 2015), cognitive coping (Salter, Criscuolo, & Ter Wal, 2014) and individual characteristics (Bogers, Foss and Lyngsie, 2018), with infrequent studies linking genetic hereditary to risk-taking behaviour (Shikishima et al. 2015; Zuckerman and Kuhlman 2000). While these studies might just have triggered a renewed focus on the human factors in innovation management, we propose that to advance the science of managing for innovation, research needs to focus on the 'whole' and argue that scientific revelations are more likely to emerge from studies that explore, explain and predict the peculiarities of the brain-mind-behaviour triad.

In the next editorial, we will progress *the beginning* introduced here to *interim discussions* on the science of managing for innovation with a focus on innovation problems and research methods before finally arriving at *the conclusion* and propositions for the future of innovation management research and practice. Meanwhile, we welcome your conceptual, theoretical, perspective and empirical contributions on topics that relate to innovation and its management.

Innovatively yours,

Anne-Laure Mention, João José Pinto Ferreira, Marko Torkkeli

The Editors

References

Abell, P., Felin, T. and Foss, N., 2008. "Building micro-foundations for the routines, capabilities, and performance links." *Managerial and decision economics*, 29(6): 489-502.

Antons, D. and Piller, F.T., 2015. "Opening the black box of "Not Invented Here": Attitudes, decision biases, and behavioral consequences." *The Academy of Management Perspectives*, 29(2): 193-217.

Ariely, D., 2009. "*Predictably irrational*", revised and expanded edition. HarperCollingsPublishers, London.

Bear, M.F., Connors, B. W., and Paradiso M.A. 2001. *"Neuroscience: Exploring the Brain."* Baltimore: Lippincott.

Bogers, M., Chesbrough, H. and Moedas, C., 2018. Open innovation: research, practices, and policies. *California Management Review*, 60(2), pp.5-16.

Bogers, M., Foss, N.J. and Lyngsie, J., 2018. The "human side" of open innovation: The role of employee diversity in firm-level openness. *Research Policy*, 47(1), pp.218-231.

Bouncken, R.B., Fredrich, V., Ritala, P. and Kraus, S., 2018. Coopetition in new product development alliances: advantages and tensions for incremental and radical innovation. *British Journal of Management*, 29(3), pp.391-410.

Butler, A.G. and Roberto, M.A., 2018. When Cognition Interferes with Innovation: Overcoming Cognitive Obstacles to Design Thinking: Design thinking can fail when cognitive obstacles interfere; appropriate cognitive countermeasures can help disarm the traps. *Research-Technology Management*, 61(4), pp.45-51.

Chesbrough, H.W., 2003. Open innovation: The new imperative for creating and profiting from technology. *Harvard Business Press.*

Ciesielska, M., 2018. Nokia on the slope: The failure of a hybrid open/closed source model. *The International Journal of Entrepreneurship and Innovation*, 19(3), pp.218-225.

Cropley, D.H. and Cropley, A.J., 2015. *The psychology of innovation in organizations.* Cambridge University Press.

Dąbrowska, J., Lopez-Vega, H. and Ritala, P., 2019. Waking the sleeping beauty: Swarovski's open innovation journey. *R&D Management.*

Descartes, R. (1637/1980). Discourse on the method for rightly conducting one's reason and for seeking truth in the sciences. In D. A. Cress (Ed.), *Discourse on method and meditations on first philosophy.* Indianapolis, IA: Hackett Publishing Company.

Eisenberger, N.I., Lieberman, M.D. and Williams, K.D., 2003. "Does rejection hurt? An fMRI study of social exclusion." *Science*, 302(5643): 290-292.

Grace, A.A., Floresco, S.B., Goto, Y. and Lodge, D.J., 2007. "Regulation of firing of dopaminergic neurons and control of goal-directed behaviors." *Trends in neurosciences*, 30(5): 220-227.

Green, C.S. and Bavelier, D., 2008. "Exercising your brain: a review of human brain plasticity and training-induced learning." *Psychology and aging*, 23(4): 692.

Grisold, T. and Peschl, M., 2017. "Organizational Predictive Mind as Obstacle for Change and Innovation: A Systems Thinking Perspective." *Marketing and Innovation Strategies for Small and Medium-sized Enterprises* (SMEs): 70.

Ilardi, S.S. and Feldman, D., 2001. "The cognitive neuroscience paradigm: A unifying metatheoretical framework for the science and practice of clinical psychology." *Journal of Clinical Psychology*, 57(9): 1067-1088.

Laureiro-Martínez, D., Brusoni, S. and Zollo, M., 2010. The neuroscientific foundations of the exploration− exploitation dilemma. *Journal of Neuroscience, Psychology, and Economics*, 3(2), p.95.

Lilienfeld, S., Lynn, S.J., Namy, L., Woolf, N., Jamieson, G., Marks, A. and Slaughter, V., 2016. "*Psychology: From inquiry to understanding* (Vol. 2)." Australia: Pearson Higher Education.

Lopez-Vega, H., Tell, F. and Vanhaverbeke, W., 2016. Where and how to search? Search paths in open innovation. *Research Policy*, 45(1), pp.125-136.

Manzini, R., Lazzarotti, V. and Pellegrini, L., 2017. How to remain as closed as possible in the open innovation era: the case of Lindt & Sprüngli. *Long Range Planning*, 50(2), pp.260-281.

Mention, A.L., 2011. Co-operation and co-opetition as open innovation practices in the service sector: which influence on innovation novelty?. *Technovation*, 31(1), pp.44-53.

Narayanan, V.K., Zane, L.J. and Kemmerer, B., 2011. "The cognitive perspective in strategy: An integrative review." *Journal of Management*, 37(1): 305-351.

Nisch, M. and Veer, T.H., 2018, July. The Role Of Heuristics In Innovation Project Selection. In Academy of Management Proceedings (Vol. 2018, No. 1, p. 14106). Briarcliff Manor, NY 10510: *Academy of Management.*

Salampasis, D. and Mention, A.L., 2017. "*Open Innovation: Unveiling the Power of the Human Element.*" Singapore: World Scientific Publishing.

Salter, A., Criscuolo, P. and Ter Wal, A.L., 2014. "Coping with open innovation: responding to the challenges of external engagement in R&D." *California Management Review*, 56(2): 77-94.

Shikishima, C., Hiraishi, K., Yamagata, S., Ando, J. and Okada, M., 2015. "Genetic factors of individual differences in decision making in economic behavior: A Japanese twin study using the allais problem." *Frontiers in psychology*, 6: 1712.

Sund, K.J., Galavan, R.J. and Brusoni, S. eds., 2018. *Cognition and innovation.* Emerald Publishing Limited.

Tsai, H.C., Zhang, F., Adamantidis, A., Stuber, G.D., Bonci, A., De Lecea, L. and Deisseroth, K., 2009. "Phasic firing in dopaminergic neurons is sufficient for behavioral conditioning." *Science*, 324(5930): 1080-1084.

von Briel, F. and Recker, J.C., 2017. Lessons from a failed implementation of an online open innovation community in an innovative organization. *MIS Quarterly Executive*, 16(1), pp.35-46.

Yang, D., Wang, A.X., Zhou, K.Z. and Jiang, W., 2018. Environmental strategy, institutional force, and innovation capability: A managerial cognition perspective. *Journal of Business Ethics*, pp.1-15.

Zuckerman, M. and Kuhlman, D.M., 2000. "Personality and risk-taking: common biosocial factors." *Journal of personality*, 68(6): 999-1029.

Cite paper as: Mention, A., Pinto Ferreira, J.J., Torkkeli, M., (2019). Towards the science of managing for innovation: the beginning, *Journal of Innovation Management*, www.open-jim.org, 7(2), 1-6.

Journal of Innovation Management
JIM 7, 2 (2019) 7-14
HANDLE: https://hdl.handle.net/10216/121201
DOI:https://doi.org/10.24840/2183-0606_007.002_0002

A Practitioners Perspective on The Benefits of Open Innovation

Tim Stroh
tim@strohinternational.com | The Wilde Consulting Group, Melbourne, Australia

Letter from Industry

Abstract. The common approaches to innovation deployed by many corporations are ineffective and associated with a collection of well-defined risks including hype driven and biased decision making, risk aversion, and disruption. In contrast, open innovation programs reduce these same risks and deliver a variety of substantial benefits ranging from increased innovation speed, reduced costs, and increased probability of success.

Keywords. Open Innovation; Strategy; Innovative Performance; Innovation.

Cite paper as: Stroh, T., (2019). A Practitioners Perspective on The Benefits of Open Innovation - Letter from Industry, *Journal of Innovation Management*, www.open-jim.org, 7(2), 7-14.

1 The High Risk of Traditional Innovation Methods

Large organizations are notoriously bad at innovating. In my experience, the vast majority respond to inconsistent or poor innovation outcomes by adopting methods used by others and thus perceived as rationally justifiable or safe even though results are uncertain. Problematically, these widely accepted methods do not appear to have changed the overall failure rate and, as such, are costly and unsustainable.

A superficial review of corporate innovation programs suggests many respond with innovation theatre. Organizations adopt and publicize initiatives that produce a market perception of innovativeness but deliver little in the way of actual innovative change and advancement. In Australia, for example, a quick review of media releases and news coverage over the last five years reveals of the largest banks, the top 10 insurance companies, and the big four consultancies nearly all have publicly adopted one or more of "Agile", "hack days", "fail fast fail cheap", an Innovation Lab, or a startup accelerator. Yet, none of these companies have introduced any substantial innovations in recent years. The "innovation" awards received and observable changes to their businesses are limited to incremental efficiency initiatives. These companies pursue the market benefits of being perceived as innovative including a positive impact on share price, superior ability to recruit high calibre new staff, and executive prestige but avoid the risks of large budget failures or customer attrition that can be caused by substantial but unappealing change. These so called "innovation" programs are largely limited to the adoption of current management fads. The vast majority remain focussed on modest incremental or low risk changes and, even when positive results are achieved, they are often short lived (Ahlback et al. 2018, Dahlström et al. 2018).

Another common response is to refocus on "core" customers and the "core" business. Organizations strive for product or service enhancements suggested primarily or exclusively by existing customers. While of value, this value is bounded and accompanied by several specific forms of risk. Adding new features or benefits based solely on traditional parameters such as requests from high-value customers leaves a company open to:

1. An unavoidable tendency toward incremental, status safe decisions (Stroh, 2018). This leaves an organization more susceptible to disruption (Christensen, 1997).

2. Poor or biased selection by executives. The so-called Hippo effect or overweighting of the highest paid person's opinion (Kohavi, et al., 2007; McAfee and Brynjolfsson, 2012). Even when tools or methods are used for feature selection, these methods have been shown to be subjective and the executive's interpretation of what should be done and ultimately what is fielded can often be unaligned with market demand (Stewart, 1992).

3. The changing nature of competition over time due to predictable and leverage-able hard trends in technology, demographics, etc. will change the nature of competition over time. No improvement to propeller fighter aircraft was ever going to make them competitive with jet-powered fighters. This wasn't disruption but an entirely predictable outcome of the progression of technology based on hard science and the known or calculated performance envelopes of the two technologies.

4. Competitive activity that is comparable in nature but superior in design or execution. Pitting your weakness to an opponent's strength has always been and always will be recipe for disaster.

Finally, there are companies that manage the risk of innovation and market change by largely setting aside any internal drive to innovate. Instead, they plan to remain competitive by waiting to see what technologies, new products, and new startups succeed. They will then endeavour to buy the winners. While this approach appears to offer greater certainty, it is both very expensive and prone to a surprising level of failure. Acquisitions regularly don't work out. Buyers make their purchase a bit too early and the company that appeared to be the next big thing often proves to be more hype than substance. Others are destroyed by the attempts to integrate the new organization into the old or simply by poor due diligence, the acquired company was simply a poor choice and cannot perform as expected. Acquirers often make their decisions based on an extraordinary lack of front-line information or first-hand experience with the acquired company's staff, the interaction of line staff with management, their collective interaction with customers, or an objective picture of current and likely ongoing performance. The decision to purchase is often formed primarily around traditional methods of financial and business data analysis that focus on the rosy picture the seller paints and the buyer wants to hear. The same faulty decision processes that result in so many failed new products, organizational change initiatives, and attempts at innovation also result in a flawed consideration of selection criteria for new acquisitions. Purchases are then made while completely overlooking the role and impact of the target organisation's strategy, non-financial performance in context, and the predictable changes that are occurring within the context market.

Thankfully, there are superior alternatives. One of these is to establish an open innovation network.

2 The Open Innovation Alternative

One of these alternatives is the establishment of Open Innovation networks. "Open Innovation is the use of purposive inflows and outflows of knowledge to accelerate internal innovation, and expand the markets for external use of innovation, respectively" (Chesbrough, 2006).

Open innovation networks offer a variety of unique and substantial advantages over most traditional approaches to innovation. First and foremost, for most organizations there will generally be a variety of quick wins to be had simply by asking questions and looking widely outside their own industry. Surprising to many, the technical challenges faced when attempting to improve a product or services have often already been overcome in a different industry or discipline of research. Due to the limited nature of staff crossover between industries, the different terminology used across different arenas of activity, and the different ways in which problems are framed and described, awareness of shared challenges and solutions is limited (Dror, 2011; Kambourov and Manovskii, 2002, 2008; Leonard-Barton, 1995; Sternberg, 2002). Many successful innovations, from Nike Air trainers and the Black & Decker Dust Buster to anti-lock brakes and silly string used for detecting boobytraps, are the product of a simple application of a piece of information,

ISSN 2183-0606
http://www.open-jim.org

technology, product or service created for a niche need in one market to a similar or novel purpose in another.

Peter Borden has pointed out, "Most advances in science come when a person for one reason or another is forced to change fields." This sentiment is reinforced by Dorothy Leonard-Barton who says “Innovation occurs at the boundaries between mindsets, not within the provincial territory of one knowledge or skills base” (Leonard-Barton, 1995). Exposure to other industries and a diversity of perspectives, innovation challenges, and ways of thinking captured via an open network, the boundaries between industry specific mindsets, enhances the probability of success in spotting opportunities, team members being intellectually open to them, and objective consideration (Blomqvist et al., 2004; Tomlinson, 2010). This reality can yield quick results for those willing to open up about their challenges, take the time to explore different ways a question can be framed, and engage across industries and arenas of expertise (Asimov, 1959; Traitler, 2011). An open innovation network makes this process more probable, easier, and faster. Pursuing and sharing knowledge of your challenges and solutions in other industries is also a great basis to start the process of creating a network.

While it might seem counterintuitive, an open approach not limited to feedback from narrowly focussed customers or users also helps overcome several of the most significant hurdles to successful innovation. The primary barriers to successful innovation in most organizations are the social nature of human decision processes and the near-universal fear of loss of status associated with making decisions outside the accepted norms or an organization, industry, or discipline (Stroh, 2018). This social nature of decision making heavily biases decisions toward lower risk options such as incremental enhancements to existing products and services and against more substantial and valuable alternatives (Stroh, 2018). Embracing an open innovation network mandates interaction with a wider circle of executives and decision makers with different norms and perceptions of what might be worth trying. This changes the nature of social influence and the psychological risk profile of decisions. The norm is no longer determined exclusively by a single organization or a single executive team’s perception of what is normal. Instead, the view of what is reasonable is expanded in proportion to the magnitude of the network and the depth of the interactions. Procter & Gamble and Amazon’s success across a variety of industries, markets and functions are excellent examples (Lafley, 2008).

The perception of tangible risk is also reduced where a network reveals similar successful solutions and decisions made by others for similar but different situations. If something doesn’t work but was aligned with successful attempts in other industries, the broader community is unlikely to judge it as having been inappropriately risky and is more likely to judge it as a reasonable calculated risk. The widespread adoption of just in time manufacturing techniques and the evolution of a variety of lean production methodologies are good examples. The success of programs such as Google X (now the Moonshot Factory) which has pursued scientists, engineers, and managers from diverse industries who are in turn avidly sought after irrespective of the success of the projects they worked on is another example. The reduced risk of a loss of professional status resulting from unsuccessful innovative choices within a more open innovation community of professionals and peers will fundamentally change what decisions are considered and what projects are supported. Exposure to other industries, companies, and problems facilitates enhanced objectivity and reduces the barriers or artificial boundaries inherent in entrenched paradigms and pre-existing more limited perspectives.

In addition, it is worth considering the growing importance of consumer offerings comprised of whole commercial ecosystems of interrelated products and services. I have conducted a brief survey of disrupted providers and markets. It suggests that susceptibility to disruption is reduced where organizations are part of a robust interdependent ecosystem of value to customers and increased where the value being transferred is the function of a single offering independent of others. Taxi's, video stores, and traditional mobile phones were easily disrupted because a superior offering that changed the criteria for selection could be easily substituted as a straight swap. It will be more difficult to disrupt smartphones, however, because they are part of an ecosystem offering. The value obtained by users from their smartphone is not simply a function of the hardware device but also the community of apps, app developers, and services accessible via the smartphone, its apps, and the smartphone's interaction with other devices. Banking, despite being ripe for disruption, is more resistant to disruption due to the ecosystem of players and value we obtain and rely upon including credit cards, access to merchant terminal networks, home loan broker networks, compliance with government legislation and thus insurance, and more.

Such networks and ecosystems can also facilitate value to an organization via improved staff engagement. Employees are the most important element of any business. Take care of them, and they'll take care of the customer, look out for risks, and constantly work to make things better. Placing artificial boundaries on your staff such that they can only see the world from one perspective is bad for them and fraught with risk for your organization. Building a learning organization, using the Prussian Staff concept to rotate people across positions, jobs, and areas of activity helps to expand horizons, reduces operational risks, builds capabilities, and fosters open mindsets to innovation. Doing so and actively assisting your best team members to move up by moving out of your organization and successfully into other organizations might seem counterintuitive. But the engagement value for those coming up through the ranks outweighs the costs in attrition. Further, the value of those staff when you poach them back after gaining a new and different perspective as well as their willingness to share via your expanded open innovation network is unprecedented. It is good for them and your organization. There is certainly research required on each of these topics to validate my observations as a practitioner. These have held true, however, across multiple businesses in different industries and of various sizes.

Finally, while the speed of technological advancement can diminish the apparent lifespan and thus return on investment from individual technologies, those that exist within and are fundamental to an ecosystem of value will have a greater lifespan. As the cost of major advances continues to rise, both optimizing ROI and reducing the risk of disruption become fundamental to success. The value of a focus on networks and ecosystems is further amplified by the increasing propensity of global markets to produce parallel invention or parallel discovery. From the simultaneously but independent development of the theory of evolution and the race to bring to market the first GUI to advanced AI systems for interpreting language that independently emerged on opposite sides of the planet, the modern world makes available similar information and inputs far more broadly than ever before. Just as intelligent people exposed to the same information will eventually reach the same or similar conclusions, so to the result of more people with the same cutting-edge information is more people independently coming up with similar new inventions. Most VC simply accept that if they are pitched something they love, it doesn't matter that they don't know of competitors. Those competitors are out there. This adds further value to both creating in context of an ecosystem and the value of speed that accompanies an open innovation network.

3 Conclusion

The benefits of open innovation are substantial and varied. For most organizations, open innovation should be part of the innovation mix and for many it should be part of the foundation of their innovation efforts. Open Innovation increases an organization's ability to see and capitalize on opportunities as well as deploy innovations that are more secure as elements of an ecosystem. While Open Innovation may not be suitable for every situation and the value of proprietary IP and traditional methods of IP protection must, of course, be considered, Open Innovation Networks make success more likely rather than less and rarely do so at the expense of an ability to protect IP either via traditional means or the development of an interdependent ecosystem of value. Facilitated cross-pollination, cooperative R&D, and cooperative ecosystem development within broad but well considered boundaries has been shown to deliver benefits. Establishing open networks across industries will bring an invaluable diversity of ideas, problem-solving methods, and paradigms of thought that cannot be obtained effectively in any other way. It will also specifically deliver a host of tangible innovation benefits.

4 References

Ahlback, K., Comella-Dorda, S., & Mahadevan, D. (2018, May 7) The drawbacks of agility. Accessed April 2019:
https://www.mckinsey.com/business-functions/organization/our-insights/the-organization-blog/the-drawbacks-of-agility

Asimov, Isaac. (1959) Isaac Asimov Asks, "How Do People Get New Ideas?" *MIT Technology Review* October 20, 2014

Blomqvist, K., Hara, V., Koivuniemi, J., & Äijö, T. (2004) Towards networked R&D management: the R&D approach of Sonera Corporation as an example. *R&D Management*, Volume 34, Issue 5, November 2004, Pages 591-603.

Chesbrough, H. (2006) Open innovation: A new paradigm for understanding industrial innovation. In: Chesbrough, H., Vanhaverbeke, W., West, J. (Eds). *Open innovation: Researching a new paradigm*, 1-12 (pp. 2). Oxford: Oxford University Press.

Christensen, C. M. (1997) *The Innovator's Dilemma.* New York: Harper Business.

Dahlström, P., Desmet, D, Singer M. (2018) The seven decisions that matter in a digital transformation: A CEO's guide to reinvention. *Digital reinvention: Unlocking the 'how'*, 22. Accessed

April 2019:
https://www.mckinsey.com/ /media/mckinsey/business%20functions/mckinsey %20digital/our%20insights/digital%20reinvention%20unlocking%20the%20how/ digital-reinvention_unlocking-the-how.ashx

Dror, I. (2011). The paradox of human expertise: why experts get it wrong. In: ed. Narinder Kapur. *The Paradoxical Brain*, (Ch 9). Cambridge: Cambridge University Press.

Kambourov, G., & Manovskii I. (2002) Occupational Specificity of Human Capital, mimeo, The University of Western Ontario.

Kambourov, G., & Manovskii, I. (2008) Rising occupational and industry mobility in the United States: 1968-1997. *International Economic Review*, 49(1):41–79.

Kambourov, G., & Manovskii, I. (2009) Occupational specificity of human capital. *International Economic Review*, 50(1):63–115.

Kohavi, R., Henne, R.M., & Sommerfield, D. (2007) Practical guide to controlled experiments on the web: listen to your customers not to the hippo, Proceedings of the 13th ACM SIGKDD international conference on Knowledge discovery and data mining, August 12-15, 2007, San Jose, California, USA

Lafley A. G. (2008) P&G's innovation culture. *Strategy+Business*, Autumn. Accessed Jun 2009: http://www.strategy-business.com/media/file/enews-08–28-08.pdf.

Leonard-Barton, D. (1998) *The Wellsprings of Knowledge: Building and Sustaining the Sources of Innovation* (Pp. 64). Boston: Harvard Business School Press.

McAffee, A., & Brynjolfsson, E. (2012) Big Data: The Management Revolution. *Harvard Business Review* Oct 2012.

Stanovich, K. (2009). *What Intelligence Tests Miss.* New Haven, CT: Yale University Press.

Sternberg, R.J. (Ed). (2002). *Why Smart People can be so stupid.* New Haven, CT: Yale University Press.

Stewart T. J. (1992) A critical survey on the status of multiple criteria decision making theory and practice, *OMEGA International Journal of Management Science*, Vol.20, No.5-6, 1992, 569-586.

Stroh, T. (2018). *A Deeper Truth: The new science of innovation, human choice, and societal scale behavior.* New Jersey: Wilde Griffen Publishing Bookbaby.

Traitler H., Watzke H.J., & Saguy I.S. (2011) Reinventing R&D in an Open Innovation Ecosystem. *Journal of Food Science*, Volume76, Issue2, March 2011, Pages R62-R68

Tomlinson, P.R. (2010). Co-operative ties and innovation: some new evidence for UK manufacturing. *Research Policy* 39, 762–775.

ISSN 2183-0606
http://www.open-jim.org

Biographies

Tim Stroh. Tim Stroh is currently pursuing a Ph.D. in Management at the Royal Melbourne Institute of Technology (RMIT) in Melbourne, Australia. His research interests include socio-biology, neuroscience, motivation, innovation, and organizational structures and norms. From 1993 to 2019, he worked as a serial entrepreneur, senior executive, and consultant. In addition to pursuing his Ph.D. he is currently head of strategy and product for Art Processors (a member of the Moorilla group of companies), is a start-up mentor for the Spark Accelerator program at Deakin University, provides consulting services to large enterprise on strategy, innovation, building engaged organizations and deploying effective and ethical incentive programs. He is also a regular keynote speaker. His publications include A Deeper Truth: The new science of innovation, human choice and societal scale behavior (2018). Mr. Stroh has been awarded several patents, the 4th Annual Ethical Investor Sustainability Award for new products in 2006, StartupSmart's 2014 So You Think You Can Start-up pitching competition and his book has received a variety of awards and medals. He has also developed and launched hundreds of products across multiple industries and taken multiple start-ups from concept through to successful trade-sale exit.

ISSN 2183-0606
http://www.open-jim.org

Journal of Innovation Management
JIM 7, 2 (2019) 15-37
HANDLE: https://hdl.handle.net/10216/121201
DOI:https://doi.org/10.24840/2183-0606_007.002_0003
SM: Mar/2018 AM: Apr/2019

Characterisation of Innovations within the Multi-Level Perspective with Diffusion Typology of Innovations: A Fruitful Combination

Dorothee Keppler
keppler@ztg.tu-berlin.de | Technische Universität Berlin, Zentrum Technik und Gesellschaft, HBS 1, Hardenbergstr. 16-18, 10623 Berlin, Germany

Abstract. This article seeks to show why and in which way a combination of the MLP with typology of innovations based on diffusion research can be fruitful for practical application of the MLP, as well as for refining the conceptual view on regime/niche interactions resulting from innovations from long established market niches. Application of the MLP to the example of absorption chiller innovations in the changing socio-technical refrigeration regime demonstrates that characterisation of innovations only by criteria offered by MLP authors can lead to inconclusive results. I argue that this is because they are innovations from market-niche technologies for which the distinction between radical and incremental innovations is not sufficient, as it neglects the changing character of innovations over time. It is important, I conclude, to clearly distinguish incremental innovations to market-niche technologies which perpetuate the radical character of their origin from incremental innovations of regime-dominant technologies. To enable a characterisation independent from the criterion of novelty that the MLP focuses on to distinguish radical and incremental innovations, I propose a more detailed classification based on theoretical and practical findings from diffusion research. Beyond facilitating a much more differentiated characterisation, this combination also opens up possibilities to reconsider and refine understanding of interdependencies of innovations from long established market-niche technologies and patterns of regime development.

Keywords. Technological innovation, Multi-level perspective, Socio-technical regime, Diffusion of innovation research, Energy efficiency

---

Cite paper as: Keppler, D., (2019). Characterisation of Innovations within the Multi-Level Perspective with Diffusion Typology of Innovations: A Fruitful Combination, *Journal of Innovation Management*, www.open-jim.org, 7(2), 15-37.

1 Introduction

At present, several supply or infrastructure systems are undergoing profound processes of change, from electricity or mobility to agricultural systems. The main challenge is to shape these processes in a way that creates more sustainable and climate-friendly system structures and mechanisms. In this context, the development and diffusion of sustainability-oriented innovations is a key element. As technology diffusion often requires and creates reconfigurations at the level of socio-technical systems and vice versa, systemic chance and innovation processes are strongly intertwined.

The multi-level perspective (MLP) has been frequently used to examine multiple fields of sustainable transition (Geels, 2007; Holtz, Brugnach & Pahl-Wostl, 2008; Raven, Heiskanen, Lovio, Hodson & Brohmann, 2007). Since this approach focuses on the interdependency of radical technological niche-innovations and socio-technical regime change, it is particularly suitable for fields of action where technology plays a significant role. One of the strengths of MLP is that it reflects the interdependency of technical and societal developments as well as of different levels of action, from innovations in socio-technical niches and pilot projects to national and international system levels.

Whereas the MLP approaches the issue of sustainability-oriented change primarily from the system perspective, diffusion theories approach the issue from the perspective of innovation. A wealth of research focuses on those factors which influence a broader dissemination of innovations that can contribute to more sustainable societal developments (Aizstrauta, Ginters & Eroles, 2015; Dibra, 2015; Fichter & Clausen, 2016; Karakaya, Hidalgo & Nuur, 2014). Aside from characteristics of the technology itself, these research approaches consider a variety of societal aspects, from provider and adopter characteristics to policy and path-related factors (Clausen, Fichter & Winter, 2011; Karnowski, 2017; Rogers, 2003).

This article discusses the positive effects of combining both the multi-level perspective and a classification of innovations based on empirical results from diffusion research. The example of absorption chiller innovations demonstrates why and in what ways this combination can be fruitful. In particular, I seek to demonstrate that

- the criterion of novelty the MLP uses for characterising radical and incremental innovations is insufficient at least in some cases
- this can be traced back to a disregard of the changing character of innovations over time, which is especially important for innovations having undergone long-term phases of stabilisation within market niches
- a combination of MLP and a more differentiated process of innovation typing based on diffusion-relevant criteria can enable a clearer classification of innovations independent from the state of regime/niche interaction at the time the characterisation takes place, and that
- this combination can also provide new ways to describe promising pathways of regime development.

Despite the known influence of innovations' characteristics on regime development, the relatively

ISSN 2183-0606
http://www.open-jim.org

simple concept of innovations within the MLP, which distinguishes only between radical and incremental innovations and which characterises radical innovations by focusing on novelty as the central criterion for regime compatibility, has not yet been revised. And although the process-oriented, diverse and long-term character of regime developments has been emphasised in the recent literature, consequences for the typing of innovations in different stages of regime and niche interaction have also not been considered within the framework.

Without question, this has proved to be an adequate approach for many cases as, in practice, relevant – radical – innovations are usually characterised on the basis of a public and/or scientific consensus that they can and probably will lead to a regime shift or because authors are engaging in retrospective analysis. In these cases a dedicated examination of the respective innovation's character may be dispensed with. The following will argue that this procedure is insufficient where no such clarity or consensus exists and where characteristics of the relevant innovation are equivocal. This will be illustrated with insights from the example of absorption chiller innovations in the field of refrigeration supply which, it is expected, will contribute to a more climate-friendly refrigeration supply regime. In this case, clear characterisation only by those criteria offered by the MLP has been hardly possible because incremental as well as radical qualities are featured. A closer investigation of the causes and possible solutions to this set of problems leads to the conclusions presented later.

This article is structured in the following way: section 2 presents the concept of socio-technical regimes and its extension to the multi-level perspective (2.1) and its current distinction between radical and incremental innovations (2.2). Based on this, section 3 then builds a socio-technical perspective on thermally driven cooling supply and current technical innovations in this field. As this attempt reveals that these exhibit characteristics of both incremental and radical innovations, I analyse underlying causes, focusing on the characteristics and function of market niches in the MLP innovations refining non-regime-dominant technologies (section 4), which has been neglected up to now. In order to address my findings, I suggest enhancing the distinction between radical and incremental innovations by using criteria from diffusion theory (5.1) and demonstrating the positive effects of this approach by applying it to the example of absorption chiller innovations (5.2), followed by a discussion in section 5.3. In section 6, I summarise essential results and draw some conclusions including the need for further research.

2 The multi-level perspective

2.1 Socio-technical regimes and the multi-level perspective

According to current definitions, socio-technical regimes can be characterised as heterogeneous and complex systems of coordinated and functionally coupled social and technical elements. A socio-technical regime includes a specific combination of physical artefacts, organisations, natural resources, scientific elements and legislative artefacts (Geels, 2002, p. 1257), allowing the system to provide a certain societal function (like water or electricity supply) (Holtz et al., 2008, p. 629; Kemp, 1996, p. 155; Kemp, Schot & Hoogma, 1998, p. 182).

The socio-technical regime approach has its roots in Nelson and Winter's conception of technological regimes as well as in the conception of technological paradigms of Giovanni Dosi (cf. Kemp et al., 1998, pp. 176 & 181). Compared with these older conceptions, however, which focused on technological properties and engineers' beliefs, the socio-technical regime approach has been broadened in two respects.

First, the research perspective has been enlarged from merely examining engineers' search heuristics and routines to a comprehensive consideration of multiple factors of technology development. Consequently, technological development paths are now held to be also shaped by existing technological designs and the alignment of a dominant technology with its particular socio-economic context, including for example production routines, producer–user relationships, accumulated knowledge, habits, abilities and skills, social norms, governmental rules or established consumer patterns and lifestyles (Geels, 2002, p. 1260; Holtz et al., 2008, p. 625; Kemp et al., 1998, pp. 177 & 181-182).

Constitutive for the conception of socio-technical regimes is, second, a multi-actor perspective that supersedes the former focus on engineers or rather engineer–entrepreneur relationships. Technology development processes and technological trajectories within socio-technical regimes are also influenced by users, politicians, societal groups, scientists, capital companies and others (Geels, 2002, p. 1260, 2007, p. 128; Raven, 2005, p. 29). Actors' decisions and activities, their interactions with each other and with technology, are structured by system-specific formal, normative and cognitive rules (Geels, 2002, p. 1259, 2004, pp. 902-906, 2007, pp. 127-128; Kemp et al., 1998, p. 182; Raven, 2005, pp. 27-29).

Socio-technical regimes usually have two typical patterns of dynamics and change, in which two types of innovation play a central role: first, path dependent, incremental change in stable systems and second, radical change or socio-technical transitions, arising from radical innovations taking place within the context of unstable socio-technical regimes and landscapes (Geels, 2002, p. 1260).

Generally, socio-technical regimes are dynamically stable entities. The close interconnections of the elements within a regime enable smooth processes but also tend to discourage deviation from existing routines and development paths. Following existing trajectories, actors can profit from realised advantages of existing technology and matching social structures (like increased performance, established producer–user relationships or competencies). This is why dynamics in stable socio-technical systems usually follow existing trajectories and innovation activities are of an incremental nature, meaning especially improvements to existing technologies which do not threaten established trajectories. (Geels, 2002, pp. 1258-1259, 2004, p. 910, 2007, p. 128; Hoogma, Kemp, Shot, & Truffer, 2002, pp. 155-156; Kemp et al., 1998, pp. 177-180 & 183-184; Raven, 2005, pp. 29 & 33)

Although the path dependency of a regime's dynamics constitutes a strong barrier to innovation, socio-technical regimes can undergo processes of radical change under certain circumstances, known as a socio-technical transition or regime shift. During this process, the material and social structures and rules of the existing socio-technical system are replaced by new ones (Geels, 2002, 2004, pp. 912-914, 2007, pp. 129-131; Holtz et al., 2008; Kemp et al., 1998; Rotmans, Kemp, & van Asselt, 2001).

To provide a framework for addressing this issue, the multi-level perspective proposes a three-level model in which the two additional levels of socio-technical landscapes and niches complement the regime level. The central hypothesis holds that radical change is the result of the interplay between these levels (Geels, 2002, 2007, 2007, 2011; Geels & Schot, 2007; Kemp et al., 1998; Kemp, Rip & Schot, 2001). Viewed through this lens, a socio-technical regime becomes embedded in a socio-technical landscape, a set of deep structural trends including factors such as oil prices, economic growth, wars, emigration, broad political coalitions or cultural and normative values, and forming an overarching structure. Landscape factors usually stabilise socio-technical regimes and favour incremental changes along existing socio-technical pathways (Geels, 2002, 2004, p. 913; Rotmans et al., 2001, pp. 19-20).

Meanwhile, socio-technical niches are situated below the regime level. They are where radical innovations which are not viable within the selection mechanisms of the current regime find a protected space. Here, new technologies (as well as their associated networks of actors) and new rules can develop until they are robust enough to be able to compete with established technologies within a socio-technical regime (Geels, 2002, pp. 1260-1261, 2004, pp. 912-913, 2011, p. 27; Kemp et al., 1998, p. 184; Raven, 2005, pp. 31-32; Smith & Raven, 2011).

Socio-technical niches are constituted by actors (research and development institutions, spin-off groups, social networks, governmental institutions) who believe in the future benefit and viability of a new technology. They are therefore prepared to invest resources in its development at a very early stage, when the technology is still immature, expensive and uncompetitive (Agnolucci & McDowall, 2007, pp. 1395-1396; Geels, 2004, p. 912; Kemp, 1994, pp. 1034-1035; Raven, 2005, p. 31; Smith and Raven, 2011, pp. 3-8). On a material level, niches consist of local experiments, pilot or demonstration projects, in which involved actors can optimise and adapt a new technology to user demands in real-world environments. Niches also help to develop necessary institutional adaptations and changes as well as social rules and networks of producers, users and regulating institutions that can enable and support further development and diffusion of the new technology. (Geels, 2002, p. 1261, 2004, p. 912; Kemp et al., 2001; Raven, 2005, pp. 37-43; Rotmans et al., 2001, p. 19; Smith & Raven, 2011, pp. 8-11)

Not every strong socio-technical niche leads, however, to large-scale regime changes. This requires the coincidence of strong, successful niche development and unstable, weak regime and landscape structures that constitute a window of opportunity. Such a situation occurs when the alignment and connection of regime elements are weakened by internal tensions. Changes at the landscape level can put pressure on an existing regime from outside, such as when public protest leads to new regulations or when sudden changes like environmental disasters occur (Geels, 2002, pp. 1261-1262, 2007, pp. 124-125 & 130-131; Kemp et al., 1998, p. 184; Raven, 2005, pp. 30-31; Rotmans et al., 2001, p. 20). Nevertheless, regime structures remain sufficiently robust in these phases to work against radical change. Consequently, radical change is generally seen as the result of numerous gradual, mutually influencing and cumulative changes over an extended period of time (Geels, 2002, p. 1272; Holtz et al., 2008, p. 623; Kemp et al., 1998, pp. 183-184; Rotmans et al., 2001, pp. 016 & 018).

2.2 Distinction between radical and incremental innovations

The differentiation between radical and incremental innovations and the focus on radical innovations is one of the basic fixed points of the MLP, as it is the foundation for the distinction "between innovations that proceed along an established trajectory and radical shifts to a new trajectory" (Geels, 2007, p. 126). With this, the MLP adopts the perhaps most popular differentiation from economic science (Garcia & Calantone, 2002, p. 120; Hellström, 2007; Konrad & Nill, 2001, p. 27). Seeking a definition in the economic literature, we find that these terms usually characterise the novelty of an innovation, meaning "the newness of the offering, i.e. a technology or process can be significantly or only marginally different from its predecessors" (Hellström, 2007, p. 150). Radical innovations feature major advances, whereas incremental innovations represent less extensive changes to existing products or systems and lead to smaller improvements (Konrad & Nill, 2001, p. 28). A high degree of novelty is typical for radical innovations and is associated with "fundamental changes in new products that represent revolutionary changes in technology" (Yang, Chou, & Chiu, 2014, p. 152). The relevance of radical innovations for larger changes has been widely discussed (Garcia & Calantone, 2002, pp. 120-121; Hellström, 2007, pp. 149-150; Yang et al., 2014, p. 152).

The MLP itself closely links radicalness with the criterion of regime compatibility and the dependent variable of need for protection which are introduced as a consequence of their novelty. A mismatch of *radical* innovations with a given regime is due to their low performance, higher costs and lack of competitiveness with respect to established incumbent and therefore, cheaper technologies. This mismatch leads to a need for protection from the regime's structures, rules and selection mechanisms (Geels, 2002, pp. 1260-1261, 2004, p. 912; Konrad & Nill, 2001, p. 32) *Incremental* innovations are characterised by only making smaller improvements to existing technologies which, at most, lead to very minor systemic adaptations that do not jeopardise existing trajectories. Due to their different needs for protection, the MLP attributes radical and incremental innovations to specific places of origin: as radical innovations are not yet viable within an existing regime, they arise and develop in the protected spaces of socio-technical niches, whereas incremental innovations develop on the regime level (ibid).

In practice, relevant – radical – innovations are usually characterised according to a public and/or scientific consensus that they can and will probably push a regime shift (socio-technical transition). The literature on the ongoing transition of the electricity regime is a good example (see e.g. Levidow & Upham, 2017; Osunmuyiwa, Biermann, & Kalfagianni, 2017; Wainstein & Bumpus, 2016). In other cases, authors are dealing with analyses from a retrospective standpoint (e.g. Geels, 2002, 2007), so that the character of the respective innovation has long been clear.

In the following section I will demonstrate that this procedure is insufficient if such clarity or consensus does not exist and if characteristics of the relevant innovation are equivocal. The multitude of possible regime/niche developments implies that characterisation of innovations by the criterion of novelty (the focus of the MLP) may be problematic from case to case. I will illustrate this assumption with insights from the field of refrigeration supply.

ISSN 2183-0606
http://www.open-jim.org

3 Absorption chiller innovations within the socio-technical regime of refrigeration supply

In the following, I apply the MLP to the cooling sector and absorption refrigeration technology innovations. Based on the framework presented in section 2.1, I sketch the current positioning of adsorption-type refrigeration systems within the socio-technical cold supply regime.

The following statements are the result of socio-technical research in a research project on absorption chillers which has been using the MLP as its theoretical basis. There were good reasons for taking this perspective, as it allows an integrative consideration of the different levels that needed to be analysed: the level of field tests and that of (currently changing) overall framework conditions influencing the future of absorption refrigeration. In order to make sure that known success factors of niche development could be taken as an adequate base for analysis, it was necessary to examine whether current absorption chiller innovations should be considered radical or not.

The specifications in this section are based on a wide-ranging literature research. Since research has generally focused on technical developments and market chances in the refrigeration sector, the following portrayals concentrate largely on these aspects.

3.1 The cooling sector as a socio-technical regime

Up to now, refrigeration has played a minor role in discussions, programmes and strategies regarding energy saving, not least because it accounts for a relatively small proportion of energy consumption in Germany and Europe. Nevertheless, around 14% of German power consumption is used for refrigeration, creating 5% of direct and indirect German greenhouse gas emissions (Heinrich et al., 2014, p. 24). A drastic increase in refrigeration demand is predicted for the future. Strong efforts towards achieving climate-friendly and more energy-efficient solutions are therefore of vital importance.

The refrigeration sector comprises a variety of so-called cross-sectional technologies, meaning that they are deployed in a huge number of fields of application in industry, commerce and private households. In Germany, for example, domestic cooling has the largest share (34% in 2011), followed by building air conditioning (15%), industrial refrigeration (14%), supermarket refrigeration (12%), food production (9%), commercial refrigeration (8%), and others (Heinrich et al., 2014, p. 25; Henning et al., 2012a, p. 162). In line with its multiple fields of application, purposes of use and usage requirements, a wide range of refrigeration technologies exists. The particular technology to be deployed depends on the type of cooling, required temperature levels, cold demand and its characteristics, and on available area and operating power (Clausen, 2007; Henning et al., 2012a, pp. 221-222).

Refrigeration technologies are distinguished according to their operating power: electrically driven compression cooling technology on the one hand and thermally driven refrigeration on the other, encompassing several technologies of which absorption chillers are one example (cf. Eicker, 2012, pp. 147-154; Henning et al., 2012a, pp. 207-208).

ISSN 2183-0606
http://www.open-jim.org

Currently, compression refrigeration is the regime-dominant technology, which is established for all performance classes (Eicker, 2012, p. 147; Förster, 2013, p. 12; Henning et al., 2012a, p. 160).

There has long been an established worldwide supply structure for compression chillers, with Reichelt (2000, pp. 4-5) listing manufacturers from Sweden, Brazil, China, Japan, the United States, Korea and elsewhere. Main sales markets can be located in (South East) Asia, the United States, Japan and Europe (Clausen, 2007, pp. 8 & 20; Eicker, 2012, p. 147).

Absorption-type refrigeration technology has the largest share of thermally driven refrigeration technologies by far (Berliner Energie Agentur, 2009, p. 11; Eicker, 2012, p. 149; Schindler, 2010, p. 62). Nevertheless, this amounts to only one percent of the cooling technologies currently used in Germany (units sold per year) and less than three percent worldwide (Schmid, 2011a). Consequently, absorption refrigeration technology can be characterised as a market-niche technology within the current refrigeration supply regime.

Thus far, absorption refrigeration has only been used in certain fields with specific preconditions and requirements in the medium- and large-scale performance range (from approx. 300 kW to the megawatt level). It has mainly been employed for commercial and industrial refrigeration with typically high refrigeration capacities (process cold or air conditioning), for example in breweries, refrigerated warehouses and other applications with high cold demand (Förster, 2013, p. 12; Jakob, 2012, p. 153; Schindler, 2010). The majority are high-temperature applications direct-fired with gas or oil or heated with steam or hot water (Eicker, 2011, 2012, p. 150; Förster, 2013; Henning et al., 2012a, p. 168; Schindler, 2010, p. 62). At the low-performance range, absorption chillers have only been on the market for a few years (Eicker, 2012, p. 152; Henning et al., 2012b, p. 160).

Absorption chillers are mostly produced by established manufacturers of compression cooling machines, for which absorption cooling is an additional business. There are also start-ups which have been more or less successful in the market up to now (Albers, Kühn, Petersen, & Ziegler, 2011, p. 1856; Clausen, 2007; Eicker, 2012, p. 147; Jakob, 2012, p. 153).

All refrigeration technologies are experiencing growing markets (Clausen, 2007, p. 8; Davis, 2015). The market for air conditioning is rising especially rapidly, with world sales in 2011 being 13% higher than in 2010 (Cox, 2012). The most rapid increases are taking place in developing countries with rising incomes and very warm regions such as India or China where sales have nearly doubled during the last few years (Davis, 2015; Sivak, 2013). However, the same trend is also occurring in Europe, though on a smaller scale (Eicker, 2011). Reasons are diverse, including the impact of climate change, rising demand for comfort, changing building designs and expanding demand in the commercial sector (Eicker, 2012, p. 147; Henning et al., 2012a, pp. 74-85 & 118; Kranzl et al., 2014; Schmid, 2011b, p. 42).

Forecasts predict that the refrigeration sector is likely to continue growing substantially in the upcoming years (Clausen, 2014, pp. 2, 18 & 20; Cox, 2012; Henning et al., 2012b, p. 191), with an estimated rise in the demand for air conditioning alone of 50% between 2006 and 2020 (Berliner Energie Agentur, 2009, p. 27; Kranzl et al., 2014, p. 30; Petersen et al., 2013, p. 42).

In the context of climate change these developments are highly problematic and have been a crucial subject of European and national climate and energy policy. For example, German regulation of energy-efficient technologies and buildings fosters more energy-efficient cooling technologies and refrigeration systems by setting standards for the maximum energy consumption of buildings (Heinrich et al., 2014, p. 179; Henning et al., 2012c, pp. 66-82; Schmid, 2011a, p. 12, 2011b, p. 42). Several programmes provide financial incentives for energy-efficient investment or climate protection measures on refrigeration plants (BMWi, 2015; Henning et al., 2012c, pp. 24-27 & 83-89). New funding programmes are promoting enhanced research and development, for example the German Energy-Optimised Building Construction programme (ENOB) or a funding programme for process cooling and heating within the energy research programme of the German federal government (Henning et al., 2012c, pp. 56-65). In addition, regulations on regenerative and energy-efficient power generation affect developments in the cooling sector, amongst others, by inducing rising prices for electricity, enlarging the availability of heat and power from renewable resources and/or the use of waste heat from industrial processes and heat from combined heat and power generation (Henning et al., 2012c, pp. 16-24 & 38-43).

Due to these developments, researchers have been predicting and demanding a substantial rise in thermally driven refrigeration. This assessment has been nurtured by a new generation of absorption chillers (Albers et al., 2011; Clausen, 2014; Eicker, 2012; Förster, 2013; Petersen et al., 2013; Schindler, 2010). Expectations regarding their possible environmental benefits are based on primary energy savings being obtained through using heat instead of electricity as operating power, using free heat capacities during summer months and thereby considerably contributing towards decreasing summer peak loads in electricity nets (e.g. Becker, 2006/2007; Clausen, 2007, pp. 1, 7 & 18; Dittmann, Dittman, Seifert, & Wirths, 2014).

Summarising the above, absorption refrigeration is a long established market-niche technology with a small but growing market share within the socio-technical regime of refrigeration supply. Innovative types of absorption chillers are giving rise to positive expectations of a substantive contribution to a more climate-friendly, regenerative-based and energy-efficient cold supply. Researchers in this field are very optimistic, but their future role and impacts on the overall share of electrically and thermally driven cooling are at the moment difficult to predict.

3.2 Characterisation of absorption chiller innovations by criteria the MLP offers

As the MLP focuses especially on radical innovations in socio-technical niches and their interactions with a particular regime, a clear characterisation is important for finding out whether the niche level is relevant at all.

For one thing, these innovations are to be characterised as incremental. Absorption refrigeration technologies are not completely new but have already been established for a long time. The technology was first developed at the beginning of the 19th century and has been more or less continually refined (Xi, Luo & Fraisse, 2007; Ziegler, 1997). Thus, recent innovations in this sector represent enhancements to an existing technology. Improvements are not significantly different from their predecessors nor fundamental changes in new products. Researchers have highlighted higher energy efficiency, lower operating temperatures, space requirements and costs.

By contrast, current innovations also exhibit characteristics the MLP approach assigns to radical innovations. Firstly, constructive enhancements with respect to existing absorption cooling technologies are marked by differences which are significant enough to support expectations that extended possibilities for application beyond existing market niches are likely to arise due, amongst others, to the potential of combining them with novel (low-temperature) heat sources. Current research promises that existing (technological) obstacles for broader use of this technology could be surmounted. Secondly, the present range and variety of promoted demonstration projects and field tests can be described as experiments which are in effect constructing a socio-technical niche, meaning that current development activities are taking place within protected spaces, generated by public funding. This indicates that, thirdly, the benefit, added value, competitiveness, efficiency, energy effectiveness and so on of these new types of absorption chillers have not yet been sufficiently substantiated, so their chances to thrive in the market beyond existing niches are still unclear.

As a result of these contradictory tendencies, I propose that clear classification of absorption cooling technology innovations cannot be easily achieved. Even though absorption cooling innovations are anything but new, a smooth adaptation to the existing regime beyond the current market niches cannot be realistically expected.

This observation raises the question of how to identify and clarify underlying causes. As an attempt to explore this, in the following section I take a closer look at the current position of absorption refrigeration technology as a market niche within the existing regime. My assumption here is that this position is crucial for understanding the dual nature of current innovations in this domain.

4 Reconsidering conceptions of "radical" and "incremental" for innovations from market niches within the MLP

In the following, I reconsider the conception and location of market niches and of radical and incremental innovations within the MLP and examine whether the fact that innovative absorption chillers originate from a market-niche – and not from a regime-dominant – technology is important for understanding their characteristics.

Contributions from the literature dealing with the process-oriented nature of niche/regime interactions and their possible outcomes provide indications regarding how the MLP conceptualises niche markets, locating them in time between socio-technical niches and mainstream markets.

Market niches are described as being small and specialised. Unlike socio-technical niches, which are built around technological innovations by actors seeing a future potential in the technology, market niches are built around specific user-demand or performance-related attributes. Due to particular application contexts or consumer preferences, selection criteria are significantly different from the mainstream market (Agnolucci & McDowall, 2007, pp. 1396-1397; Markard

& Truffer, 2008, pp. 605-606). As Markard and Truffer (2008, p. 605) propose, “Market niches [. . .] can be regarded as some kind of ‘natural anomalies’ in regimes”.

Compared with socio-technical niches, market niches have a higher level of stability but offer lower protection, though they can offer some protection against the design and selection rules of a socio-technical regime (Raven, 2005, pp. 44 & 47). This applies if a niche market is protected or even created by technology policies in the form of subsidies or other financial resources, regulatory exemptions, expectations and strategic decisions (Raven et al., 2007, pp. 47-48). Public intervention usually takes place in order to “internalise unaccounted social benefits of a technology” (Agnolucci & McDowall, 2007, p. 1397). To distinguish such niches from “regular” market niches, they are called “protected market niches” (Raven, 2005, p. 48).

Some in the literature have addressed variations in the interactions between socio-technical niches, regimes and landscapes, fanning out the linear consideration of the positioning of market niches within the MLP in time (Geels, 2002a; Geels and Schot, 2007; e.g. Konrad et al., 2004; Raven, 2005). Due to these contributions, refining the process from niche formation to different possible outcomes, the role or position of market niches within the MLP has become clearer.

Typically, innovations develop from research and development niches into socio-technical niches and then, if niche development is successful, into market niches from which they can finally – in the event of a regime shift – become strengthened into a regime-dominant technology on mainstream markets (Geels, 2011, p. 32; Schot & Geels, 2008, pp. 539-540; Smith, Kern, Raven & Verhees, 2014, p. 116; Smith & Raven, 2012, p. 1025). In this case, market niches are an interim phase that radical innovations have to run through before the process of niche accumulation gives rise to replacement of the formerly dominant technology which had previously occupied mainstream markets.

In addition to their function as an interim phase, market niches can also represent permanent loci for radical innovations at the regime level. Raven (2005, p. 44), for example, describes the “development of market niches” as one of four possible development patterns for socio-technical niches. This pattern implies that niche markets develop in which a new technology is competitive in certain fields of application, though its extent remains limited and its effects on the regime usually very small. Geels (2002b) emphasises that market niches are loci where socio-technical niches can remain or develop even within stable regimes. Following his approach, new radical technologies can develop further into “small new markets”. These new markets are created by new functionalities the novel technology offers, before possibly (but not necessarily) threatening the incumbent firms and replacing the dominant technology. Second, niche innovations can also be used in small market niches within existing markets, which implies that they have to compete directly and from the start with existing technologies (Geels, 2002b, p. 342). In a later version of these ideas, Geels and Schot (2007, pp. 405-412) additionally take into account the relationship between niche and (stable) regime which may be competitive or symbiotic. According to them, it is possible that socio-technical niches which have a symbiotic relationship with an existing stable regime can complement the existing regime but also give rise to modifications, without necessarily changing the regime’s overall architecture (“transformation”) (Geels & Schot, 2007, pp. 406-408). Furthermore, radical niche innovations with a symbiotic relationship to the regime can be incorporated into it over a longer period of time, during which learning processes and ongoing improvements accumulate. This can (but likewise does not necessarily) lead to further changes to the regime architecture in situations of regime destabilisation and landscape pressure at a later time ("sequences of component innovations" that induce "reconfiguration") (Geels & Schot, 2007, pp. 411-412).

With regard to the role of market niches within the MLP, I conclude that radical innovations can temporarily or permanently stabilise within market niches and, by this means, be incorporated into an existing socio-technical regime. Market niches are spaces where non-system-compatible, radical innovations can survive at the regime level, even for long periods. For a clear linguistic distinction, I suggest introducing the term "radical technologies" for (formerly radical) innovations which have since stabilised in a market niche. In this sense, I propose to call absorption chillers a radical technology.

To understand the relevance of these considerations for characterising absorption chiller innovations – and for innovations from market-niche technologies in general – it is necessary to take into account that talking about *an* innovation (the usual assumption, and not only in the MLP literature) is a generalisation. Long-term socio-technical processes of change typically include numerous incremental innovations following the initial radical innovation over time. It is these subsequent innovations that exhibit changing degrees of regime compatibility and may be perceived as incremental at a certain point in time.

Bearing these insights in mind, I suggest distinguishing between two kinds of incremental innovations within the MLP: first, improvements to the technology from within mainstream markets (i.e., from regime-dominant technologies) and, second, improvements offered by radical technologies (i.e., from market-niche technologies). Whereas the statements of the MLP are true for the first (i.e., no protection necessary), they do not necessarily apply to the latter. Unlike incremental innovations from regime-dominant technologies, incremental innovations from radical technologies indeed require protection (see section 2.1) to gain relevance. Current innovations in the field of absorption refrigeration technology can be characterised as the latter.

What we can learn from the example of absorption chiller innovations and the subsequent reflections on market niches in this section is that novelty is not a sufficient indicator for an innovation's regime compatibility and need for protection, since a reduction in novelty over time is not necessarily accompanied by an increase in regime compatibility. The example of absorption chillers can be taken to show that the mismatch between an innovation and the current regime may remain, even if the related technology can no longer be characterised as novel. With regard to the usual practice of characterising technological innovation according to the features of the initial innovation (see introduction) it can be concluded that this is not always an adequate practice.

Nevertheless, some uncertainty remains, as the finding that radical innovations can stabilise in market niches does not necessarily imply that every market-niche technology is radical. This encourages the assumption that a characterisation of innovations within the MLP should focus not only on the criterion of novelty but also include a broader range of criteria. Regime compatibility should be understood as a discrete aspect, and criteria should address the aspect of regime compatibility in a more direct and nuanced way. In the following I suggest a typing for this purpose worked out by Fichter and Clausen (2013) which is based on diffusion theory.

5 Refining current typing of innovations within the MLP through diffusion-relevant aspects

Fichter and Clausen (2013) have worked out a typing of innovations focusing on typical diffusion patterns of sustainability innovations, which seems to offer a reasonable starting point. This typing can be useful for our purposes, because it includes several influencing factors and can therefore connect the innovation's characteristics with the regime environment and as a result ease the assessment of its regime compatibility and need for protection.

5.1 Diffusion types of innovations

Based on an empirical analysis of 100 "diffusion cases" Fichter and Clausen (2013) suggest that the following seven main factors, which cluster known factors of influence from diffusion theory, can lead to differences in the diffusion chances and pathways as well as velocities of diffusion processes:

- market power of established suppliers,
- political push and pull,
- influence of pioneers,
- incentives to buy,
- consistency with routines on supplier and adopter sides,
- prices and economic efficiency, and
- transparency of an innovation.

Subsequently, they define five "diffusion types" of innovations representing specific combinations of these factors:

1. Capital goods of established suppliers, enhancing energy efficiency (e.g. energy-efficient servers);
2. Transparent consumer goods with enhanced characteristics (e.g. energy-efficient washing machines, organic cotton);
3. Promoted capital goods of "green" pioneer suppliers (e.g. wind and water power, combined heat and power plants);
4. Basic innovations with high demand for behavioural changes (e.g. bioenergy villages, electric cars); and
5. Complex products with unclear or long-term benefit (e.g. long-term thermal energy storage units) (Fichter & Clausen, 2013, pp. 236-249).

ISSN 2183-0606
http://www.open-jim.org

The five innovation types differ with regard to their diffusion dynamics in characteristic ways: innovations of types 1 and 2 feature high diffusion dynamics and can achieve strong market shares in a relatively short period of time (5 to 10 years), as they offer improvements to established, widely used investment (1) or consumption (2) goods. These types of innovations are well-known to adopters, developed and introduced by established suppliers; they have relatively short amortisation periods and show high profitability – factors which allow for their relatively smooth integration within the existing system. Innovation types 3, 4 and 5 need considerably longer periods of time for successful diffusion – that is, until a critical mass of buyers and adopters has been reached. Typical for these types is a longer phase of stagnation at a low level, where they hardly gain any market share over a relatively long period of time (15 to 25 years or longer), demanding different, partly complex and multidimensional regime adaptations or complementary innovations to an increasing extent. Key characteristics of type 3 innovations are their high degree of innovation, uncertainties on the adopter side, importance of pioneering companies, lack of established distribution channels and a resistance on the part of established firms. In cases of type 4, a critical mass of adopters is achieved very late or not at all, especially due to necessary changes of behaviour on the adopter side, the large involvement of new enterprises and difficulties in constituting necessary new routines. Type 5 innovations have the lowest diffusion dynamic of all types, and the probability of their success is the most unclear, due to factors such as high complexity, low consistency with routines, high degree of interrelated uncertainties, relative lack of political support and unclear future prospects (Fichter & Clausen, 2013, pp. 239-259).

5.2 Reconsidering current absorption chiller innovations within this framework

As Fichter and Clausen (2013, p. 237) point out, this typology describes ideal types of innovations and diffusion paths, in relation to which real-world cases may differ. Also, the possibility of intervention can result in alternative path developments with respect to the described diffusion paths (Fichter & Clausen, 2013, p. 249). However, this typing can be useful for our purposes, because it includes several factors of influence and, therefore, connects the innovation with the systemic environment within which it arises.

Referring to the seven main factors of influence on diffusion types identified by Fichter and Clausen, absorption chiller innovations feature the following characteristics:

Transparency of the innovation: Absorption refrigeration innovations are very complex technological solutions due, for example, to the numerous components of refrigeration systems (and their several possible variations) and related interdependencies, such as operating-power requirements.

Incentive to buy: The investment costs of absorption chillers are still higher than those of compression chillers, leading to the lack of a price incentive to buy. As the energy efficiency of absorption-based refrigeration systems is yet to be proved, their advantages over compression chillers are not yet clear. In addition, the future role of absorption refrigeration in the refrigeration supply regime is unclear.

Price and economic efficiency: Purchase costs for absorption cooling technologies are not yet on the same level as compression cooling technologies. Operating costs vary and are case specific. For most applications, an economic benefit is not immediately apparent or can be achieved only under certain circumstances (like availability of free heat sources). Future developments are difficult to predict. Due to currently high purchase costs and unclear or relatively few advantages regarding energy and cost efficiency, absorption cooling can be expected to be profitable – if at all – only in the long term.

Consistency with routines: The technical, institutional and/or cultural connectivity of absorption refrigeration innovations is limited by the need for (cheap or free) heat sources. Due to the high complexity of the technology, the availability of new heat sources (providing fluctuating heat) and the need for energy-efficient adjustment within building service engineering, the routines of engineering firms running the overall planning and the implementation of refrigeration systems need to change. This also requires enhanced competencies. As most investors still focus on purchase costs and neglect operating costs, routines in procurement have to change. Dependence on long-term payback periods combined with uncertainties regarding cost effectiveness are hindering trouble-free diffusion and integration of absorption refrigeration innovations into the existing regime.

Market power of established suppliers: The established, economically strong manufacturers of refrigeration technologies tend to focus on compression technology and, therefore, have little interest in promoting absorption refrigeration.

Influence of pioneers: The existing start-ups have low market power and reputation. The development of economically strong providers that exclusively manufacture absorption chillers has stagnated.

Political push and pull: Political push and pull has increased during the last years. However, current support and promotion is not particularly focused on absorption chillers but rather on energy-efficient solutions in general. Thus it is not clear to what extent political activities will benefit absorption refrigeration innovations.

Based on this analysis, absorption refrigeration innovations can be characterised as type 5 innovations: complex products with unclear or only long-term benefits. For our purposes here, this confirms a lack of system compatibility and a substantial need for protection.

5.3 Discussion

The example of absorption chillers clearly shows that the typing of innovations by seven diffusion-relevant aspects identified by Fichter and Clausen allows for a markedly more differentiated characterisation of innovations than the mere distinction between incremental and radical innovations according to the novelty criterion used by the MLP. It allows characterising innovations independently from the newness of the respective technology, and from the location of the considered innovation (at the regime level, in a socio-technical niche or in a market niche). Regime compatibility and need for protection can be identified independently from the criterion of novelty.

At the same time, the five types identified by Fichter and Clausen are able to take into account the distinction between radical and incremental innovations, which in this typology is extended by two subtypes of incremental and three subtypes of radical innovations. Diffusion-relevant factors related to innovation types 1 and 2 allow a relatively smooth integration within the existing system; these are incremental innovations from regime-dominant technologies. In contrast, type 3, 4, and 5 innovations feature radical characteristics or characteristics of incremental innovations from radical technologies, but with important differences concerning characteristics, barriers, dynamics and (increasing) need for protection.

Moreover, the classification scheme offered by Fichter and Clausen is connected with statements on tendencies regarding diffusion velocities related to the specific characteristics of each type of innovation. Thus, these aspects are most likely relevant for possible patterns of regime development and can contribute to further differentiation of these patterns, complementing those aspects of "stability of regime" and "relationship between existing and challenging technology" that Geels, Shot, Raven and others (see section 4) refer to. Interesting variables appear, for example, to be the kind of technology (capital or investment goods/consumer goods), complexity and transparency/comprehensibility of the particular technology, and those actors (established suppliers/pioneer suppliers) introducing an innovation. These aspects, though addressed by the MLP, have not yet been considered as relevant for possible patterns of regime change.

6 Conclusions

The changing character of innovations and related difficulties with their characterisation is a well-known challenge. New technologies are not developed all at once into their final form but, rather, pass through a long process, including several changes in design and functionality (Konrad & Nill, 2001, p. 28).

This article has discussed the advantages of combining both the multi-level perspective and a classification of innovations based on empirical results from diffusion research for characterisation of innovations with regime-changing potential and the need for regime changes as a precondition for their further diffusion (radical innovations). The example of absorption chiller innovations demonstrates why and in which way this combination can be fruitful.

Application of the MLP requires clear classification of innovations as being radical in order to evaluate whether the MLP is able to provide an adequate framework for analysis. (If a considered innovation is incremental and its dissemination does not require or push more than merely smaller regime adaptations, it is not necessary to include the interplay with systemic change in such a prominent and elaborated way the MLP suggests, as no socio-technical niche is necessary to protect incremental innovations from regime conditions.) The example of absorption chiller innovations, refining a market-niche technology, shows that the novelty focused on by the MLP is not always a sufficient criterion for system (in-)compatibility. This analysis has revealed that these innovations combine characteristics of radical and incremental innovations. Concerning the causes, I argue that these have been the result of neglecting the possibly changing character of (subsequent) innovations in time within the MLP, a fact which is of essential importance for innovative refinements (or incremental innovations) from market-niche technologies.

I therefore conclude that it is reasonable to distinguish incremental innovations within regime-dominant technologies from those of established market-niche technologies. I have suggested considering the latter as improvements of non-regime-compatible, radical technologies which perpetuate the radical character of the technology (or formerly radical innovation) they refine and do not fit the characterisation of incremental innovations generally accepted by researchers using the MLP. If it is socially desirable that they gain higher relevance within the mainstream markets of a socio-technical regime, these innovations should be treated as radical-type innovations requiring a high degree of protection, be it political support in the form of funding or regulation or new supporting actors and actor networks (see section 2.1).

However, the market-niche status of a technology appears to be a helpful but insufficient indicator for an innovation's character. To avoid unreasonable reverse, further criteria are needed to operationalise this aspect in a more direct way so that it becomes possible to assess the respective need for protection independently from the criterion of novelty. Classification of innovations based on diffusion-relevant criteria seems to offer a promising perspective for this purpose. Its application to innovations in the field of absorption chiller technologies suggests that a systematic orientation towards such criteria can facilitate characterisation of such innovations in a markedly more differentiated way than offered by mere orientation towards the criterion of novelty. Operationalised by the criteria "price and economic efficiency", "consistency with routines", "market power of established suppliers", "influence of pioneers" and "political push and pull" (and associated sub-criteria), the dimension of regime compatibility, which is an essential point of interest for the MLP, emerges clearly.

As the results and conclusions drawn in this paper have been based on one example study, supplementary analyses of further examples are necessary to put them on a stronger footing.

Nevertheless, the example of absorption chillers shows that especially the case of innovations from long existing market-niche technologies seems worth considering in a more in-depth manner. In addition to regime/niche interactions the MLP focuses on, interactions between (radical) market-niche (technology) and derived innovations (in socio-technical niches) may have substantial impact on diffusion patterns and the potential degree of related regime change. It may be intriguing to pursue the issue of whether and to what extent long-term stabilisation in market niches affects the probability of larger regime changes. Specific barriers could for example result from experiences within the market niche, consolidated expectations and beliefs of actor groups, or the presence and nature of structures that support the established market-niche status of the technology.

It is especially important to examine more closely the interactions in the triangle of socio-technical regimes, market niches and socio-technical niches with incremental innovations from radical technologies (see section 4) and their implications for possible patterns of regime development. It not only seems probable that innovations that take a long time to develop and come to fruition require special political promotion to gain higher market share, but closer examination of impacts on possible patterns of regime development should lead to progressive insights. As the MLP is frequently used in sustainability research which is mostly practice-oriented, this will be useful for research and practice as well.

7 References

Aizstrauta, D., Ginters, E., & Eroles, M.-A. P. (2015). Applying Theory of Diffusion of Innovations to Evaluate Technology Acceptance and Sustainability. *Procedia Computer Science*, *43*, 69–77.

Albers, J., Kühn, A., Petersen, S., & Ziegler, F. (2011). Development and Progress in Solar Cooling Technologies with Sorption Systems. *Chemie Ingenieur Technik*, *83*(11), 1853–1863.

Becker, M. (2006/2007). Energieeffiziente Kältetechnik: Stellenwert der Automatisierungstechnik für einen energieeffizienten Betrieb sowie optimierte Betriebsführung von Kälteanlagen. *Fachjournal - Fachzeitschrift für Erneuerbare Energien und Technische Gebäudeausrüstung*, 6–14.

Berliner Energie Agentur. (2009). *Summerheat – Meeting cooling demands in Summer by applying HEAT from cogeneration.* EU-Projektreport. Berlin. Accessed April 2019:
https://ec.europa.eu/energy/intelligent/projects/sites/iee-projects/files/projects/documents/summerheat_publishable_final_report_en.pdf

BMWi. (2015). Förderdatenbank: Klimaschutzinitiative - Maßnahmen an Kälte- und Klimaanlagen in Unternehmen. Accessed April 2019:
http://www.foerderdatenbank.de/Foerder-DB/Navigation/Foerderrecherche/suche.html?get=views;document&doc=10155&typ=RL

Clausen, J. (2007). *Zukunftsmarkt Solares Kühlen.* Fallstudie im Auftrag des Umweltbundesamtes. Accessed April 2019:
http://www.isi.fraunhofer.de/isi-wAssets/docs/n/de/publikationen/Zukunftsmarkt_Solares-Kuehlen.pdf

Clausen, J. (2014). *Neue Ansätze in der Kälteerzeugung: Absorptionskältemaschinen und Rückkühlung mit Umgebungskälte.* Accessed April 2019:
http://www.energiekonsens.de/cms/upload/Downloads/Vortraege/Downloads_und_Publikationen/Vortrag_Clausen_140211.pdf

Clausen, J., Fichter, K., & Winter, W. (2011). *Theoretische Grundlagen für die Erklärung von Diffusionsverläufen von Nachhaltigkeitsinnovationen.* Grundlagenstudie. Berlin.

Cox, S. (2012). Cooling a Warming Planet: A Global Air Conditioning Surge. Accessed April 2019:
https://e360.yale.edu/features/cooling_a_warming_planet_a_global_air_conditioning_surge

Davis, L. (2015). Air conditioning and global energy demand. Accessed April 2019:
https://energyathaas.wordpress.com/2015/04/27/air-conditioning-and-global-energy-demand/

Dibra, M. (2015). Rogers Theory on Diffusion of Innovation - The Most Appropriate Theoretical Model in the Study of Factors Influencing the Integration of Sustainability in Tourism Businesses. *Procedia - Social and Behavioral Sciences*, *195*, 1453–1462.

Dittmann, A., Dittman, L., Seifert, J., & Wirths, A. (2014). Absorptionskälteanlagen für die

Gebäudekühlung mit Fernwärme: Chancen und Grenzen. Teil 2. *EuroHeat&Power*, *43*(5), 32–35.

Eicker, U. (2011). Technologien und Betriebserfahrungen mit solarer Kühlung im Nichtwohnungsbau. *KI Kälte Luft Klimatechnik*, *47*(11), 16–19.

Eicker, U. (2012). *Solare Technologien für Gebäude: Grundlagen und Praxisbeispiele* (2., vollst. überarb. Aufl). Wiesbaden: Vieweg + Teubner.

Fichter, K., & Clausen, J. (2013). *Erfolg und Scheitern "grüner" Innovationen: Warum einige Nachhaltigkeitsinnovationen am Markt erfolgreich sind und andere nicht.* Marburg: Metropolis.

Fichter, K., & Clausen, J. (2016). Diffusion Dynamics of Sustainable Innovation - Insights on Diffusion Patterns Based on the Analysis of 100 Sustainable Product and Service Innovations. *Journal of Innovation Management*, *4*(2), 30–67.

Förster, H. (2013). Neue Generation von Absorptionskälteanlagen. *KI Kälte Luft Klimatechnik*, *49*(01-2/2013), 12–16.

Garcia, R., & Calantone, R. (2002). A critical look at technological innovation typology and innovativeness terminology: a literature review. *Journal of Product Innovation Management*, *19*(2), 110–132.

Geels, F. W. (2002). Technological Transitions as Evolutionary Reconfiguration Processes: A Multi-Level Perspective and a Case-Study. *Research Policy*, *31*(8-9), 1257–1274.

Geels, F. W. (2004). From sectoral systems of innovation to socio-technical systems: Insights about dynamics and change from sociology and institutional theory. *Research Policy*, *33*, 897–920.

Geels, F. W. (2007). Transformations of Large Technical Systems: A Multilevel Analysis of the Dutch Highway System (1950-2000). *Science, Technology & Human Values*, *32*(2), 123–149.

Geels, F. W. (2011). The multi-level perspective on sustainability transitions: Responses to seven criticisms. *Environmental Innovation and Societal Transitions*, *1*(1), 24–40.

Geels, F. W., & Schot, J. (2007). Typology of sociotechnical transition pathways. *Research Policy*, *36*(3), 399–417.

Heinrich, C., Wittig, S., Albring, P., Richter, L., & Safarik, M. (2014). *Nachhaltige Kälteversorgung in Deutschland an den Beispielen Gebäudeklimatisierung und Industrie.* Studie im Auftrag des Bundesumweltamtes. Dessau-Roßlau.

Hellström, T. (2007). Dimensions of environmentally sustainable innovation: the structure of eco-innovation concepts. *Sustainable Development*, *15*(3), 148–159.

Henning, H.-M., Ragwitz, M., Bürger, V., Jochem, E., Kranzl, L., & Schulz, W. (2012a). *Erarbeitung einer Integrierten Wärme- und Kältestrategie: Arbeitspaket 1 - Bestandsaufnahme und Strukturierung des Wärme- und Kältebereichs.* Bonn. Accessed April 2019:
http://www.erneuerbare-energien.de/fileadmin/
Daten_EE/Dokumente__PDFs_/WuK-AP1-Abschlussbericht_BMUFormat_bf.pdf

Henning, H.-M., Ragwitz, M., Bürger, V., Jochem, E., Kranzl, L., & Schulz, W. (2012b). *Erarbeitung einer Integrierten Wärme- und Kältestrategie: Arbeitspaket 2 - Bestandsaufnahme und Strukturierung der Akteure des Wärme- und Kältebereichs*. Berlin, Bonn. Accessed April 2019: http://www.erneuerbare-energien.de/fileadmin/Daten_EE/Dokumente__PDFs_/WuK-AP2-Abschlussbericht_BMUFormat_bf.pdf

Henning, H.-M., Ragwitz, M., Bürger, V., Jochem, E., Kranzl, L., & Schulz, W. (2012c). *Erarbeitung einer Integrierten Wärme- und Kältestrategie: Arbeitspaket 4 - Darstellung des aktuellen Rechts- und Förderrahmens und dessen Wirkungen*. Bonn. Accessed April 2019: http://www.erneuerbare-energien.de/fileadmin/Daten_EE/Dokumente__PDFs_/WuK-AP4-Abschlussbericht_BMU_Format_bf.pdf

Holtz, G., Brugnach, M., & Pahl-Wostl, C. (2008). Specifying "Regime" - A Framework for Defining and Describing Regimes in Transition Research. *Technological Forecasting and Social Change*, *75*(5), 623–643.

Hoogma, R., Kemp, R., Shot, J., & Truffer, B. (2002). *Experimenting for sustainable transport: the approach of strategic niche management*. London, New York: Spon Press.

Jakob, U. (2012). Solare Kühlung: Eine Alternative zu herkömmlichen Kältemaschinen. *Energy 2.0*, 152–156.

Karakaya, E., Hidalgo, A., & Nuur, C. (2014). Diffusion of eco-innovations: A review. *Renewable and Sustainable Energy Reviews*, *33*, 392–399.

Karnowski, V. (2017). *Diffusionstheorie* (2., aktualisierte Auflage). Baden-Baden: Nomos.

Kemp, R. (1996). The Transition from Hydrocarbons: The Issues for Policy. In S. Faucheux, D. W. Pearce, & J. L. R. Proops (eds.), *New horizons in environmental economics. Models of sustainable development* (pp. 151–175). Cheltenham: Edward Elgar.

Kemp, R., Rip, A., & Schot, J. (2001). Constructing transition paths through the management of niches. In R. Garud & P. Karnøe (eds.), *Path dependence and creation* (pp. 269–299). Mahwah: Lawrence Erlbaum Associates.

Kemp, R., Schot, J., & Hoogma, R. (1998). Regime Shifts to Sustainability through Processes of Niche Formation: The Approach of Strategic Niche Management. *Technology Analysis & Strategic Management*, *10*(2), 175–195.

Konrad, W., & Nill, J. (2001). *Innovationen für Nachhaltigkeit: Ein interdisziplinärer Beitrag zur konzeptionellen Klärung aus wirtschafts- und sozialwissenschaftlicher Perspektive* (Schriftenreihe des IÖW No. 157/01). Accessed April 2019: http://www.ioew.de/fileadmin/_migrated/tx_ukioewdb/IOEW_SR_157_Innovationen_fuer_nachhaltigkeit.pdf

Kranzl, L., Hummel, M., Matzenberger, J., Müller, A., Toleikyte, A., Totschnig, G., . . . Neusser, M. (2014). *Power through Resilience of Energy Systems: Energy Crises, Trends and Climate Change (PRESENCE)*. Final report. Vienna. Accessed April 2019: http://www.eeg.tuwien.ac.at/eeg.tuwien.ac.at_pages/research/downloads/PR_356_B068675_PRESENCE_FinalPublishableReport_submitted.pdf

Levidow, L., & Upham, P. (2017). Linking the multi-level perspective with social representations theory: Gasifiers as a niche innovation reinforcing the energy-from-waste (EfW) regime. *Technological Forecasting and Social Change*, *120*, 1–13.

Osunmuyiwa, O., Biermann, F., & Kalfagianni, A. (2017). Applying the multi-level perspective on socio-technical transitions to rentier states: The case of renewable energy transitions in Nigeria. *Journal of Environmental Policy & Planning*, *9*(4), 1–14.

Petersen, S., Albers, J., Hennrich, C., Hunt, S., Hüls, W., Lanser, W., & Schröder, M. (2013). Absorptionskälteanlagen für die Gebäudekühlung mit Fernwärme: Projektergebnisse aus EnEff Wärme. *EuroHeat&Power*, *43*(5), 42–49.

Raven, R. P. J. M. (2005). Strategic Niche Management for Biomass: A Comparative Study on the Experimental Introduction of Bioenergy Technologies in the Netherlands and Denmark (Dissertation). Technische Universität Eindhoven.

Raven, R. P. J. M., Heiskanen, E., Lovio, R., Hodson, M., & Brohmann, B. (2007). The Contribution of Local Experiments and Negotiation Processes to Field-Level Learning in Emerging (Niche) Technologies: Meta-Analysis of 27 New Energy Projects in Europe. Paper submitted for the special issue of the Bulletin of Science, Technology & Society on Renewable Energy and Sustainability. Accessed April 2019:
http://www.oeko.de/oekodoc/720/2007-201-en.pdf?PHPSESSID=bcet37132hiqdnl69k4pu6cl76

Reichelt, J. (2000). Wo steht die Kältetechnik in Deutschland und weltweit? Accessed April 2019:
http://www.treffpunkt-kaelte.de/kaelte/de/html/vortrag/allgemein/reichelt.pdf

Rogers, E. M. (2003). *Diffusion of innovations* (5th ed.). New York: Free Press.

Rotmans, J., Kemp, R., & van Asselt, M. (2001). More Evolution than Revolution: Transition Management in Public Policy. *Foresight - the Journal of Futures Studies, Strategic Thinking and Policy*, *3*(1), 15–31.

Schindler, W. (2010). Wärme ist Antrieb für Kälte. *Kälte Klima Aktuell, 29*, 62–65.

Schmid, W. (2011a). KWK-Gesetz ist wichtigster Treiber für Absorbermarkt: Wachstumsmarkt Absorptionskältemaschinen. *EuroHeat&Power*, pp. 12–13.

Schmid, W. (2011b). Nachhaltige Kälteerzeugung durch Fernwärme-angetriebene Absorptionskältemaschine: Hohe Auskühlung des Rücklaufs. *EuroHeat&Power*, *40*(6), 42–45.

Sivak, M. (2013). Will AC Put a Chill on the Global Energy Supply? *American Scientist*, *101*(5), 330.

Smith, A., & Raven, R. P. J. M. (2011). What is protective space? Reconsidering niches in transitions to sustainability (Working Paper 11.05). Eindhoven University of Technology, Eindhoven. Retrieved from: http://alexandria.tue.nl/repository/books/729198.pdf

Wainstein, M. E., & Bumpus, A. G. (2016). Business models as drivers of the low carbon power system transition. A multi-level perspective. *Journal of Cleaner Production*, *126*, 572–585.

Xi, H., Luo, L., & Fraisse, G. (2007). Development and applications of solar-based thermoelectric technologies. *Renewable and Sustainable Energy Reviews*, *11*(5), 923–936.

Yang, K.-P., Chou, C., & Chiu, Y.-J. (2014). How unlearning affects radical innovation: The dynamics of social capital and slack resources. *Technological Forecasting and Social Change*, *87*, 152–163.

Ziegler, F. (1997). *Sorptionswärmepumpen.* Habilitationsschrift. *Forschungsberichte des Deutschen Kälte- und Klimatechnischen Vereins: Vol. 57.* Stuttgart.

ISSN 2183-0606
http://www.open-jim.org

Biographies

Dorothee Keppler. Dorothee Keppler is a Research Associate and Head of the Research Area "Climate and Energy" with the Center for Technology and Society, Technische Universität Berlin, Germany. She holds a diploma and a PhD in planning sciences. In her doctoral thesis she examined possibilities and limits of regional players to promote renewable energies in German mining regions, combining approaches from sociology of technology and regional science. Since almost twenty years she has been working as a social scientist, often in inter- and transdisciplinary research projects. Her research focuses on the societal dimension of the German "energy turnaround", including interdependencies of innovations and socio-technical transitions in the energy sectors, regional and local (renewable) energy governance, and citizens' and stakeholder participation. Up to now she has authored more than forty articles, books, chapters and papers and was co-editor of three books.

ISSN 2183-0606
http://www.open-jim.org

Journal of Innovation Management
JIM 7, 2 (2019) 38-58
HANDLE: https://hdl.handle.net/10216/121201
DOI: https://doi.org/10.24840/2183-0606_007.002_0004
SM: Set/2018 AM: Abr/2019

Effective assimilation of technological innovation in an organization characterized as a Complex Adaptive System (CAS)

Alon E. Hasgall
alon_h@mla.ac.il | The Center for Academic Studies, O Yehuda, Israel; 34, Tzoran. Pob. 5203, Shoham, 6085000. Israel
Niv Ahituv
ahituv@post.tau.ac.il | Tel Aviv University, Israel
Nily Naveh
nilinaveh@gmail.com | VP Pedagogy and Technology. National Educational Network. Israel

Abstract. Most organizations seek for innovative solutions to address external changes and competition. However, each organization is required to launch rapid and effective processes in order to assimilate the technological innovation. The purpose of this study was to understand whether an organization characterized as CAS (Complex Adaptive System) can affect the process of assimilating technological innovation. CAS organizations are naturally decentralized, and contain sub-systems named "fractals" that allow an immediate reaction to change in the environment, while simultaneously informing and updating all other sub-systems. A sample of 300 employees from 15 organizations of different sectors responded to an online questionnaire. Pearson and regression analyses were used to examine the relationships between the functioning of the workers as fractals in CAS organizations and their attitude toward the process of assimilation of technological innovation. The findings indicate that workers functioning as knowledge-worker were able to adhere to personal benefits together with organizational goals. They had sensitivity to changes in the environment, integration of the information required for the process, and the ability to socialize among themselves. These abilities have significantly influenced the development of positive attitudes towards the process of assimilation of technological innovation, a better understanding of the technology and its advantages to them, which make them ready to be involved in the process. The practical contribution of this study is the ability to best portray the characteristics of an optimal work environment in an organization that wishes to encourage technological innovation, to undergo assimilation processes, and to manage the dissemination of relevant knowledge for organizational use. Such an organization is required to provide its employees with a certain degree of operational autonomy, enabling them to interweave personal interests and organizational goals, and to be involved and to influence the processes of assimilating technological innovation in the organization.

Keywords. Innovation; Technology Assimilation; Complex Adaptive Systems; Fractals.

Cite paper as: Hasgall, E.A., Ahituv, N., Naveh, N., (2019). Effective assimilation of technological innovation in an organization characterized as a Complex Adaptive System (CAS), *Journal of Innovation Management*, www.open-jim.org, 7(2), 38-58.

1 Background and literature review

The 21st century market is typified by continuous changes in consumer habits and preferences, by innovative technology that is rapidly reaching commercial maturity, and by new competitors that manage to overcome barriers to enter into the market by using technological innovation (Jackson, 2010) that can disrupt the competitiveness of the organization (Christensen, Bartman, and Van Bever, 2016). The latest development of different contemporary technologies affects all areas of work in the organization. Both on the work processes in the organizations and on the method of management, administration, and customer service. The organizations now a days, employ means such as internal information systems, global communications systems, big data sources, social networks, and mobile applications. In recent years, artificial intelligence has begun upgrade the automation and use of robotics. These technological innovations enable to upgrade the quality of the organization's products and services, to improve performance, to reduce costs, and to improve employee working conditions while maintaining competitiveness (Zhu, Kenneth and Xu, 2006). Enterprise management should carefully examine technological changes and innovations in their relevant environment in an attempt to identify the most appropriate innovation. As the rate of technological innovation increases dramatically, organizations need a high level of adaptation and tolerance to changes: to be more up-to-date, to identify innovative technologies that will advance the organization's competitiveness, and to employ processes to implement this innovation in products and technologies (Potter and McGittigan, 2013).

1.1 What is innovation?

Organizational innovation is defined as the development of a new product or service (Jackson, 2011), or even a major modification of an existing product or service. This may include the expansion of new products, services and markets, production methods, or a value-added management approach to the organization (Crossan and Apaydin, 2010, Lundvall, 2010). Innovation is a result of an "out of the box" thinking, and its outcomes generate a breakthrough phenomenon that represents a potential improved product or service aimed at upgrading the value of the product or service to the customer (Schumpeter, 1991). When talking about innovation, it is commonly used in terms of creativity and entrepreneurship to create a better profitability while maintaining a high level of customer satisfaction. The process of innovation involves creating an alternative idea to an existing situation that in a linear process transforms the idea from a raw state to a unique conceptual framework, and then to the practical development of a business model to maintain profitability over time (Garud, Tuertcher and Van de Ven, 2013). Innovation also includes higher-quality versions of existing products, and the assimilation of products and services in new markets, new production or distribution methods, new sources of production for existing products or even new forms of economic organization in the organization (Denning and Dunham, 2010). Innovation can be observed on two levels: incremental (evolutionary) and radical. "Revolutionary technological innovation also includes" disruptive "innovation - innovation based on a product or service that is not perceived as threatening or necessary, but at a certain point of time may change the market in a way that no one expects. If a market-leading organization ignores the emergence of a new competitive factor in the market Considered "niche",

ISSN 2183-0606
http://www.open-jim.org

this could disrupt the organization's competitive ability and cause the company to collapses" (Christensen, Bartman, and Van Bever, 2016). In the 21st century, technological innovation has become a major factor in understanding the business and economic structure of the company. However, the constant need of organizations to create innovation began to cause a process of "creative destruction" - a continual process of removing old technology and the introduction of new technology, sometimes without examining the organization's ability to assimilate innovation (Potter and McGittigan, 2013). Technological innovation is now seen as the driving the wheels of business, economics and society in general. As a result, the processes of assimilating new technologies in the organization have become critical.

1.2 Organizational innovation management

Achieving success requires the development of complex business models and complex internal processes. It was found that the greater the degree of decentralization and accessibility to internal information, the greater the ability to cope with external complex relationships (Snihura and Tarzijan, 2018). Over the years, various models have developed for organizational innovation management. A leading one is the integrative model for management of innovation in the organization. It is implemented in three stages: initiation and adoption, increasing willingness to receive technological innovation, and integration of innovation in organizational processes. Several criteria affect the effective adoption process and the ability to integrate innovation into the organization: an orderly process of initiation, the scope of innovation embedded in the organization, the intensity of competition, the regulatory environment, and management obstacles (Freeman and Soete, 2009). It was also found that the larger the organization, the more emphasis it places on integrating a broader range of technological innovation over time (Zhu, Kraemer and Xu, 2006). A new study found that intensive competition in the organization's environment does add to organizational entrepreneurship, but limits the process of managing innovation assimilation, as there is a desire to rapidly promote processes and carry out long-term assimilation processes (Akgün et al, 2014). The Company's management is committed to locating the innovative products in different niches that may threaten the Company's status, while ignoring innovation that is not relevant at all. Today, there is a mess of complex analytical tools that allow the organization to focus on risky products. However, examples of organizations that have lost their stability [such as Digital] or organizations that maintain their market standing despite the ongoing controversy with disruptive new niches [such as Apple] need to identify and track innovations, an ongoing warning process that enables decision making within a short time. This process cannot be done only by senior management, or using advanced analytical tools, but with the participation of most of the employees (Christensen, Bartman, and Van Bever, 2016). Thus, effective management of innovation is a process that adapts innovation to the business model of the organization or changes the business model to more effective implementation of technological innovation, while adapting the organization's work processes, product quality, and profit level (Potter and McGittigan, 2013). Innovation management in the organization must be done quickly and accurately in all processes of production, marketing, and quality, in accordance with the relevant target audiences (Christensen, Bartman, and Van Bever, 2016)

ISSN 2183-0606
http://www.open-jim.org

1.3 Assimilating technological innovation

"Assimilation" is a concept that expresses a process in which an organism adapts resources that it absorbs from the natural environment it needs for its existence. The resources vary according to the changes in the environment and therefore, the assimilation process requires constant adaptation of the organism to its environment. A human also performs such an assimilation process, whether alone (e.g., in a boat at sea) or is in a group or an organization. In an environment where there are many changes, the resources required for the organization are also changing, so the organization needs to constantly adapt and change while acquiring varying resources from the environment (Potter and McGittigan, 2013). Innovation, by definition, is a process of change and development of new technologies. A survey of 144 companies conducted in Spain shows a direct link between the rise in innovation in the organization and the assimilation of new technologies. It turns out that technology contributes to streamlining work processes in improving the work environment (Camisón and Villar-López, 2014). Therefore, an organization in the 21st century, which is under a very rapid development of technological innovation, needs to continuously adapt to the rapidly changing environment (Stacey, Griffin and Shaw, 2000). The changes required in the organization relate to the organizational structure, employee roles, business model, work methods, organizational culture, social atmosphere, and management method (Garud, Tuertcher and Van de Ven, 2013). If the process is carried out effectively, the expected results might improve product quality, customer satisfaction, cost reduction, and organizational profit (Anjariny, Zeki and Hussin, 2012).

However, any process of permanent status change is likely to change the status quo. In a state of assimilation and adoption of technological innovation, the employees value the effort required from them in order to achieve the organizational goals while maintaining their status and working conditions. This assessment determines the extent of their consent or opposition to the process. This process is called the "information processing model". It can lead to negative emotions and resistance by developing a sense of self-threat and lack of usefulness in the worker's work, due to the fear of heavy workload, reduction of status, and changes in the traditional way of performing tasks (Bessen, Ford and Meurer, 2011). The traditional approach to assimilation emphasizes the top-down direction as well as the tight control of changes, allowing managers to cope better with the difficulty of losing control (Anjariny, Zeki and Hussin, 2012) The basic assumption is that procedures facilitate the process of assimilation (Potter and McGittigan, 2013.) This approach does not take into account the employee's ability to perform "rational thinking" and reach agreement. The "consent" factor can influence the reduction of resistance, acceptance of the change, involvement in the process of assimilation of technological innovation, and gaining a faster and more efficient improvement of processes after assimilation. The "consent" factor of employees is expressed, among other things, in the significant correlations found in research, between the employee's ability to cope successfully with organizational changes, adapting work processes and resources to his needs, and the variety of options that the worker receives in the work environment at the organization (Andriani and Cattani, 2016). Therefore, it is important for the managers of the organization to create a process of consent that will lead to positive attitudes of employees towards the newly embedded technology. The acceptance model explains the need for a transparent and agreed process between employees in applying innovation (Armstrong and Sambamurthy, 1999). Consent requires not only sharing of the idea, but also a well-managed assimilation process. Intermediate steps and milestones should be defined according to the traits that characterize the organization. There is a need for a process of training and building the innovative solution in the work environment, even if it changes the lifestyle of the employee or the manager (Arciénaga Morales, et al, 2018).

Planning a process of agreement before the implementation begins is the main challenge. Such process can hone the employee's perception and convince that this adoption can improve the working conditions, facilitate the work, and improve his/her position in the organization and the organization's status in the competitive environment (Arciénaga Morales et al, 2018). Such a planned process requires prioritization of organizational activity, employment planning, and budget assessment (Bessen, Ford and Meurer, 2011). The process takes at least five stages that combine the organization's goals with the employee's interests in order to create the employee's sympathy, consent, and involvement: Awareness - The employee becomes aware of innovation and is exposed to collecting information related to it. Persuasion - the employee is attracted to the innovation and is actively seeking information about it. Decision - The employee assesses the innovation and form an attitude towards it. The attitude can be sympathetic or antagonist. Permanent use - the employee decides to adopt the innovation and use it on a regular basis. Confirmation - the employee receives approvals or reinforcement from the environment and the management regarding the adoption of the innovation (Oliveira and Martins, 2011).

In this study, we try to understand what can affect the employee's ability to successfully integrate the organization's goal of succeeding in adopting a new technology, and develop a sympathetic perception of the changes, implying awareness and agreement that the new technology can improve the working conditions and the status in the organization.

1.4 The organization as a Complex Adaptive System (CAS)

A Complex Adaptive System [CAS] contains a collection of autonomous subsystems that have a common affinity, interdependence, and processes that work for a common goal. Such subsystem is named "fractal" (Stacey, Griffin and Shaw, 2000). The complex model of adaptive systems (CAS) is found in many structures in nature such as leaf arteries, snowflake structure, ants' convoy, and a swarm of sardines. The decentralized structure allows each fractal to react immediately to changes in its environment while simultaneously updating other fractals to the environmental changes it recognizes. Fractals in CAS are independent employees who have access to the resources they need, but at the same time interact with other fractals and continuously share information with them allowing for quick sensitivity to changes in the environment and faster response (Holland, 2006, Zimmerman and Hrust, 1993). An analysis of the fractal function in CAS shows that the effectiveness of the complex system is based on two opposing processes. An autonomous ability of each fractal in the execution of its task, simultaneously with performing constant integration of information and resources with all other fractals. Thus, each unit can benefit from the knowledge and resources of other fractals and regularly share knowledge and resources with them. Because of this structure, each fractal can respond directly and immediately to changes occurring in the environment while simultaneously updating the rest of the system about the changes it detects. (Stacey, Griffin and Shaw, 2000). For these reasons, the CAS model provides a high level of survival in nature and is therefore considered a successful model replicated in many structures in nature.

It was two decades ago that the relationship between CAS systems in nature and human behavior in modern organizations was identified to portray a complex and changing environment (Roos and Oliver, 1997). Systems characterized by CAS enable intelligent coping with changing processes. It was found that these systems also exist in the human and social level. But since a human environment is characterized by behaviors that are not always repetitive, and they are based on emotion, power, and control, the results cannot be expected to repeat themselves as in natural systems. Human solutions in CAS will vary according to the person's needs, not just the system requirements (Törnberg, 2014). Subsequently, there was a positive correlation between the degree to which businesses and government organizations can be characterized as CAS, and the ability of employees in these organizations to cope with environmental changes successfully. The more the organization is characterized by CAS, the greater the ability of each employee to reach innovative solutions and help the organization coping with a dynamic environment more effectively (Shoham and Hasgall, 2005).

Workers in organizations that function as a CAS show four distinct behavioral characteristics, which allow them to function as autonomous fractals and to constantly update and be updated of organizational activities (Hasgal and Ahituv, 2017):

Operational autonomy: The employee is considered an expert in his profession. The employee can demonstrate his abilities, expertise, and interests. The employee can make decisions autonomously. Employee works respectively for immediate solutions, as a sub-system (= fractal) under the backing of the organization.

Environmental sensitivity: The worker is granted the ability to sense the external environment and to respond to changes in this environment in a consistent and methodological manner. This capability allows the worker to adjust the relevant solutions to the needs of the managers and to the demands of the customers.

Integration of information: The worker share knowledge and can use methods and organizational systems to integrate various types of information that are found in shared databases and in the databases of other workers.

Social networking: The worker can manage his or her social resources in a distributed and synchronized manner to share information, find innovative solutions, and self-develop.

The findings of the study showed that an organization that enables employees to function as fractals increase the organizational ability to cope with environment changes. Fractals behavior create The Knowledge worker who operate autonomously, communicate, update and share knowledge with other employees.

1.5 Assimilating technological innovation in CAS Organizations

Successful implementation of technological innovation is critical to the organization's ability to adapt to its environment and turn itself into a competitive and successful organization. However, this process may be long and complex, and may be difficult for workers and arouse objections.

Various studies have shown the relationship between the CAS organization and the involvement of organizations in promoting its goals and in developing innovation. A Study that examined how organizations defined as CAS adjust to a dynamic and changing environment, found that in those organizations, workers were given the possibility of coordinating activities among them, through social interactions and work involvement. It was found that employees, initiated innovation in a new product development processes (NPD), on demand (Akgün et al, 2014). Another research found that knowledge workers in an organization with CAS characteristics knew how to combine the organization's goals with their personal benefit, share knowledge, and be part of a social network that supports the organization (Shoham and Hasgall, 2005). Thus, it can be assumed that in an organization with CAS characteristics and employees functioning as fractals, more positive approaches to desirable change processes will emerge (Hasgall, 2015). These positive approaches have a high potential for positively influencing the process of assimilating technological innovation in the organization.

The next part of this article presents some empirical findings related to that assertion.

2 The empirical study

This section presents the research question, variables, the hypotheses, and the results of the empirical study.

2.1 Research question:

Considering all above, our research question is: Can an organization with CAS characteristics [independent variables] influence the development of positive attitudes and involvement of employees in the process of assimilation of technological innovation in the organization over time?

2.2 Research variables

Dependent variable:

"The employee's attitude towards innovation in the organization" (Oreg, 2003). According to the "Acceptance Model", the worker's attitudes towards the process of assimilating the innovation will predict the extent of his investment and the degree of his willingness to assimilate organizational innovation in his work environment (Armstrong and Sambamurthy, 1999).

The characteristics of the worker's attitudes are based on the following dimensions (Oreg, 2003):

A. The employee's perception of the impact of the new technology on organizational processes. This dimension was assessed by four questions on a scale from "1" (the perception that the new technological technology does not affect organizational processes) to 5 (corresponds to the perception that the new technology greatly influences organizational processes). The average response to the four questions was calculated and used as an indicator of the "degree of impact" dimension.

B. The extent to which the employee is personally involved in the process of integrating the innovative technology in the organization. This dimension was assessed using four questions, which respondents answered on a scale from "1" (corresponding to minimal involvement in the process) to 5 (corresponding to high involvement in the process). The average response to the four questions was calculated and used as an indicator of the personal involvement dimension.

C. The type of emotional response of the employee to the integration of new technologies in the organization. This dimension was assessed using five questions, which respondents answered on a scale from 1 (relating to stress and anxiety with respect to the new technology) to 5 (in accordance with the calmness of the new technology). The average response to the five questions was calculated and used as an indicator of the "emotional response" dimension, with higher values ??indicating a less anxious attitude toward modern technology.

Independent variables:

An organization with the characteristics of CAS is an organization in which "knowledge workers" can function as fractals, implying that they can test innovation, and find its advantages more effectively, thus influence its positive attitudes (Hasgall, 2015). The characteristics of the organization as a CAS have four different dimensions:

A. Operational Autonomy - The ability to act on an immediate solution based on an autonomous decision. This variable was assessed by four questions, which respondents answered on a scale from 1 (= no benefit) to 5 (= high personal benefit). The average response to the four questions was the measure of the utility benefit of innovation per worker.

B. Environmental sensitivity - the employee's ability to identify and respond to changes in the organizational environment in a methodological and consistent manner. This variable was assessed using four questions, which respondents responded to on a scale from 1 (low awareness of environmental changes) to 5 (= high awareness of environmental changes). The average response to the four questions was the measure of the "environmental sensitivity" variable.

C. Information integration – Knowledge sharing base on the employee's ability to integrate information from various organizational sources and systems. This variable was assessed using four questions, which respondents responded to on a scale from 1 (= inability to integrate information from different sources) to 5 (= high ability to integrate information from different sources). The average response to the four questions was used as a measure of the "integration of information" variable.

D. Social networking - the ability to manage social resources in a distributed and synchronized manner. This variable was assessed using four questions, which respondents answered on a scale from 1 (= organizational isolation) to 5 (= high level of continuous social networking). The average response to the four questions was used as a measure of the variable "Networking".

2.3 The method of analysis

For each variable, descriptive measures [mean and standard deviation] were specified. Each hypothesis was measured using Pearson's correlation. The higher and positive correlation was found, the conclusion was that there was a strong positive correlation between the variables.

2.4 Hypotheses

Hypothesis 1: There is a correlation between the variable "Operational autonomy, that characterizes a knowledge worker in the organization as CAS" and the variable "positive attitudes of an employee towards the innovation embedded in the organization" [In dimensions of: enthusiasm, influence and involvement].

Hypothesis 2: There is a correlation between the variable "sensitivity to changes in the environment that characterizes the knowledge worker in the organization as CAS"?? [Which includes the dimensions: transparency and knowledge sharing], and the variable "??positive attitudes of an employee towards the innovation embedded in the organization" [In dimensions of: enthusiasm, influence and involvement].

Hypothesis 3: There is a correlation between the variable "?the integration of information that characterizes a knowledge worker in an organization as a CAS", and the variable ?"positive attitudes of an employee towards the innovation embedded in the organization"?? [In dimensions of: enthusiasm, influence and involvement].

Hypothesis 4: There is a correlation between the variable "social networking that characterizes a knowledge worker in an organization as a CAS" and the variable "the positive attitudes of an employee toward the innovation embedded in the organization" [In dimensions of: enthusiasm, influence and involvement].

2.5 The sample

Sample: 300 subjects were sampled in clusters of organizations [11 organizations] and professions [4 types].

48.3% of the respondents were males and 51.7% were females. The distribution of the subject by profession is displayed in Figure 1.

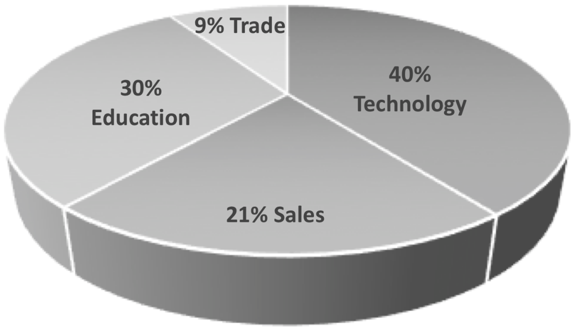


Fig. 1. Distribution of Subjects by Profession

The types of organizations from which the workers were sampled as shown in figure 2: 5 high-tech organizations (computers and technology) 46%. 3 educational and teaching organizations 27%, 3 trade and business organizations 27%. Division of respondents by profession: Technology professionals - 40% of respondents. Sellers - 21%. Teachers and instructors about 30%. Merchants - 9% of respondents.

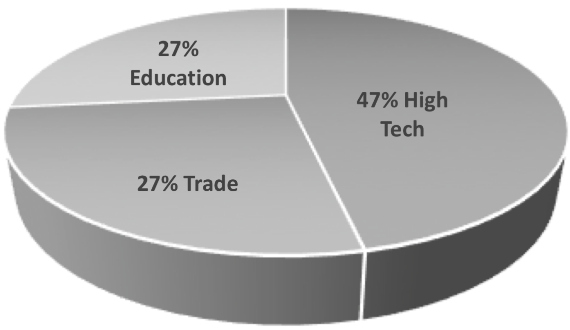


Fig. 2. Organization Type

3 Results

The results are presented in Table 1. Accordance with the Dimensions of the variable.

Table 1. Descriptive statistics of the dimension of dependent variable

Dependent variable	Dimension	Mean	Standard Deviation
Employee attitudes towards innovation	Emotional response	2.2	0.048
	The effect of innovation on employee work	3.7	0.048
	Employee involvement	3.5	0.045

ISSN 2183-0606
http://www.open-jim.org

1. The dependent variable: Employee attitudes towards innovation:
   - Emotional response from stress to enthusiasm, average = 2.2 SD standard deviation = 0.048. The level of enthusiasm for innovation was medium and common to most workers.
   - The effect of innovation on employee work: Average = 3.7 standard deviation = 0.048. The degree of influence was relatively high among most workers.
   - Employee involvement: average = 3.5 standard deviation = 0.043. The degree of desire for involvement was relatively high among most of the workers.
2. Independent variables: "Characteristics of the adaptive complex system".
   - The dimensions of this variable will be specified as part of the hypothesis test.

3.1 Hypothesis testing

The hypotheses were examined using Pearson correlation analysis and the significant unique contribution of each dimension in each hypothesis. The results are presented in Table 2.

Table 2. Predictive indicators of the variable: Attitude toward the technological innovation [by 3 dimensions: degree of influence, personal involvement, and emotional response]

V1	**V2**	$\mathbf{R^2}$	**Significant unique contribution**	**Beta** (Regression)
CAS: Operational autonomy	Attitude toward the technological innovation	0.119***	Personal involvement	0.369***
CAS: Environmental sensitivity	Attitude toward the technological innovation	0.132***	Personal involvement	0.368***
			Emotional response	− 0.203*
CAS: Integration of information	Attitude toward the technological innovation	0.084***	Personal involvement	0.317***
CAS: Social networking	Attitude toward the technological innovation	0.055***	Personal involvement	0.264***

Notes: n = 300, *$p < 0.05$; ***$p < 0.001$

Hypothesis 1: A correlation between positive attitudes towards innovation and the Operational autonomy benefit that characterizes a knowledge worker in the organization as CAS: As shown in Table 2, this hypothesis was examined by means of a multivariate linear regression in which the predictive variables were the three dimensions of employee attitudes towards innovation: enthusiasm, influence, and involvement. It was found that the model comprising the three predictive variables is significant: p <0.001 Adjusted R square = 0.119. The main contribution was found to be a measure of "the degree of desire for involvement" -- beta = 0.369, p <0.001

Hypothesis 2: A correlation between positive attitudes towards innovation and the environmental / situational sensitivity of an employee in an organization characterized by CAS:

As shown in Table 2 the model containing the three predictive variables was found to be significant: $p < 0.001$ Adjusted R square = 0.132. It was also found that the measure "the degree of desire for employee involvement in the process of assimilation of innovation" has a distinctly significant contribution to the prediction: beta = 0.368, $p < 0.001$.

Hypothesis 3: A correlation between positive attitudes towards innovation and integration of information by the employee in the organization as CAS:

As shown in Table 2 the model containing the three predictive variables was found to be significant: $p < 0.001$ Adjusted R square = 0.084. It was also found that the variable with a unique contribution to the prediction is the extent of the employee's desire to be involved in assimilating the innovation: beta = 0.317, $p < 0.001$

Hypothesis 4: A correlation between positive attitudes towards innovation and the social networking of an employee in an organization characterized by CAS:

As shown in Table 2 the model containing the three predictive variables was found to be significant: $p = 0.001$ Adjusted R square = 0.055. It was also found that the only variable that has a distinctly significant contribution is the extent of the employee's desire to be involved in assimilating the innovation: beta = 0.264, $p < 0.001$

4 Discussion

The rapid pace of technological development influenced the need for a much faster rate of development of technological innovation in organizations, particularly those residing in a competitive environment (Arciénaga Morales et al, 2018). This need engenders an urge to assimilate innovation that can improve the organization's performance and enable it to reach fast, effective and valuable solutions for customers (Zhu, Kenneth and Xu, 2006).

Once the managers find innovative technologies tailored to the organization, they should implement a process of assimilating them within the organization. The process of assimilation of technological innovation in the organization may involve complex organizational changes. Hence, the need for technological innovation in an organization requires the processes of implementing innovation effectively and quickly (Bessen, Ford and Meurer, 2011).

The adaptive systems model [CAS] describes an organization that has a rapid adaptability to changes among employees who function as fractals within it (Shoham and Hasgall, 2005). These workers have a great deal of professional autonomy, social connections and constant integration of information (Hasgall; 2015). new research shows that functional autonomy of employees plays a significant role in workers' perceptions of pro-work behaviors, including taking initiative to find solutions and adapting work processes in the organization to environmental demands (Haas, Ryan and Hoebbel, 2018).

This study examined the relationship between the development of an employee's positive attitude toward processes of changes during an assimilation of technological innovation, and the variables that describe the employee's behavior in an organization with CAS characteristics. The assumption in this study is that an organization with CAS characteristics will allow the employee to become more involved in the process of assimilating technological innovation, and thereby develop positive attitudes towards the process of change (Bessen, Ford and Meurer, 2011). These positive attitudes have a great influence on the implementation of an efficient and faster process of assimilating innovation, in an era of great technological development and many changes in the market.

An analysis of the results of the study found that there was a significant positive effect of all four variables that represent the employee's behavior in an organization with CAS characteristics, the creation of positive attitudes and greater involvement of the employee in processes of technological change and innovation in the organization.

Another finding shows that there is a significant correlation between the employee's personal interest and the goals of the organization. The more the employee identified personal benefits from the innovative technologies and processes that are to be introduced into the organization, the more positive his/her attitude will be towards them. This is consistent with the "agreement" model, which claims that as employees agree with an implementation process, it will make it easier for the organization to make urgent changes, especially those that require the assimilation of technological innovation that is changing and renewing at a high rate.

It seems, therefore, that the positive attitudes towards changes due to assimilation of technological innovation in a CAS type organization have a direct and significant relationship to its perception of personal utility. However, do the organization's managers understand that there is a need to develop employees as knowledge workers and to design the work environment as a complex adaptive organization? Do they understand the need to strengthen the perception of the employee's personal benefits and positive attitude towards assimilating technological innovation in the organization?

In many cases, managers see the employee as part of the organization's resources and take for granted the cooperation with the assimilation process. They forget to check the personal and direct relationship of each employee to the innovation itself. This direct connection and the extent to which the employee will perceive the personal benefits from innovation will be among the main factors behind the development of positive attitudes towards innovation and thus the involvement and success of the innovation implementation process in the organization.

In view of this, it appears that employees working in an environment that allows them greater transparency and sensitivity, attending external conferences, participating in discussions and meetings, familiarity with competitors, exposure to technological innovation, understand the required process more, and keep the employees updated, will make them more positive and increase their level of involvement. The same is true of the variables: "integration of information" and "social networking". In both, there is a significant relationship and a significant impact on the development of positive attitudes of the employee to the process of assimilation of technological innovation in the organization.

The personal dimensions of this study should be noted. It turns out that the enthusiasm of the employees for the change stemming from the assimilation of technological innovation was moderate, but the degree of willingness to be involved was higher. It is reasonable to assume

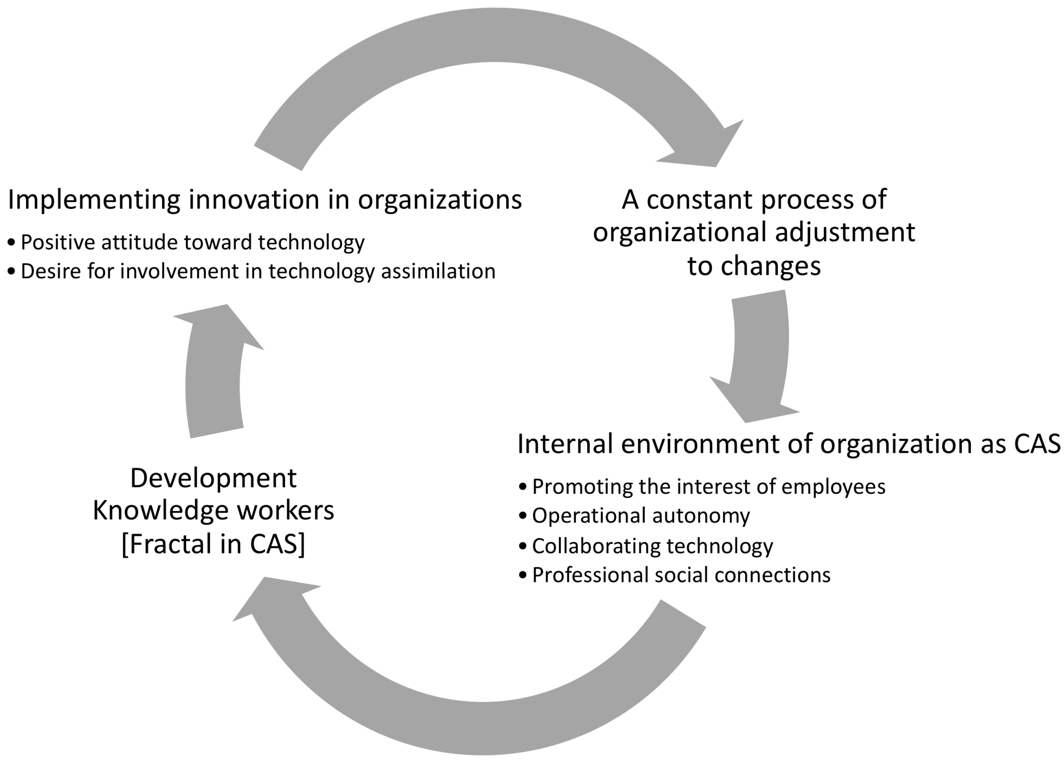


Fig. 3. A constant organizational process to adjust to innovation changes

that the greater is the degree of involvement of the employee in the process of assimilation, the greater is the enthusiasm for the innovative technology. This hypothesis should be examined in future research. Another important conclusion of this study is that the employee's individual perception of the organizational change generated by the innovation is critical to the success of the process. Apparently, the process of assimilating successful technological innovation requires constant and substantive involvement of the employees. It is important to allow employees to influence the implementation process, to be involved in the method, and to receive updates about times and locations for the implementation process. Equally important is the need to explain the benefits of innovation, and to allow employees to talk about and update the personal benefits they find in it. The major challenge for managers is to explain and even invest in marketing the benefits of innovation to employees within the organization. To allow employees to ask, to keep up to date, and to tell of cases in which innovation helped and upgraded their operations. The worker's involvement will not only advance the process of assimilation but will also adapt the technology to the work processes in the organization.

Ultimately, as shown on figure 3: an organization that that his internal environment will act like CAS, will encourage Knowledge workers, his Employee will start desire to involved will better cope with the assimilation process and achieve practical and effective adjustment to environmental complex demands and changes.

5 Practical contribution

This study helps us to understand the great importance of the characteristics of the workspace within a CAS organization: the relationship between employees and managers, the ability to act autonomously and promote personal interests, the ability of the employee to manage the resources required for the work, the quality and friendliness of systems, the ability to update the activities, and to keep abreast of all the important things that are done in the organization. All these are the basis for the employees' ability to have a say in innovative processes and their implementation. Without the employee's ability to identify personal benefits, it will be difficult to implement the innovation, thus the organization will suffer from a delay in assimilation or from inferior competitive status.

It turns out that a working environment in an organization with complex adaptive system characteristics is an environment that is remarkably effective for the development of a knowledge worker who is capable of contributing and applying technological innovation in the organization in an optimal way. Such an employee will be able to cope better with changes, successfully assimilate technological innovation that comes from outside the organization, and perhaps even create technological innovation within the organization. This needs to be examined in further research.

If so, a working environment suitable for implementing innovation requires the organization to allow the employee operational autonomy. It is necessary to design a situation where the employee is granted responsibility and personal authority to reach a solution through the organization's resources and social networking. In this situation, the manager's roles change. From a manager of people who requires constant monitoring and control, to a process manager who tracks the progress of the process, enables resources and supports the employee's activity in this situation. The manager should let the employee to move toward a solution and do so through a process of innovation. In addition, there is a need for full transparency in the organization. This transparency will allow the employee to connect external customer requirements with the organization's objectives, organizational resources, and other employees at his side. This transparency should be pro-active. It should not only provide the employees with information, but also creates a situation of active updating of employees on the evolving changes and provide employees with technological platforms in order to update their knowledge and report about their activities. According to the findings of this study, systems that support social networking are preferable. The organization must recruit employees with autonomous work ability and technological readiness to use information systems and social networking. When the employee enters the organization, he/she must be given comprehensive training regarding the use of these information systems for the purpose of updating, transparency, and cooperation. The employee's ability to be up-to-date and involved in the organization's work processes will generate positive attitudes towards innovation and will actively participate in intra-organizational innovation.

Another recommendation is the role of the CDO (Chief Digital Officer). The organizational innovation manager, who knows the work methods required to create innovation, understands the conditions required, knows the sources of innovation, and adapts them to the requirements of the organization, its goals, and business model.

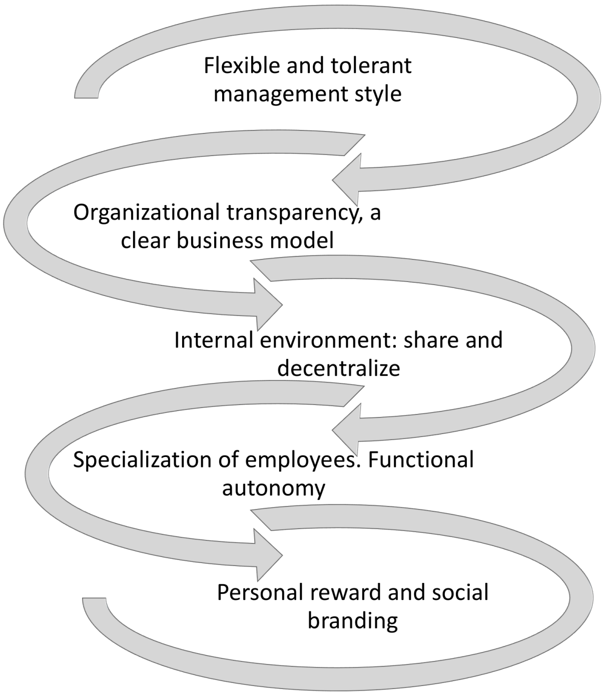


Fig. 4. A process of Innovative response in CAS organization

Transformation from a traditional organization to an organization with CAS characteristics

As found, in an environment characterized as CAS, the potential to assimilate innovation as required can significantly improve. If so, what is the proper way to transform the internal organization form into that of a CAS?

As shown in Figure 4. The Internal organizational environment As CAS affects the organizational ability to response innovatively to changing requirements.

So, before the transition of the internal organizational environment to be characterized as a CAS, there is a need to change the management concept to one that will not place too much emphasis on excessive and intrusive control by managers. On the contrary, the new managerial style should encourage managers to enable knowledge workers to experiment, to cope, to make independent decisions, and to develop their own innovative solutions. They should not be "punished" for trying to peruse ideas that eventually fail. In lieu, they should be praised for trying to think out of the box. In such internal organizational environment, each worker has to be considered as an autonomous fractal capable of applying his/her own solution in his/her own time. Managers need to reflect to employees the business model required, the organizational goals and the main challenges and tasks facing the organization. The internal environment has to contain procedures enabling the worker to obtain the information and resources needed for developing required solutions in time, without having to be subject to the on-going managerial control. As part of the development of a management concept that will enable the knowledge worker to act optimally, it is necessary to deploy organizational transparency. The worker has to "feel" the demands arising from the external organization's environment and respond immediately to innovative solutions and to the cooperation of the other fractals in the environment. An organization that is interested in the development of a knowledge worker must also allow him/her to experience processes outside the organization, and to keep up with any new findings relevant to his work.

Organizational transparency is reflected in a continuous and up-to-date flow of top-down information on the organization's activities vis-a-vis customers and competitors. Information on business models used in the organization, on new requirements arising from the customers of the organization, on new technologies introduced into the organization, on the types of products and services provided by the organization, should be circulated continuously. Most of the information mentioned above is now confined to senior executives in the organization. However, today, the organization's environment is dynamic, complex, and stormy. The organization relies on the ability of the knowledge workers to develop and innovate solutions adapted to changing requirements. Therefore, an internal organizational environment characterized by CAS, which enables the development of knowledge workers, must be transparent, using open access techniques that enable the worker to operate autonomously and develop solutions according to immediate requirements. The knowledge worker will not be able to do so without familiarity with and understanding of the core of the organizational activities. In an organization with CAS-like characteristics, managers have to focus on the quality of the work processes, the transfer of resources, and the support to knowledge workers' activities, rather than the supervision and control of each employee's daily activities. Manager can take the responsibility to transfer relevant knowledge from one worker to another rather than to monitor and re-monitor the status of each task.

Another element in the internal organizational environment focuses on the combination of the transfer of innovative solutions and the operational autonomy. Yet, the usual internal organizational environment does not allow the employee to stand out. In an organization with CAS-like characteristics, it is necessary to change this perception. The internal environment characterized in a CAS, must allocate each fractal knowledge worker, to develop in the organizational ecosystem, and to promote personal interests of working groups focused on specific solutions or developing knowledge on core organizational issues.

Workers must be allowed to relate to their innovative solutions not only as part of achieving organizational goals, but also as part of promoting their professional and social personal interest. The knowledge worker should be exposed to social and professional recognition and be able to become a "unique brand" among the managers and co-workers. This recognition is a key tool in maintaining an employee's ability to function as a knowledge worker. Management should create an atmosphere that directly and independently rewards each employee in line with his/her contribution to the organizational knowledge, and to the integration with other employees. From this point onwards, it is easy to implement a systematic process of developing and disseminating innovation in the organization with the participation of every employee and adapting it to events, tasks, changes, and external requirements. The innovation is shared independently and immediately by each employee (Hasgall,2015). Social communication technologies tools are also required elements in an internal organizational environment as CAS. The social communication technologies tools include knowledge systems, social networks, social and group communication applications, whose function is not only to convey information and to enable the workers to update their knowledge on a regular basis, but also to support ongoing social networking. This social integration provides the worker with emotional support and the ability to receive credit and recognition from colleagues and managers immediately and continuously. Such recognition encourages personal development as part of the improvement of abilities and social status

6 Avenues for further research

This study focused on understanding the relationship between positive attitudes and perceptions of employees towards the process of assimilating innovation in the organization as an adaptive complex system (CAS). This study examined the relationship between each of the variables. Future studies can further develop the findings by examining the cumulative effects of the variables examined here. In addition, it should be noted that the study was conducted in one country only. However, this country is well advanced in the areas of innovation and therefore it can be assumed that the sample can also represent populations in other developed countries. It seems that the sample size is large enough to draw conclusions, and the findings presented here seem reliable - at least as a basis for broader, multinational research.

7 References

Akgün, A. E., Keskin, H., Byrne, J. C., & Ilhan, Ö. Ö. (2014). Complex adaptive system mechanisms, adaptive management practices, and firm product innovativeness. *R&D Management*, *44*(1), 18-41.

Andriani, P., & Cattani, G. (2016). Exaptation as source of creativity, innovation, and diversity: Introduction to the special section. *Industrial and Corporate Change*, *25*(1), 115-131.

Anjariny, A. H., Zeki, A. M., & Hussin, H. (2012, November). Assessing organizations readiness toward business intelligence systems: a proposed hypothesized model. In 2012 International Conference on Advanced Computer Science Applications and Technologies (ACSAT) (pp. 213-218). IEEE.

Armstrong, C. P., & Sambamurthy, V. (1999). Information technology assimilation in firms: The influence of senior leadership and IT infrastructures. *Information systems research*, *10*(4), 304-327.

Bessen, J., Ford, J., & Meurer, M. J. (2011). The private and social costs of patent trolls. *Regulation*, 34, 26.

Camisón, C., & Villar-López, A. (2014). Organizational innovation as an enabler of technological innovation capabilities and firm performance. *Journal of business research*, *67*(1), 2891-2902.

Christensen, C. M., Bartman, T., & Van Bever, D. (2016). The hard truth about business model innovation. *MIT Sloan Management Review*, *58*(1), 31.

Crossan, M. M., & Apaydin, M. (2010). A multi-dimensional framework of organizational innovation: A systematic review of the literature. *Journal of management studies*, *47*(6), 1154-1191.

Denning, P. J., & Dunham, R. (2010). *The innovator's way: Essential practices for successful innovation*. MIT Press.

Freeman, C., & Soete, L. (2009). Developing science, technology and innovation indicators: What we can learn from the past. *Research policy*, *38*(4), 583-589.

Garud, R., Tuertscher, P., & Van de Ven, A. H. (2013). Perspectives on innovation processes. *Academy of Management Annals*, *7*(1), 775-819.

Hasgall, E. A. (2015), From assimilation to acclimatization of social digital Technology in organizations. International Journal of Computer Systems (IJCS). 2: (10).

Hasgal, A., & Ahituv, N. (2017, December). The Development of Knowledge Workers in an Organization characterized as Complex Adaptive Systems (CAS). In *International Conference on Intellectual Capital and Knowledge Management and Organisational Learning* (pp. 97-103). Academic Conferences International Limited.

Haas, E., Ryan, M., & Hoebbel, C. (2018). Job Autonomy and Safety Climate: Examining Associations in the Mining Industry. *Professional Safety*, *63*(12), 30-34.

Hasgall, A. E., & Shoham, S. (2015). Effective use of digital applications promotes professional self-efficacy. *Vine*, *45*(2), 279-291.

Holland, J. H. (2006). Studying complex adaptive systems. *Journal of systems science and complexity*, 19(1), 1-8.

Jackson, M. O. (2010). *Social and economic networks*. Princeton university press.

Jackson, D. J. (2011). What is an innovation ecosystem? *National Science Foundation*, *1*. Accessed April 2019: http://erc-assoc.org/content/what-innovation-ecosystem.

Lundvall, B. Å. (Ed.). (2010). *National systems of innovation: Toward a theory of innovation and interactive learning* (Vol. 2). Anthem press.

Arciénaga Morales, A., Nielsen, J., Bacarini, H., Martinelli, S., Kofuji, S., & García Díaz, J. (2018). Technology and innovation management in higher education—Cases from Latin America and Europe. *Administrative Sciences*, *8*(2), 11.

Potter, K., & McGittigan, G. (2013). IT Metrics: A Critical Evaluation of Decentralized IT Spending and Digital Enterprise Readiness. Gartner, Inc.

Oliveira, T., & Martins, M. F. (2011). Literature review of information technology adoption models at firm level. *Electronic Journal of Information Systems Evaluation*, *14*(1), 110.

Oreg, S. (2003). Resistance to change: Developing an individual differences measure. *Journal of applied psychology*, *88*(4), 680.

Roos, J., & Oliver, D. A. V. I. D. (1997, February). The poised organization: Navigating effectively on knowledge landscapes. In *LSE complexity and strategy seminar*.

Snihur, Y., & Tarzijan, J. (2018). Managing complexity in a multi-business-model organization. *Long Range Planning*, *51*(1), 50-63.

ISSN 2183-0606
http://www.open-jim.org

Shoham, S., & Hasgall, A. (2005). Knowledge workers as fractals in a complex adaptive organization. *Knowledge and Process Management*, *12*(3), 225-236.

Stacey, R.D., Griffin, D. and Shaw, P. (2000). Complexity and management: Fad or radical challenge to systems thinking? London: Rutledge.

Snihur, Y., & Tarzijan, J. (2018). Managing complexity in a multi-business-model organization. *Long Range Planning*, 51(1), 50-63.

Schumpeter, J. A. (1991). *The economics and sociology of capitalism.* Princeton University Press.

Törnberg, P. (2014). Innovation in Complex Adaptive Systems. Thesis for the degree of Licentiate of Engineering. Chalmers University of Technology.
Accessed April 2019: http://publications.lib.chalmers.se/records/fulltext/203938/203938.pdf

Zimmerman, B. J., & Hurst, D. K. (1993). Breaking the boundaries: The fractal organization. *Journal of Management Inquiry*, *2*(4), 334-355.

Zhu, K., Kraemer, K. L., & Xu, S. (2006). The process of innovation assimilation by firms in different countries: a technology diffusion perspective on e-business. *Management science*, *52*(10), 1557-1576.

Biographies

Alon E. Hasgall. Today, he is a faculty member in the Department of Business Administration at the Center for Academic Studies, Or Yehuda, Israel. Researcher, senior lecturer and program director. Head of the Center for Innovation in the Information Technology Bureau, a board member of international academic journals. In the past, Alon was in the Israel Defense Forces until 1998 and is a lieutenant colonel in the reserves. He received his doctorate from Bar-Ilan University, Israel in 2004. He then worked on assimilating innovative technologies as a project manager in high-tech companies, and later founded and managed social technology start-ups. Between 2010-2010 he served as the Director and Chairman of the Israel Internet Association. Alon's range of occupations has enabled him to develop as an expert consultant to companies and organizations in the fields of digital transformation and the assimilation of smart technological innovation in organizations.

Niv Ahituv. A Professor Emeritus of Tel Aviv University. He was the founder (2003) and the Academic Director of the Institute of Internet Studies and held the chair for Research in Information Evaluation at Tel Aviv University. From 1989 to 1994 he served as the Dean of Graduate School of Business Administration, and from 1999 to 2002 he served as Vice President and Director General (CEO) of Tel Aviv University. Since 2006 he represents the Israeli Academy of Sciences in CODATA – an international committee on Data Sciences, where he was a Vice President from 2014 to 2018. He holds degrees of B.Sc. in Mathematics, MBA, M.Sc. and Ph.D. in Information Systems Management.

Nily Naveh. Dr. Nili Naveh began her technological career in the I.D.F and was part of the development teams for applications in advanced technological fields, starting from the perspective of development and the integration of advanced systems into existing systems. Her last job was head of project which develop simulation systems. Upon completion of her position in I.D.F. She takes part into the business world. She has been engaged in technology, innovation and solutions for clients and organizations for nearly 40 years. Her Technological knowledge gives her ability to identifying innovation and addressing the relevance of the organization as a key player in the market. In addition to her work in the business market, she is involved in technological education in Israel. She has written and authored curricula, lectured at colleges and academia for many years, and takes part in the implementation of innovative software programs in Israeli schools. For ten years she worked in the field of technological education networks in Israel, both in leading technological schools, integrating the industry in education, introducing innovation into the learning system and developing projects by students. In her last position she served as VP of pedagogy and technology in a national educational network - the second largest in Israel. Dr. Nili Naveh's heterogeneity of work - a combination of education and a business market - is characterized by the constant search for innovative technology and the ability to identify new technology relevant to the organization, with the goal of advancing it to achieve its objectives. The expertise of Dr. Nili Naveh is expressed in the business development of organizations, while adapting innovation to the nature of the organization and its activities.

ISSN 2183-0606
http://www.open-jim.org

Journal of Innovation Management
JIM 7, 2 (2019) 59-77
HANDLE: https://hdl.handle.net/10216/121201
DOI:https://doi.org/10.24840/2183-0606_007.002_0005
SM: Oct/2018 AM: Jun/2019

Biopharmaceutical Entrepreneurship, Open Innovation, and the Knowledge Economy

James J. Gillespie
jgillespie@saintmarys.edu | Faculty at Saint Mary's College, Department of Business and Economics, Notre Dame, IN 46556
Gregory J. Privitera
gprivite@sbu.edu | Faculty at St. Bonaventure University
Joseph Gaspero
Joseph@chisite.org | President at the Center for Healthcare Innovation

Abstract. This article focuses on the paradigm shift of the global biopharmaceutical sector's utilization of open innovation models to optimize drug development. Leveraging four exemplars, this review highlights that traditionally propriety, non-collaborative biotechnology and pharmaceutical companies increasingly use principles, processes, and structures of open innovation to increase drug R&D effectiveness and efficiency. We discern three essential elements in the successful creation of open innovation partnerships: (i) culture, (ii) collaborative management skills, and (iii) strategic capability alignment. This analysis provides guidance for business leaders and scholars interested in the managerial and strategic dimensions of applying open innovation to the drug development environment. Theoretically, the article contributes to the growing stream of research integrating the concepts of knowledge economy, open innovation, and Enterprise 2.0. We discuss the specific ways in which open innovation holds potential to improve quality, increase speed, and lower costs and thus yield positive benefits for global health.

Keywords. Biopharmaceutical; Business Model Innovation; Knowledge Economy; Open Innovation.

Cite paper as: Gillespie, J., Privitera, G., Gaspero, J., (2019). Biopharmaceutical Entrepreneurship, Open Innovation, and the Knowledge Economy, *Journal of Innovation Management*, www.open-jim.org, 7(2), 59-77.

1 Introduction

The knowledge economy is attaining preeminence in business and fundamentally altering managerial perspectives on corporate strategy, communication technologies, information access, and knowledge sharing. It is pushing managers toward business model innovation (BMI). Successful strategy development and implementation in the knowledge economy require a different set of managerial capabilities. In the new landscape, creating collaborative networks, effectively managing knowledge, and valuing intellectual capital are top priorities. Intangible assets are now an important indicator of national and organizational level performance (Del Giudice and Maggioni, 2014), and knowledge is a key competitive differentiator and vehicle for achieving increased firm performance (Del Giudice and Maggioni, 2014; Nicotra et al., 2014). Information technology is a core factor enabling organizations to design and implement effective knowledge management systems (Del Giudice and Della Peruta, 2016), which are increasingly essential for developing sustainable competitive advantages (Quintane et al., 2011).

Knowledge management has heightened importance because data, information, and knowledge are increasingly liquid, with relational reconfigurations emerging that challenge traditional organizational, industry, and societal hierarchies for business decision-making, value generation, and resource allocation (Del Giudice et al., 2016). The implications of the knowledge economy asserting itself are particularly profound for entrepreneurs and new ventures. The composition of a geographic region and its entrepreneurship ecosystem, as well as the institutional context, exert a strong influence on the creation, absorption, and dissemination of strategic knowledge by a new venture (Carayannis et al., 2016).

Along with relational reconfigurations, the knowledge economy also demands a reevaluation of an organization's business models. An organization requires a competitive value proposition and a functional business model, enabling the generation and capture of value, which can then be redistributed internally (e.g., to employees) and externally (e.g., to shareholders) (Carayannis, Grigoroudis et al., 2014). A firm's entrepreneurial activities are tools for any business model innovation and can be characterized as "strategic entrepreneurship" (Schneider and Spieth, 2013). For example, a company may leverage existing capabilities and competencies to launch a venture in a new geographic region (e.g., Brazil) or novel market space (e.g., biologics). While typically having to operate in environments characterized by substantial change, risk, and uncertainty, organizations are open systems seeking to balance consistency and stability with a business model (Carayannis, Grigoroudis et al., 2014).

Business models are more than just plans; they are fundamental drivers that help communicate, decode, and explain strategy, internally and externally (Carayannis et al., 2015). A firm's business model represents a concise conceptualization of how value is created (e.g., by developing a better, cheaper, or faster product), captured (i.e., monetizing the innovation), and allocated (e.g., rewarding the product development team with bonuses or additional stock options) (Johnson, 2010; Abdelkafi et al., 2013; De Reuver et al., 2013; Carayannis, Grigoroudis et al., 2014). BMI plays a crucial role stimulating an organization's level of excellence, resilience, and stability (Carayannis, Grigoroudis et al., 2014). As such, any BMI has a profound impact on organizational sustainability and the organization's stakeholders, including customers, employees, and partners (Carayannis et al., 2015). The normal environmental turbulence of economic, political, social, and technologic advances forces organizations to be responsive by adapting or even completely changing their business model or risk extinction (Chesbrough, 2010).

This paper examines BMI in the biopharmaceutical industry as firms turn to open innovation (OI) models of drug discovery. The biopharmaceutical, medical device, and pharmaceutical sectors have always been R&D intensive, and the knowledge economy places an even stronger premium on data, information, and knowledge. The growing cost and length of drug discovery have generated political, regulatory, and strategic challenges, shaping new ways of thinking and managing. Enterprise 2.0 is fundamentally collaborative in generating intellectual capital, and biopharma firms are leveraging OI drug development to generate, organize, and share intellectual capital relating to R&D for new medicines. Based on our review of four key exemplars, we identify three essential elements for making this interfirm generating, organizing, and sharing process effective: (i) culture, (ii) collaborative management skills, and (iii) strategic capability alignment.

2 Open innovation business model

2.1 OI defined and explained

OI is a key business model innovation emerging in response to the knowledge economy. Chesbrough (2003) defines OI as utilization of external and internal ideas and pathways to create value. OI, as a form of co-opetition, is a new paradigm that purposively utilizes inflows and outflows of information and knowledge to accelerate internal innovation and to extend the markets for external use (Chesbrough, 2006). The modern open-source movement began in the early 1990s in Finland. A young university student named Linus Torvalds used the then novel Internet message board to post a free operating system with openly available source code others could add to. This innovative approach led to the creation of Linux and represented a fundamental shift in code development. The globally successful open-source software ecosystem provided an exemplar of OI via de-emphasis of intellectual property and decentralization of R&D.

OI in the biopharmaceutical industry is a distributed and permeable development model, structure, and process driven by intentionally catalyzed and managed information and knowledge flows across organizational boundaries; the goal is the creation of new products or services, principally novel drugs, devices, or drug-device combinations (Chesbrough and Bogers, 2014; Nilsson and Minssen, 2018;). The key drug development stages amenable to OI are target identification and screening, tool compounds and preclinical studies, clinical trials, and initial post-FDA approval market entry. The Human Genome Project is an example of a long-standing, open scientific collaboration. OI is widely used in the consumer goods, electronics, and software industries (Gassmann et al., 2010). Much of OI operates informally, but it is increasingly integrated with regular, formal innovation practices (Wikhamn et al., 2016). OI could eventually become the new normal and is generating significant interest among policymakers, practitioners, and scholars (Chesbrough et al., 2014; Niosi and McKelvey, 2018; Schweizer and He, 2018; Toma et al., 2018).

With biopharmaceutical OI, multidisciplinary, multilayered, and multimodal innovation networks composed of government, universities, and industry (GUI) collaborate in creating, diffusing, and utilizing knowledge in nontraditional ways. (Carayannis and Ziemnowicz, 2007; Carayannis and Campbell, 2009). Although the primary generators of novel developments continue to be academically trained scientists operating in corporate or university facilities, there is a democratization of knowledge production (e.g., modeling the structure of certain proteins) via a dramatic increase in citizen science and open science innovation (Carayannis and Campbell, 2006).

2.2 Competitive advantages of OI

By creating strong interfirm networks, OI accelerates the advancement of medical science and helps deliver novel therapies to patients. OI also allows for the sharing of R&D costs, lowering the financial risk for any given partner, and extracting value from an external network of scientific and technology organizations. Participation in intellectual capital and knowledge sharing collaboratives increases an organization's ability to assess, monitor, and integrate new scientific and technological information (Carayannis, Del Giudice et al., 2014). For example, OI can facilitate sharing banks of clinical compounds ready for preclinical studies and for patients, as well as jointly identifying drug-like properties for novel compounds. OI can help researchers understand the causes and pathways of diseases and to identify potential targets for new drugs to intervene, with one key goal being to reduce repetition of assays, experiments, and clinical trials.

Across a variety of industries, data analytics is fundamentally altering business dynamics, and the biopharmaceutical industry is no exception. An inherent characteristic of OI is the leveraging of data from many sources: clinical trials, computer simulations, genomics, social media, and wearable devices. As artificial intelligence, big data, the Internet of Things, viral robots, and numerous other factors contribute to enormous growth in data, it is notable that data analytics is at the core of the OI approach to drug development.

Although OI as a biopharmaceutical BMI is still in the early stages of propagation, there is initial empirical evidence finding a positive link between OI and entrepreneurial growth. (Wikhamn et al., 2016). Not only does open science prove more efficacious in many cases, but also it is arguably a more ethical approach to biomedical research (Shaw, 2017). At a minimum, open scientific approaches can operate as a form of corporate social responsibility, generating positive reputational effects.

3 Biopharmaceutical sector

3.1 R&D intensive industry

The biopharmaceutical sector is a knowledge-intensive industry, and in the broadest sense, it is defined as the application of medicine, science, and technology to alter organic and nonorganic materials for the enhanced production of knowledge, products, and services (Organisation for Economic Co-operation and Development, 2015). This paper focuses on the sector's production of regulatory approved drugs designed to improve human health and wellness. In this capacity, the industry generates and utilizes some of the most advanced science and technology available: advanced imaging, biomarkers, cell therapy, companion diagnostics, gene therapy, genomics, precision medicine, regenerative medicine, and sophisticated bioinformatics. This quality makes it an apt setting to study knowledge economy dynamics.

Biopharma is a high-risk and high-reward industry, heavily reliant on intellectual property rights and patents. The prime modalities for R&D collaboration include alliances, joint ventures, licensing agreements, mergers, and outsourcing. Structural forms of interorganizational collaboration have traditionally included agreements regarding licensing, manufacturing, marketing, R&D, and technology transfer. Companies are evolving their business models away from the big blockbuster drug strategy to more collaborative and specialty product approaches (Schuhmacher et al., 2013), accompanied by aggressive pursuit of mergers and acquisitions. Large players such as AstraZeneca, GlaxoSmithKline, Johnson & Johnson, Eli Lilly, Merck, Novartis, and Pfizer are assertively pursuing OI (Chesbrough and Chen, 2015).

Drug development is scientifically complex. Identification and validation of appropriate biomarkers are essential in commercial biotechnology, particularly with precision medicine. One reason why drugs fail during the discovery phase is inadequate therapeutic responses to novel biomarkers. Late stage failures of potential new medicines are costly and are best prevented with enhanced target identification and validation. The biological, pathophysiological, and physiological dimensions of biomarkers generate high complexity, often requiring combined expertise and skills beyond the domain of a given organization, even large biopharmaceutical companies. OI offers a promising way to address this innovation gap and increase the probability of biomarker success (Landeck, Lessl, Busch et al., 2016).

3.2 Business and environmental challenges for biopharma

Biopharmaceutical companies are among the most successful global business organizations, routinely ranking among the highest in gross revenues and profit margins. Even with this track record of financial achievement, the industry is not immune from the dictates of Enterprise 2.0 and the knowledge economy, so it is assertively turning to more collaborative management practices and network-oriented scientific development. The core drivers are a set of profound business and environmental challenges, many of which are unique to the biotechnology and pharmaceutical sectors.

The drug development process is expensive and lengthy. Bringing a new drug to market costs $2.6 billion and takes about 12 years on average (Tufts Center for the Study of Drug Development, 2015). Total expenditures are significant; in 2016, for drug R&D spending in the United States, National Institutes of Health accounted for about $30 billion (U.S. Department of Health and Human Services, 2016) and industry accounted for about $50 billion (Pharmaceutical Research and Manufacturers of America, 2016). Moreover, the process has a high failure rate. Even the most experienced executives and savviest scientists cannot predict with consistent accuracy which drugs will make it from computer models to FDA approval. The probability of gaining final regulatory approval is only 9.6% for drugs making it to Phase I (Biotechnology Innovation Organization et al., 2016). Perhaps most striking, the approval rate for Phase III drugs is only 60%, yet by the time a drug reaches that stage, the company has probably invested hundreds of millions or even billions (US$) in financial capital.

These drug development expenditures are eventually passed onto patients, thereby putting political and regulatory pressure on the industry to lower drug costs (Hartung et al., 2015; Howard et al., 2015). Established drug R&D models are routinely critiqued as expensive, inefficient, and

ISSN 2183-0606
http://www.open-jim.org

opaque, creating a business and scientific impetus to embrace new strategies (Paul et al., 2010; Munos, 2009, 2016; Shaw, 2017). During the early 2010s, the decreasing or stagnant pace of new drug discovery in the biopharmaceutical industry prompted many experts to call for disruptive innovation and radical changes to the existing paradigm (Paul et al., 2010; Munos and Chin, 2011; Scannell et al., 2012; Ekins et al., 2013). There was a positive trend line in the number of drugs developed by the industry that gained FDA approval: 27 in 2013, 41 in 2014, and 45 in 2015 (FDA, 2014, 2015, 2016), but the number slumped to 22 in 2016 (FDA, 2017).

Many experts continue to identify an increasing disparity between resource inputs (e.g., funding, lab space, researchers, scientific knowledge) and outcomes (e.g., new biological entities, new molecular entities) (Bowen and Casadevall, 2015). Since 1965, the numbers of scientific publications and article authors have increased 527% and 807% respectively (Shaw, 2017), yet the flow of drug approvals has not increased correspondingly. This has provided an additional impetus to develop drug production processes based on more collaboration, communication, and networking.

3.3 Closed innovation evolving to open innovation

The biopharmaceutical industry is highly proprietary, with corporate R&D centers often isolated and protected like fortresses. The modal model involves research completed within the legal, organizational, and physical boundaries of a vertically integrated corporation. R&D proceeds in a secretive way in seeking regulatory approval (e.g., European Medicines Agency in the European Union, Food and Drug Administration in the United States, and Ministry of Agriculture, Forestry and Fisheries in Japan) for new biological entities (NBEs) and new molecular entities (NMEs) that are protected as firm-specific IP. Most of large pharma drug development still occurs through this more traditional, closed model. However, as noted, the current institutional processes for drug development seem recursive and unscalable—surprisingly lacking in economics of scale or scope.

With the assertion of the knowledge economy, the closed innovation model, while still the dominant approach, is losing ground to more collaborative, open approaches. Large biopharmaceutical organizations increasingly seek to fill scientific and technology gaps through external innovation and embracing open approaches. To retain competitive advantages, these organizations are opening their innovation funnel. The industry is shifting from a model based on large, vertically integrated companies, conducting R&D in relative isolation, to more of an OI networked model, and companies are increasing the ratio of collaborative and outsourced drug development to in-house lab staff.

This trend is not entirely new. Knowledge clusters are an important dimension of OI drug development (Carayannis and Campbell, 2006), and biotechnology firms have long utilized clustering physically in formal and mostly informal ways similar to OI business models (Segers, 2015). This is prominent in certain geographies, such as Flanders and Wallonia in Belgium; Rhine-Neckar in Germany; and Cambridge, MA, San Diego, CA, and San Francisco, CA, in the United States. (Segers, 2016). Also, the industry has always maintained ties to academia and has long partnered with small and medium-sized enterprises (SMEs).

Despite a history of collaboration, biopharma has yet to embrace OI on a widespread basis. Part of this is attributable to the highly regulated nature of the biopharma industry, making it inherently resistant to change. Also, the successful financial track record of the sector as a whole means many companies feel no need to change business models. Other barriers to open strategies include cultural norms, IP concerns, and scientific complexities.

Nonetheless, the business imperative of the knowledge economy is forcing the fortress doors ajar, allowing for incorporation of Enterprise 2.0 approaches. SMEs that collaborate are now key drivers of drug development, accounting for most drugs currently in the development pipeline (Thomas and Wessel, 2015). These alliances are a win-win because, operating on their own, SMEs encounter many challenges, particularly in terms of designing and implementing clinical development initiatives (Moscicki and Tandon, 2017). Given the high-risk and capital-intensive nature of drug development, these small firms are especially subject to the liability of newness (Stinchcombe, 1965) and the liability of smallness (Freeman et al., 1983). There is also a growth in garage science start-ups and garage-bred innovation, as Enterprise 2.0 drug development pairs highly sophisticated global biopharmaceutical companies with amateur inventors and citizen scientists who provide a fresh scientific lens on drug development.

4 OI in the biopharma ecosystem

4.1 Different business models and production processes

The biopharmaceutical OI umbrella, as an industry-wide form of BMI, includes several mini-BMIs practiced to varying degrees by different institutions and organizations. These sub-innovations include big firm–SME collaboration, citizen scientists, crowdsourcing, data sharing, open sourcing, public engagement, pre-competition, and virtual R&D. In the precompetitive research model, consortia collaborate to reduce R&D duplication. Pre-competitive consortia in Europe and the United States include the Biomarkers Consortium, the Critical Path Institute's Predictive Safety and Toxicology Consortium, the Joint European Compound Library, the IMI's European Lead Factory, the Patient-Oriented Outcomes Consortium, and PrecisionFDA. These precompetitive collaborations yield gains for private, public, and NGO stakeholders in drug development. The virtual R&D model involves a core group of scientists pursuing new drug development with help from external researchers who typically are not co-located and do not share organizational affiliation (Schuhmacher et al., 2013).

There are even model variations within the variations. Within the R&D incubator model, some companies pursue a "strings attached" approach whereby incubator companies (typically SMEs) are required to sign licensing agreements with the host (typically a large, global biopharma company). In other cases, there are no legal obligations whatsoever, and the incubated company is commercially and legally free to utilize their IP in whatever way they deem most advantageous. Thus, there are dozens of distinct variations of OI drug development BMIs. Munos and Orloff (2016) delineate a helpful typology:

- "Pull" model where industry pulls new developments from external entities into its pipeline (e.g., Pfizer Centers for Therapeutic Innovation, the Novartis-Penn Center for Advanced Cellular Therapeutics)
- "Push" model where academia pushes to translate its bench lab developments into clinical candidates (e.g., Tri-Institutional Therapeutics Discovery Institute with partners such as

Memorial Sloan Kettering Cancer Center, Rockefeller University, Takeda Pharmaceutical Company, and Weill Cornell Medical College)

- "Public-private partnership" model involving GUI collaborations (e.g., Alzheimer's Disease Neuroimaging Initiative, Biomarkers Consortium, Medicines for Malaria Venture, TB Alliance)
- "Risk-sharing" model where a large company, usually with future options to build or buy the scientific results, provides funding and other key resources to a small company with unique IP

These four models are frequently adapted and combined depending on the R&D context, so there are a variety of mini-BMIs within the overall OI BMI paradigm. Ultimately, in the Enterprise 2.0 era, there is no "best" BMI appropriate for every drug development situation. Moreover, due to the normal economic cycles, changing consumer tastes, and technologic advancements, BMIs have a shelf life and must eventually be altered (Chesbrough, 2010).

4.2 Application of OI and crowdsourcing to drug development

All signs point to OI as a pathway to renew the industry's drug development process (Wikhamn et al., 2016). Rather than a full-scale widespread adoption, the biopharmaceutical industry is selectively utilizing open science models in different stages of the development process, including target identification, compound screening, clinical trials, and market launch. The industry has a tradition of embracing open science if one considers the publications of research studies in peer-reviewed medical and scientific journals. This represents a sharing of information with the epistemological community and the broader public, often at little or no cost to the consumer. However, this "openness" has fixed institutional parameters and historically does not extend to the research production process itself. Thus, the scale and type of open innovation currently underway by several companies are fundamentally different. Of course, within the biopharma industry, the OI model has enthusiasts, skeptics, and varieties of opinions between those two extremes, but consensus is trending toward OI.

OI platforms are premised on a collaborative approach linking scientific expertise, compound libraries, optimized molecules, services, technologies, and unique research tools. OI aims to stimulate collaboration among stakeholders who usually have divergent interests. As such, OI partnerships can be symmetric (e.g., collaborators are all large companies or all SMEs), asymmetric (e.g., big global pharma company paired with small biotech firm), or mixed (e.g., GUI consortium involving public, private, and NGO entities of all sizes). OI stimulates long-term value creation and multidirectional relationships between co-development collaborators (e.g., customers, suppliers, external researchers/scientists, governments, universities, and even competitors) and is characterized by a strong coevolutionary element (Del Giudice et al., 2015).

As an emergent tool in the Enterprise 2.0 era, OI is disruptive, and there is an interrelationship between disruptive business models, OI, regional systems of innovation, and technology clustering (Segers, 2015, 2016). OI drug development includes collaborative firms and their extended networks leveraging data and technology to generate, organize, and share knowledge to accelerate innovation in the scientific community. Breast cancer, malaria, and tropical disease are three of

ISSN 2183-0606
http://www.open-jim.org

the more prominent clinical areas where open practices have thrived. Companies create awareness of their open network through a variety of methods, including social media, advisements in key journals, direct mailings to key thought leaders and scientific societies, and presentations at conferences. OI leverages the digital collaboration, social media, and social networking tools popular with Generation Y, and so it is sometimes characterized as a millennial approach to drug development.

Crowdsourcing, a type of OI using novel platforms, peer production, and virtual communities, is particularly associated with Generation Y and Generation Z. Jeff Howe and Mark Robinson, editors at *Wired* magazine, first coined the term *crowdsourcing,* and the original applications were in the business-to-consumer sector (Howe, 2008). Crowdsourcing is often done via the Internet with an open call to the community/crowd for assistance in providing a solution. To take one prominent example, Procter & Gamble frequently invites consumers to provide ideas for novel household products or for improvements on existing goods (Procter & Gamble, 2016). Crowdsourcing allows for the collection of many innovative ideas beyond the one selected. While its use in the drug development process remains in the infancy stage, crowdsourcing is an ascendant mini-BMI.

In particular, biopharmaceutical companies are leveraging crowdsourcing drug development for finding biomarkers and new molecular targets. Eli Lilly was one of the first companies to apply this approach via a platform called InnoCentive, which was eventually spun off as a separate entity that is now a community of over 200,000 experts in more than 20 countries (InnoCentive, 2017). The respondent selected by Eli Lilly as having the best solution is provided with a financial reward in exchange for transferring the IP. Bayer's Grants4Targets (G4T) initiative involves academic institutions applying for competitive grants in support of discovering novel drug targets (Bayer, 2017). Winning applicants are funded by Bayer to conduct focused experiments to provide further validation (or disconfirmation) of proposed biomarkers and targets, and Bayer makes available its own expertise in drug development and target validation. Crowdsourcing is a particularly interesting type of BMI within the new knowledge economy because it represents the combining of Enterprise 2.0 processes (e.g., peer production), structures (e.g., open competition and rewards framework), and tools (e.g., social media).

4.3 Exemplars of Enterprise 2.0 biopharma collaboration

Companies continue to explore new and innovative ways of partnering with academic institutions and with other biotechnology and pharmaceutical companies as they seek to increase the probability of delivering effective disease treatment. This collaborative research and sharing of intellectual capital across multiple organizations addresses the enlarged scale and scope of scientific, social, and technological challenges, with the GUI R&D partnership being a prominent organizational example (Carayannis, Del Giudice et al., 2014). The goals of these collaborations are to accelerate medical science and to positively impact patients' lives. There are many potential permutations involving academic institutions, large pharmaceutical companies, small biotechnology companies, medical research charities, contract research organizations (CROs), and contract manufacturing organizations (CMOs).

Academic institutions and medical research charities are playing an enlarged role in all stages of drug development, from initial idea to early clinical development. For example, the Innovative Medicines Initiative (IMI) is a large public-private European partnership composed of large and small biopharmaceutical companies, hospitals, patient organizations, regulatory agencies, and research organizations with the goals of developing medicines faster and less expensively for patients (IMI, 2017). In the biomarker space, there are a growing number of successful collaborations between government, academia, and business (Asadullah et al., 2015; Landeck, Lessl, Reischl, et al., 2016). Below, four additional examples of important Enterprise 2.0 type collaborations currently underway in the field of drug development are considered. We selected these four examples after scanning dozens of other OI collaborations and consulting with several industry experts. These were ultimately selected because of their breadth, complexity, and success to date.

First, WIPO Re:Search is a global platform whose membership includes biopharmaceutical companies, academic institutes, and government research centers openly sharing IP property with the goal of accelerating drug development for neglected infectious diseases, including malaria and tuberculosis, which collectively afflict nearly 1.5 billion people. This Enterprise 2.0 oriented, cross-sector, multi-stakeholder program has proven highly successful in advancing product R&D for these diseases. It now has more than 105 members from 30-plus countries, including large players such as Alnylam, Eisai, GlaxoSmithKline, Johnson & Johnson, Merck KGaA, Merck (MSD), Novartis, Pfizer, Sanofi, and Takeda. All members of WIPO Re:Search agree to a guiding principle that any product developed will be provided to the 49 least-developed countries on a royalty-free basis. IP assets are shared for free among members, but users of another member's IP assets retain ownership to any IP they develop via WIPO Re:Search. Thus, this consortium strikes a nuanced balance between protecting IP rights, which provides an important financial inducement for participation, and encouraging free and open sharing, which provides the needed context for collaborative scientific advancement.

Second, Pistoia Alliance is a global, not-for-profit consortium of academic institutions, biopharmaceutical companies, publishers, and vendors. Created in 2009 during a conference in Pistoia, Italy, with AstraZeneca, GlaxoSmithKline, Novartis, and Pfizer as founding members, the alliance's mission is to transform the R&D innovation model by stimulating precompetitive collaboration. There are now more than 80 members ranging from the aforementioned large life science conglomerates to several SMEs. In the knowledge economy spirit of overcoming shared organizational and scientific obstacles, the partners work to identify root causes of R&D inefficiencies, develop best practices, and pursue technology pilots. Pistoia Alliance provides a legal framework to guide partnering efforts, acting as a roadmap and safety net for collaborative efforts. For example, even with its significant in-house resources, Pfizer had difficulty handling complex macromolecules computationally. It approached the Pistoia Alliance, which facilitated a collaborative project that successfully created an open-source standard bimolecular language called Hierarchical Editing Language for Macromolecules (HELM). HELM is now widely utilized by biopharmaceutical companies, regulatory agencies (e.g., FDA), and scientific publishers.

Third, Johnson & Johnson (J&J) has a state-of-the-art lab in La Jolla, CA, called JLABS focused on collaborative innovation that houses as tenants many current and potential J&J competitors. J&J created this "no strings attached" OI incubator in 2012 and has subsequently created 5 additional sites in North America. J&J uses the JLABS concept to develop relationships with scientists and other innovators. Eventually, these companies can develop drug candidates or technology of interest to J&J. Across its 6 JLABS, J&J is currently incubating almost 150 companies. The tenants have access to J&J's compound library, as well as its commercial and regulatory experts. JLABS staff assist the biotech entrepreneurs with attaining needed permits and ensuring environment, health, and safety standards. The subsidized rent for a lab space is a little over $1,000 per month, only partially offsetting J&J's overhead costs; this is a considerably less expensive option than investing $5–10 million for an adequate start-up lab space. JLABS also conducts periodic competitions for early stage innovators, with winners being awarded free JLABS space. Tenants get access to many of the platforms and resources available to internal teams. Essentially, this allows for external entities to gain the advantages of closed innovation (e.g., legal expertise) within an OI construct.

Fourth, AstraZeneca's Open Innovation initiative encourages research partners at all stages of the R&D process to utilize its clinical compound bank, new molecule profiling, and pharmacology toolbox. Potential collaborators can access more than 250,000 current and discontinued compounds for screening. The initiative has received in excess of 400 proposals from researchers in nearly 30 countries, which has led to more than 150 collaborations. In addition, Compound Passport Service (CPS) is a platform produced by AstraZeneca to manage the shared access and rights implications of OI projects. The CPS provides a system to record and manage compounds throughout their life cycle to prevent, among other problems, the issue that arises if AstraZeneca mistakenly reveals IP subject to a proprietary legal agreement with a prior collaborator. Enterprise 2.0 structures create, develop, and distribute business-to-consumer(B2C) products and services by leveraging the latest innovation approaches and open-source principles. As shown by AstraZeneca's CPS platform, sometimes that output requires the creation of foundational business-to-business (B2B) frameworks crucial for effectively managing shared access and potentially overlapping IP. Thus, in the biopharma context, Enterprise 2.0 innovation yields two value-generating outputs: (i) novel B2C goods/services (e.g., a new cure for brain cancer or breast cancer) and (ii) novel B2B frameworks/processes (e.g., software for managing and allocating IP rights).

Because of differences in institutional norms and organizational cultures, these Enterprise 2.0 partnerships are difficult to create and even more challenging to manage (Carayannis, Del Giudice et al., 2014). Abstracting across these examples, potential keys to creating a beneficial GUI collaboration include cultural fit, appropriate technology, external champions, internal champions, and long-term oriented risk capital. However, because each situation is so specific, there may not be a set formula for success (Carayannis, Del Giudice et al., 2014). Thus, one set of Enterprise 2.0 structures and tools may work in the open innovation development of Drug A, but another set might be better for OI development of Drug B. Moreover, in some cases (e.g., development of Drug C), Enterprise 2.0 and the knowledge economy notwithstanding, the best approach might be the traditional, highly proprietary, closed innovation pathway.

5 Discussion and observations

Several observations emerge from our examination of Enterprise 2.0, collaborative firms/networks, and the knowledge economy in the context of OI drug development. First, for OI drug development to be effective, the collaborating entities must have an open-minded culture to accompany the OI network. Collaboration is not a natural human or organizational behavior (Carayannis, Del Giudice et al., 2014). Thus, OI should include joint goal direction and open data, as well as permeable boundaries and communication transparency. Cultural resistance to OI is natural, and GUI collaborations typically fail because of cultural and managerial resistance, rather than for scientific or technical reasons (Carayannis, Del Giudice et al., 2014). In fact, OI does carry risks related to a collaborator's behavior, including impairing competitiveness by premature submission of publications, limiting commercialization by the ill-timed filing of patents, and outright theft of ideas and other IP (Alexy et al., 2009; Robertson et al., 2014). Thus, a certain measure of internal resistance is functional and protective of corporate interests, but fundamental cultural clashes, particularly when driven by one or more party's failure to fully embrace the OI ethos, can result in failure or severe underperformance (e.g., the collaboration produces no new medicines).

Second, OI requires the right collaborative management skills (e.g., communication, decision-making, and structure) for successful implementation.In terms of communication, because much of OI drug development is virtual, there is a heavy reliance on Enterprise 2.0 type digital communication and technology platforms to maintain connectivity and stimulate collaboration among geographically disbursed partners. In terms of decision-making, ideas generation, selection, and implementation, these functions need to become less hierarchical, with more of the key decisions deferred to researchers, scientists, and ground managers. In terms of structure, m embers of an OI partnership should reach a priori agreement on the origin, ownership rights, and usage of compounds. As the OI business model has evolved, structural tools are emerging to facilitate open collaboration. The process of pairing companies with solution providers is becoming more efficient, reducing issues like rampant "window-shopping" (i.e., smaller potential collaborators previewing their ideas and technologies for large companies who ultimately decline to partner). New innovative workflow solutions are emerging for the management of IP concerns (e.g., AstraZeneca's CPS platform).

Third, strategic capability alignment is crucial. When interorganizational learning occurs in a global context, it requires organizations to acquire skills, implement structures, and develop novel and multiple forms of learning (Del Giudice and Maggioni, 2014). Because interorganizational collaboration is the core idea in open innovation (Levine and Prietula, 2013), capabilities for effectively developing interfirm trust are needed for this fast-changing R&D environment. With open networks as the foundation, executives must ensure that corporate strategy and firm capabilities are synced with BMI.

6 Limitations and further research

As with any examination of complex new business models, this article contained a number of limitations. First and principally, while a review piece approach has advantages (e.g., inclusion of rich, contextual elements), there are some inherent limitations on generalizability. We carefully selected the four exemplars explored, but that still represents a small subset of the hundreds of various types of OI biopharmaceutical collaborations currently underway globally. A limitation of the current article and an area for future research is undertaking a database-driven, quantitatively

ISSN 2183-0606
http://www.open-jim.org

empirical analysis with a reasonably large N. The practical and statistical difficulty of such studies is that the unit of analysis is the collaboration itself, yet there are an enormous variety of biopharmaceutical OIs. This makes application of traditional quantitative methods challenging, yet this is an important and essential next step for this body of research.

Second, the article references ethical and legal considerations but does not explore these in any detail. Ethical and legal dimensions of open source biopharmaceutical developments are tremendously consequential—often of greater import than the pure scientific or strategic considerations. While delving into ethics or the legal/regulatory aspects of OI would unduly expand the scope of the article, they are crucial dynamics that have been the subject of entire articles and merit further research. Third, the article makes several references to regulation, which is clearly an important consideration given the highly regulated nature of the pharmaceutical industry. However, whereas the article generally presents regulation as a barrier, regulatory agencies, officials, and rules can also serve as crucial enablers of an increasingly open innovation world. Thus, future research could address this limitation by viewing regulation less descriptively (e.g., as a barrier to OI) and more normatively and prescriptively (e.g., how could and should regulation enable increased OI drug development).

There are additional key directions for future research. As alluded to, the application of OI to the normally highly competitive, propriety drug development space is sufficiently new and infrequent that assessing efficacy is not yet amenable to large N longitudinal data analyses, so that remains an area for subsequent examination. Moreover, the lengthy average time to develop a drug (often 10–12 years) creates a long lag between the use of OI drug development and final successful outcomes (e.g., regulatory approval). However, once there is sufficient data, it will be important to undertake longitudinal quantitative analyses comparing different models of OI to different R&D outcomes. Building on classic work by Bass (1969), ongoing research explicates the process by which knowledge-sharing technologies diffuse within an ecosystem of potential adopters (Della Peruta and Del Giudice, 2013), but there is a need for more long-term oriented quantitative, empirical work on the role of value chain networks (e.g., competitors, complementors, customers, regulators, suppliers) in BMI and how members of that network can impact outcomes.

Another direction for future research is a focus on more of the specific collaboration and communication tools OI partners are leveraging for knowledge sharing. What social media and technology platforms are most effective for stimulating and supporting R&D partnering? How does the application of social networking tools affect governance and performance of a GUI collaboration? When and how are social networking sites used for crowdsourcing and other efforts to bring together otherwise disparate researchers? Addressing these questions related to utilization of Enterprise 2.0 tools, as well as future quantitative analyses comparing R&D inputs with new medicine outputs, would illuminate how OI collaborative firms and networks impact management research and practice regarding the global biopharmaceutical industry.

7 Conclusion

The growth in collaborative networks and interfirm partnering has profound implications for management research and practice. As the knowledge economy asserts itself, BMI can enhance learning and yield adaptive outcomes. Key tools in this regard include collaborative technology platforms, digital communication, OI (e.g., crowdsourcing), peer production, and social media. We applied these developments in OI, the knowledge economy, and Enterprise 2.0 to the setting of the biopharmaceutical industry and four specific exemplars. In particular, we examined the utilization of OI drug development to make the R&D process for developing new medicines more effective and efficient. A growing number of biotechnology, medical device, and pharmaceutical companies are leveraging collaborative approaches and knowledge sharing to work with GUI. This new era requires that biopharma executives develop new managerial capabilities related to cooperation, co-opetition, flexibility, and innovation.

Via OI, the development of multidirectional relationships between large, global biopharma firms and their R&D partners is creating long-term value in the form of new OI processes, products, structures, and tools. We noted several summary observations in this regard. First, productive OI drug development requires an open-minded culture among network participants. Second, effective OI requires a new set of specific managerial capabilities geared toward interfirm collaboration and communication. Third, biopharma executives must synergize corporate strategy and firm capabilities with the OI form of BMI. Increasingly, at least with respect to the operation of the global life sciences sector in the knowledge economy, effective management of innovation will require development of OI methods as a core competency.

Acknowledgments

The authors would like to thank the reviewers and the editor for excellent feedback and helpful insights on earlier versions of the manuscript.

8 References

Abdelkafi, N., Makhotin, S., & Posselt, T. (2013). Business model innovations for electric mobility—What can be learned from existing business model patterns*? International Journal of Innovation Management*, *17*(1), 1–41.

Alexy, O., Criscuolo, P., & Salter, A. (2009). Does IP strategy have to cripple open innovation? *MIT Sloan Management Review*, *51*(1), 71–77.

Asadullah, K., Busch, A., Gottwald, M., Reinke, P., & Landeck, L. (2015). Industrial–academia collaborations for biomarkers. *Nature Reviews Drug Discovery*, *14*(12), 805–806.

Bass, F. M. (1969). A new product growth for model consumer durables. *Management Science*, *15*(5), 215–227.

Bayer. (2017). Retrieved October 25, 2017, from www.grants4targets.bayer.com

Biotechnology Innovation Organization, Biomedtracker, & Amplion, Inc. (2016). Clinical development success rates, 2006–2015. Retrieved October 25, 2017, from http://bit.ly/22o5TGf?_ga=1.226529307.7

64361380

Bowen, A., & Casadevall, A. (2015). Increasing disparities between resource inputs and outcomes, as measured by certain health deliverables, in biomedical research. *Proceedings of the National Academy of Sciences*, *112*(36), 11335–11340.

Carayannis, E. G., & Campbell, D. F. (Eds.). (2006). *Knowledge creation, diffusion, and use in innovation networks and knowledge clusters: A comparative systems approach across the United States, Europe, and Asia.* Westport, CT: Greenwood Publishing Group.

Carayannis, E. G., & Campbell, D. F. (2009). 'Mode 3' and 'quadruple helix': Toward a 21st century fractal innovation ecosystem. *International Journal of Technology Management*, *46*(3/4), 201–234.

Carayannis, E. G., Del Giudice, M., & Della Peruta, M. R. (2014). Managing the intellectual capital within government-university-industry R&D partnerships: A framework for the engineering research centers. *Journal of Intellectual Capital*, *15*(4), 611–630.

Carayannis, E. G., Grigoroudis, E., Sindakis, S., & Walter, C. (2014). Business model innovation as antecedent of sustainable enterprise excellence and resilience. *Journal of the Knowledge Economy*, *5*(3), 440–463.

Carayannis, E. G., Provance, M., & Grigoroudis, E. (2016). Entrepreneurship ecosystems: an agent-based simulation approach. *The Journal of Technology Transfer*, *41*(3), 631–653.

Carayannis, E. G., Sindakis, S., & Walter, C. (2015). Business model innovation as lever of organizational sustainability. *The Journal of Technology Transfer*, *40*(1), 85–104.

Carayannis, E. G., & Ziemnowicz, C. (Eds.). (2007). *Rediscovering Schumpeter: Creative destruction evolving into 'Mode 3.'* Boston, MA: Palgrave Macmillan.

Chesbrough, H. (2003). *Open innovation: The new imperative for creating and profiting from technology.* Boston, MA: Harvard Business School Press.

Chesbrough, H. (2006). *Open business models: How to thrive in the new innovation landscape,* Boston, MA: Harvard Business School Press.

Chesbrough, H. (2010). Business model innovation: Opportunities and barriers. *Long Range Planning*, *43*(2/3). 354–363.

Chesbrough, H., & Bogers, M. (2014). Explicating open innovation: Clarifying an emerging paradigm for understanding innovation. In H. Chesbrough, W. Vanhaverbeke, & J. West, (Eds.), *New Frontiers in Open Innovation*, (pp. 3–28). Oxford, England: Oxford University Press.

Chesbrough, H. & Chen, E. L. (2015). Using inside-out open innovation to recover abandoned pharmaceutical compounds. *Journal of Innovation Management*, *3*(2), 21–32.

Chesbrough, H., Vanhaverbeke, W., & West, J. (Eds.). (2014). *New frontiers in open innovation.* Oxford, England: Oxford University Press.

Del Giudice, M., Caputo, F., & Evangelista, F. (2016). How are decision systems changing? The contribution of social media to the management of decisional liquefaction. *Journal of Decision Systems*, *25*(3), 214–226.

Del Giudice, M., & Della Peruta, M. R. (2016). The impact of IT-based knowledge management systems on internal venturing and innovation: A structural equation modeling approach to corporate performance. *Journal of Knowledge Management*, *20*(3), 484–498.

Del Giudice, M., Della Peruta, M. R., & Maggioni, V. (2015). A model for the diffusion of knowledge sharing technologies inside private transport companies. *Journal of Knowledge Management*, *19*(3), 611–625.

Del Giudice, M., & Maggioni, V. (2014). Managerial practices and operative directions of knowledge management within inter-firm networks: A global view. *Journal of Knowledge Management*, *18*(5), 841–846.

Della Peruta, M. R., & Del Giudice, M. (2013). Knowledge accumulation and reuse for spinning off firms from learning organizations: An individual knowledge based perspective. *International Journal of Social Ecology and Sustainable Development*, *4*(4), 20–29.

De Reuver, M., Bouwman, H., & Haaker, T. (2013). Business model roadmapping: A practical approach to come from an existing to a desired business model. *International Journal of Innovation Management*, *17*(1), 1–18.

Ekins, S., Waller, C. L., Bradley, M. P., Clark, A. M., & Williams, A. J. (2013). Four disruptive strategies for removing drug discovery bottlenecks. *Drug Discovery Today*, *18*(5/6), 265–271.

FDA (2014). Novel New Drugs 2013 Summary. Retrieved October 25, 2017, from: https://www.fda.gov/media/ 87579/download

FDA (2015). Novel New Drugs 2014 Summary. Retrieved October 25, 2017, from: https://wayback.archive-it.org/7993/20170406032101/https://www.fda.gov/downloads /Drugs/DevelopmentApprovalProcess/DrugInnovation/UCM430299.pdf

FDA (2016). Novel Drugs Summary 2015. Retrieved October 25, 2017, from: https://www.fda.gov/drugs/new-drugs-fda-cders-new-molecular-entities-and -new-therapeutic-biological-products/novel-drugs-summary-2015

FDA (2017). Novel Drugs Summary 2016. Retrieved October 25, 2017, from: https://www.fda.gov/drugs/new-drugs-fda-cders-new-molecular-entities-and -new-therapeutic-biological-products/novel-drugs-summary-2016

Freeman, J., Carroll, G. R., & Hannan, M. T. (1983). The liability of newness: Age dependence in organizational death rates. *American Sociological Review*, *48*(5), 692–710.

Gassmann, O., Enkel, E., & Chesbrough, H. (2010). The future of open innovation. *R&D Management*, *40*(3), 213–221.

Hartung, D. M., Bourdette, D. N., Ahmed, S. M., & Whitham, R. H. (2015). The cost of multiple sclerosis drugs in the US and the pharmaceutical industry: Too big to fail? *Neurology*, *84*(21), 2185–2192.

Howard, D. H., Bach, P. B., Berndt, E. R., & Conti, R. M. (2015). Pricing in the market for anticancer drugs. *Journal of Economic Perspectives*, *29*(1), 139–162.

Howe, J. (2008). *Crowdsourcing: Why the power of the crowd is driving the future of business.* New York, NY: Crown Publishing Group.

InnoCentive (2017). Retrieved October 25, 2017, from https://www.innocentive.com

Innovative Medicines Initiative (2017). Retrieved October 25, 2017, from http://www.imi.europa.eu

Johnson, M. W. (2010). *Seizing the white space: Business model innovation for growth and renewal.* Boston, MA: Harvard Business Press.

Landeck, L., Lessl, M., Busch, A., Gottwald, M., & Asadullah, K. (2016). The role of open innovation in biomarker discovery. *Advances in Precision Medicine*, *1*(2), 1–4.

Landeck, L., Lessl, M., Reischl, J., Busch, A., Carrigan, P., Gottwald, M., Reinke, P., & Asadullah, K. (2016). Collaboration for success: The value of strategic collaborations for precision medicine and biomarker discovery. *Advances in Precision Medicine*, *1*(1), 25–33.

Levine, S. S., & Prietula, M. J. (2013). Open collaboration for innovation: Principles and performance. *Organization Science*, *25*(5), 1414–1433.

Moscicki, R. A., & Tandon, P. K. (2017). Drug-development challenges for small biopharmaceutical companies. *New England Journal of Medicine*, *376*(5), 469–474.

Munos, B. H. (2009). Lessons from 60 years of pharmaceutical innovation. *Nature Reviews Drug Discovery*, *8*(12), 959–968.

Munos, B. H. (2016). Biomedical innovation: Lessons from the past and perspectives for the future. *Clinical Pharmacology & Therapeutics*, *100*(6), 588–590.

Munos, B. H., & Chin, W. W. (2011). How to revive breakthrough innovation in the pharmaceutical industry. *Science Translational Medicine*, *3*(89), 89–105.

Munos, B. H., & Orloff, J. J. (2016). Disruptive innovation and transformation of the drug discovery and development enterprise. *NAM Perspectives.* Discussion Paper. National Academy of Medicine, Washington, D.C. doi: 10.31478/201607c

Nicotra, M., Romano, M., & Del Giudice, M. (2014). The evolution dynamic of a cluster knowledge network: The role of firms' absorptive capacity. *Journal of the Knowledge Economy*, *5*(2), 240–264.

Niosi, J. & McKelvey, M. (2018). Relating business model innovations and innovation cascades: The case of biotechnology. *Journal of Evolutionary Economics*, *28*(5), 1081–1109.

Nilsson, N., & Minssen, T. (2018). Unlocking the full potential of open innovation in the life sciences through a classification system. *Drug Discovery Today*, *23*(4), 771–775.

Organisation for Economic Co-operation and Development (2015). Key Biotechnology Indicators. Retrieved October 25, 2017, from:
http://www.oecd.org/innovation/inno/keybiotechnologyindicators.htm

Paul, S. M., Mytelka, D. S., Dunwiddie, C. T., Persinger, C. C., Munos, B. H., Lindborg, S. R., & Schacht, A. L. (2010). How to improve R&D productivity: The pharmaceutical industry's grand challenge. *Nature Reviews Drug Discovery*, *9*(3), 203–214.

Pharmaceutical Research and Manufacturers of America (2016). Retrieved October 25, 2017, from https://www.phrma.org

Procter and Gamble. (2016). Retrieved October 25, 2017, from http://www.pgconnectdevelop.com

Quintane, E., Casselman, R. M., Sebastian, B. R., & Nylund, P. A. (2011). Innovation as a knowledge-based outcome. *Journal of Knowledge Management*, *15*(6), 928–947.

Robertson, M. N., Ylioja, P. M., Williamson, A. E., Woelfle, M., Robins, M., Badiola, K. A., Willis, P., Olliaro, P., Wells, T. N., & Todd, M. H. (2014). Open source drug discovery—A limited tutorial. *Parasitology*, *141*(1), 148–157.

Scannell, J. W., Blanckley, A., Boldon, H., & Warrington, B. (2012). Diagnosing the decline in pharmaceutical R&D efficiency. *Nature Reviews Drug Discovery*, *11*(3), 191–200.

Schneider, S., & Spieth, P. (2013). Business model innovation: towards an integrated future research agenda. *International Journal of Innovation Management*, *17*(1), 1–34.

Schuhmacher, A., Germann, P., Trill, H., & Gassmann, O. (2013). Models for open innovation in the pharmaceutical industry. *Drug Discovery Today*, *18*(23/24), 1133–1137.

Schweizer, L., & He, J. (2018). Guiding principles of value creation through collaborative innovation in pharmaceutical research. *Drug Discovery Today*, *23*(2), 213–218.

Segers, J. (2015). The interplay between new technology based firms, strategic alliances and open innovation, within a regional systems of innovation context. The case of the biotechnology cluster in Belgium. *Journal of Global Entrepreneurship Research*, *5*(1), 16.

Segers, J. (2016). Regional systems of innovation: Lessons from the biotechnology clusters in Belgium and Germany. *Journal of Small Business and Entrepreneurship*, *28*(2). 133–149.

Shaw, D. L. (2017). Focus: Drug development: Is open science the future of drug development? *The Yale Journal of Biology and Medicine*, *90*(1). 147–151.

Stinchcombe, A. L. (1965). Organizations and social structure. *Handbook of Organizations*, *44*(2). 142–193.

Thomas, D., & Wessel, T. (2015). Emerging therapeutic company investment and deal trends. Biotechnology Industry Organization. Washington, D.C. Retrieved October 25, 2017, from https://nmbio.org/wp-content/uploads/BIO-Emerging-Therapeutic-Company-Report-June-11-2015.pdf

Toma, A., Secundo, G., & Passiante, G. (2018). Open innovation and intellectual property strategies: Empirical evidence from a bio-pharmaceutical case study. *Business Process Management Journal*, 24 (2), 501 - 516.

Tufts Center for the Study of Drug Development. (2015). *Outlook 2015*. Boston, MA: Tufts University. Retrieved October 25, 2017 from https://csdd.tufts.edu/outlookreports

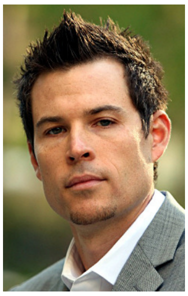
U.S. Department of Health and Human Services (2016). HHS FY2016 Budget in Brief. Retrieved October 25, 2017, from http://www.hhs.gov/about/budget/budget-in-brief/nih/index.html#budget

Wikhamn, B. R., Wikhamn, W., & Styhre, A. (2016). Open innovation in SMEs: A study of the Swedish bio-pharmaceutical industry. *Journal of Small Business and Entrepreneurship*, *28*(2), 169–185.

Biographies

James J. Gillespie. James J. Gillespie received his PhD in management and organization behavior at the Northwestern University Kellogg School of Business. His education includes Carnegie Mellon University, Harvard University, Massachusetts Institute of Technology, and Princeton University. He is a Faculty Member in the Department of Business and Economics at Saint Mary's College where he focuses on international management and new ventures. His experience includes the Center for Healthcare Innovation in Chicago, the Stanford University School of Medicine's Clinical Excellence Research Center, and the Yale University School of Medicine's Center for Digital Health & Innovation. Dr. Gillespie is coauthor of Patient-Centric Analytics in Health Care: Driving Value in Clinical Settings and Psychological Practice (Lexington Books, 2017).

Gregory J. Privitera. Gregory J. Privitera received his PhD in behavioral neuroscience at the State University of New York at Buffalo in 2006 and completed his postdoctoral work at Arizona State University, Tempe, AZ. He is a Professor of Psychology at St. Bonaventure University where he is recipient of their highest teaching honor and their highest honor for research and scholarship. He is a veteran of the U.S. Marine Corps, and his research bridges knowledge creation across the areas of business and psychology. He is author of more than two dozen books and three dozen peer-reviewed articles for texts across these fields. Dr. Privitera is author of Statistics for the Behavioral Sciences (SAGE, 2017), a best-selling book in its third edition. His texts are adopted internationally at over 200 institutions including Harvard University, Stanford University, Johns Hopkins University, Columbia University, and Dartmouth.



Joseph Gaspero. Joseph Gaspero is the Chief Executive Officer and Co-Founder of the Center for Healthcare Innovation, an independent, nonprofit research and educational institute dedicated to entrepreneurship and innovation in healthcare and medicine. At the Center, Mr. Gaspero leads research and education initiatives focusing on health equity, patient-driven healthcare, patient engagement, clinical trials, drug pricing, and other pressing healthcare issues. Under his leadership, several patient-focused initiatives have received grant support and funding from large corporate and philanthropic organizations.

Journal of Innovation Management
JIM 7, 2 (2019) 78-104
HANDLE: https://hdl.handle.net/10216/121201
DOI:https://doi.org/10.24840/2183-0606_007.002_0006
SM: Feb/2019 AM: Apr/2019

The contradictory role of humor in international competitiveness and innovativeness

Jialei Yang
jialei.yang@oulu.fi | University of Oulu, P.O. Box 8000, FI-90014 Oulu, Finland
Pia Hurmelinna-Laukkanen
pia.hurmelinna-laukkanen@oulu.fi | University of Oulu
Eeva-Liisa Oikarinen
eeva-liisa.oikarinen@oulu.fi | University of Oulu

Abstract. This study explores the relationships among the use of different types of humor (affiliative, aggressive, reframing, and coping humor)—both among immediate co-workers ("ingroup"), and with actors external to the firm ("outgroup"), international competitiveness, as well as innovativeness. An exploratory study based on survey data suggests that humor, when connections exist, is negatively related to international competitive potential and performance. Whether or not these negative effects emerge, depends on with whom and which type of humor is used. However, the situation is not straightforward: innovativeness is positively related to international competitiveness, and to innovativeness, humor types relate in different ways, some positive, some negative. Overall, humor seems to play a relevant, but challenging-to-manage role especially in settings where borders—organizational or national—are crossed: Humor that works as a lubricant for innovation processes, does not necessarily work directly in advancing international competitiveness.

Keywords. Humor; International competitiveness; Innovativeness; Innovation behavior; Innovation output.

Cite paper as: Yang, J., Hurmelinna-Laukkanen, P., Oikarinen, E., (2019). The contradictory role of humor in international competitiveness and innovativeness, *Journal of Innovation Management*, www.open-jim.org, 7(2), 78-104.

1. Introduction

International competitiveness at the firm level refers to the capability of a firm to sustainably and profitably satisfy international customer requirements (Cetindamar & Kilitcioglu, 2013; Chikán, 2008). It can be measured in terms of three aspects: competitive potential (assets/factors, i.e., input), competitive performance (outcome), and management processes (Buckley, Pass, & Prescott, 1988, 1990; Cetindamar & Kilitcioglu, 2013), and it can be enhanced in different ways, among which advancing innovativeness has been found highly relevant (Alvarez & Iske, 2015; Özçelik & Taymaz, 2004). Relatedly, earlier research has considered innovativeness and international competitiveness not only in terms of their interactions (e.g., Brännback & Wiklund, 2001; Kafouros, Buckley, Sharp, & Wang, 2008; Keogh, 1999; Kodama, 2017), but also in terms of the common denominators. In this area, it has been established that relationships—internal and external—are relevant for both innovation and international business (see Alvarez & Iske, 2015; Ramamoorthy, Flood, Slattery, & Sardessai, 2005). By managing these relationships, one can find ways to enhance innovation and international processes. Thus, this topic has been interesting to academics and practitioners.

This study turns attention to a specific issue within this realm, acknowledging that in the internal and external relationships—and therefore, in international advancements and innovation processes—humor may become a factor to be reckoned (see Cooper, 2005; Graham, 1995). First, extant research has indicated that humor might have an effect on the competitiveness of companies in the international environment (Buckley et al., 1988, 1990; Cetindamar & Kilitcioglu, 2013). However, the (direct and indirect) connections between humor and international competitiveness are not self-evident, and existing studies incorporating humor related elements (e.g., in connection to cultures) seem to consider international competitiveness at the national level rather than at the firm level (e.g., Skoric & Park, 2014). The international competitiveness discourse calls for augmentation. Second, on the other side, humor has been found to bear importance in creativity and innovation activities and processes of firms (Hurmelinna-Laukkanen, Atta-Owusu, & Oikarinen. 2016; Jones & Bear, 2018; Lussier, Grégoire, & Vachon, 2017). However, these findings are not completely conclusive—they often focus on creativity (the front-end of innovation), and they tend to lack connection to international activity.

There is also a challenge in the existing management studies that the majority of humor studies has focused on the positive aspects of humor (e.g. Barroso-Tanoira, 2017; Hassan, Razek, & Alharbi, 2017), overlooking the potentially negative features (Mesmer-Magnus, Glew, & Viswesvaran, 2012) and failed humor (Robert & Wilbanks, 2012). While the "double-edged sword" nature of humor has been acknowledged in the field of business management in general (Malone, 1980), and the misuse of inappropriate humor can produce unfavorable results has been known (Cooper, 2008; Robert & Wilbanks, 2012), the understanding of humor in relation to the premises and outcomes of innovation and international competitiveness suffers from fragmentation and limitations. In particular, it is not very clear whether humor works in similar ways in different managerial situations, and when humor exactly causes negative or positive effects. Therefore, there exist both academic and practical needs to build up a more comprehensive picture, providing a framework that better explains the role of humor in these processes and activities that set the direction for firm competitiveness.

Following from this setting, this explorative study investigates how different humor types inside and outside firm's boundaries, premises, and outputs of international competitiveness, and innovativeness are interconnected. It is the first study, to our best knowledge, that explores these links. With the help of this knowledge, it is possible to understand better, how humor could be used strategically to promote competitiveness—instead of unintendedly harming it.

In the following, we first briefly discuss the constructs of interest and their interconnections in the light of existing literature. We then proceed to an empirical and quantitative examination. Finally, the main conclusions are discussed in terms of theoretical contributions to the international business and innovation management research, managerial implications, limitations, and directions for future research.

2. Theoretical background

2.1. Humor types in ingroup and outgroup social settings

Existing literature on humor suggests that humor takes various conceptualizations with regard to definitions, styles, and uses (Mesmer-Magnus et al., 2012). This study adopts one of the most widely accepted definitions of humor in the business management literature given by Mesmer-Magnus et al. (2012), defining humor as amusing communication shared between two or more actors. Rather than regarding humor as a key interpersonal resource (e.g. Cooper, Kong, & Crossley, 2018), this study assumes generally that humor works as a mechanism that triggers different emotions. Furthermore, we treat humor as a two-dimensional concept, following Martin, Puhlik-Doris, Larsen, Gray, and Weir (2003): (1) humor (as a form of communication) allows the enhancement of oneself in an intra-psychic way or in one's interpersonal social relationships, and (2) humor has the nature of being either positive or negative.

Based on previous literature (aiming to extend especially the study by Hurmelinna-Laukkanen et al., 2016), this paper groups humor into four types to capture humor's complex and multifaceted nature: affiliative humor, aggressive humor, coping humor, and reframing humor. Affiliative humor refers to relatively harmless and benevolent humor (Martin et al., 2003); aggressive humor refers to humor that intends to condemn, manipulate and put down others under the guise of playful fun (Martin et al., 2003; Romero & Cruthirds, 2006); coping humor is a mix of so-called liberating and stress relieving humor that distances oneself from experiencing negative stimuli (Lang & Lee, 2010); and reframing humor refers to humor that addresses things in other ways to inspire new perspectives (Kahn, 1989; Kuiper, McKenzie, & Belanger, 1995). These categories illustrate how humor can have quite different features and implications—especially when placed in contexts where organizations with varying cultures are interacting (Caloghirou, Kastelli, & Tsakanikas, 2004).

In fact, the "locus" of humor use can be quite relevant. Earlier literature provides some specific examples on it. When affiliative humor is used in daily activities between co-workers who are members of the same team—"Ingroup"—relationships between co-workers can be enhanced and positive climate in organizations can be built (Romero & Cruthirds, 2006). Likewise, in this kind of setting, it could be expected that humor can be useful for renewal, since the routines of the ingroup can be broken (see Lussier et al., 2017, p. 171 noting that "a lighter atmosphere at work is known to foster collaborative discussions and new problem-solving perspectives"). Mild aggressive humor in an otherwise stable environment can be good for group cohesion (Romero & Cruthirds, 2006), i.e., the attraction among group members (Kakar, 2018), like coping humor in stressful situations.

On the other hand, when humor is used in interactions with external actors who have a business relationship with the organization (e.g., customers, suppliers, and other stakeholders), it is regarded as being used in the "outgroup" context (see e.g., Lussier et al., 2017). In such a setting—especially if the relationships are not well established, aggressive humor, for example, might have notable adverse effects (Hurmelinna-Laukkanen et al., 2016). Collaboration and knowledge sharing call for norm distance, i.e., "the degree to which the source and recipient of knowledge share the common value system and organizational culture" (Dey & Mukhopadhyay, 2018, p. 32) to be close enough, but aggressive humor may increase rather than narrow the gap (Romero & Cruthirds, 2006). Likewise, coping humor could be tricky, if it hits the firm's reputation and image in some ways. Affiliative humor may be useful, if it allows "salespeople [to] become more inclined to provide creative and innovative business solutions to customers", for example (Lussier et al., 2017, p. 171).

At the same time, due to its context-dependency (Mesmer-Magnus et al., 2012), humor could yield quite different influences. In varying firm processes, humor can be useful for intermediate outcomes, while the end result might not be affected (see, e.g., Hurmelinna-Laukkanen et al., 2016, for differences in premises and outcomes in innovation processes), or vice versa, or the results could be quite opposite in different stages, depending on what factors are observed. While it indicates that having a clear understanding and awareness of the consequences brought by different humor types in a specific business context is managerially meaningful, scholarly information and empirical evidence are relatively scant. It applies especially to international business environments, where complex contexts and cultural differences make it more challenging to understand and predict if specific humor types can be used safely and productively and if there are ones that should be used with caution (or even avoided) (e.g. Cleveland, Laroche, & Papadopoulos, 2015), and the need for knowledge is even more notable regarding how humor functions in the interaction of innovation and international competitiveness.

2.2. International competitiveness: competitive potential and competitive performance

International competitiveness is a multifaceted concept that has been conceptualized at four levels: product-, firm-, industry-, and national level (Bhawsar & Chattopadhyay, 2015). Attention is increasingly paid to the firm-level international competitiveness, because it is closely associated with sustainability and success of an entity in international markets (Bhawsar & Chattopadhyay, 2015).

Previous studies have made efforts to develop measurements of dimensions of international competitiveness (e.g., Buckley et al., 1988, 1990; Cetindamar & Kilitcioglu, 2013). We decided to focus on two that capture the advancement and realization processes of international competitiveness: competitive potential and competitive performance (Buckley et al., 1988). Competitive potential generates the resources that are used to achieve and improve competitive performance, which in turn reflects the outcome of the international activities (Buckley et al., 1988; see also, e.g. Pascucci, 2018). Therefore, we assume that competitive potential contributes to the performance outcomes:

H1. Competitive potential is positively related to competitive performance.

Internal and external relationships and communication are of relevance when considering competitive potential, and competitive performance (e.g. Barnes, Leonidou, Siu, & Leonidou, 2015; Buckley et al., 1990; Eng, 2005). For example, Kotro and Pantzar (2002) describe how humor as one of the communicative elements allowed Sony to extend the product lifecycle and range in the international markets. However, we are not aware of any empirical or theoretical studies that would consider how different humor types interlink with these dimensions of international competitiveness.

Nevertheless, we can identify some patterns and build some preliminary expectations based on the existing theorization. For example, of the humor types, affiliative humor is considered generally positive, and it is a non-threatening type of humor that enhances social interactions (Romero & Cruthirds, 2006) and group cohesion (Mesmer-Magnus et al., 2012). However, a negative relationship might emerge between affiliative humor used with ingroup and perceived firm-level competitiveness, if too much humor starts to dilute effectiveness (Romero & Pescosolido, 2008). Therefore, it could be expected that affiliative humor enhances competitive potential, and further, competitive performance—unless the adverse effects counteract the positive features (for both ingroup and outgroup).

Another expectation relates to aggressive humor. Aggressive humor is intuitively harmful interpersonal humor type with manipulative and putting down features (see Martin et al., 2003; Romero & Cruthirds, 2006). However, mild aggressive humor might help build cohesive groups (Romero & Cruthirds, 2006). Therefore, aggressive humor might not be harmful when used between people who know each other well, but when used with the outgroup, it could be riskier (see e.g., Podmetina & Smirnova, 2013; Tajfel, 1982). In the same line, the dimensions of international competitiveness may also be affected differently, although it is more likely that negative effects emerge (for both potential and performance) if aggressive humor is introduced (in ingroup and outgroup).

As for coping humor and reframing humor (Hurmelinna-Laukkanen et al., 2016), these two types of humor could potentially ease preparation (within ingroup) for entering foreign business environments (i.e., improve competitive potential) and facilitate interactions with parties coming from outside (outgroup)—thereby possibly facilitating business relations and contributing to competitive performance (see Lussier et al., 2017), for example. However, theory (and empirical evidence) are even more silent about these two than other humor types in this context. The role of these four humor types in international competitiveness is in need of more research and empirical examination.

Following these considerations – especially the multiple dimensions and potential contradictions – we take an exploratory approach as we formulate the following hypotheses:

H2a. Different types of humor used with ingroup and outgroup are related to competitive potential.

H2b. Different types of humor used with ingroup and outgroup are related to competitive performance.

We intend to not only explore the relationships between humor types and international competitiveness, but also go deeper into the complexities in our scrutiny. We believe that insight could be gained from combining innovation research with international competitiveness, especially since international competitiveness is not isolated from innovation activities and processes (Buckley et al., 1990). Among researchers who have examined the topic, Buesa and Molero (1998), for example, suggest that the degree of innovative regularity is positively related to the accumulation of international firm competitiveness, verified by Galende and de la Fuente (2003) and Alvarez and Iske (2015). Kafouros et al. (2008) and Oura, Zilber, and Lopes (2016) also find these kinds of connections. Therefore, it could be that humor relates indirectly to international competitiveness, though having an effect on the dimensions of innovativeness. These dimensions are discussed next.

2.3. Innovativeness: innovative behavior and innovation output

Innovation output (Damanpour & Gopalakrishnan, 1998) in organizations is mainly realized through innovative behavior such as exploring and implementing ideas (Dorenbosch, van Engen, & Verhagan, 2005; Kesting & Parm Ulhøi, 2010). Therefore, like international competitiveness, innovativeness can be considered to consist of different elements that connect to each other (Ferreira, Mention, & Torkkeli, 2015). As earlier studies (e.g. Andries & Czarnitzki, 2014; Hurmelinna-Laukkanen et al., 2016; Prajogo & Ahmed, 2006; Scott & Bruce, 1994) have indicated a tight relationship to exist between innovative behavior and innovation output in organizations, we propose the following hypothesis:

H3. Innovative behavior is positively related to innovation output.

Furthermore, earlier literature notes that innovative process is influenced by individual and contextual factors such as the interactions between individuals within and outside organizations, and organizational climate (e.g. Barczak, Lassk, & Mulki, 2010; Bartel & Garud, 2009; Mcfadzean, 1998; Perry-Smith & Shalley, 2003; Scott & Bruce, 1994). In these interactions, and with regard to organizational climate, humor as a form of communication plays different roles. Hurmelinna-Laukkanen et al. (2016) and Lussier et al. (2017) have found that humor can promote both innovative behavior and innovation output, but variation exists. As creativity can be promoted with the use of humor (Hurmelinna-Laukkanen et al., 2016; Lussier et al., 2017), it is likely that the use of varying types of humor—with the exception of aggressive humor (for both ingroup and outgroup)—would promote innovative behavior, the premises of innovation in the process. In this case, the same logic as described above in connection to international potential would apply, except perhaps even more strongly. Reaching better innovation output, however, is a more complicated matter, as suggested by Hurmelinna-Laukkanen et al. (2016). For example, innovative output may be hurt if too much affiliative humor is present (ibid.). Likewise, there are probable differences with regard to ingroup and outgroup contexts. Aggressive humor, in particular, may not be detrimental with ingroup, but with external actors, challenges likely emerge. Following the above-used logic with regard to hypothesis building for the complex relationships when humor types are of concern, we put the relationships examined in Hurmelinna-Laukkanen et al. (2016) in renewed test through the following hypotheses:

H4a. Different types of humor used with ingroup and outgroup are related to innovative behavior.

H4b. Different types of humor used with ingroup and outgroup are related to innovation output.

In order to develop a research model with a full set of hypotheses, we also investigated the relationships between the dimensions of international competitiveness and innovativeness. It has been suggested that innovation (and more specifically, the whole innovation process more than R&D indicating the potential only) is an important contributor to the competitiveness of firms (see, e.g., Peneder & Rammer, 2018). Nevertheless, to gain a full view, we draft the following four expectations to constitute Hypothesis 5:

H5a. Innovative behavior is positively related to competitive potential.

H5b. Innovative output is positively related to competitive potential.

H5c. Innovative behavior is positively related to competitive performance.

H5d. Innovative output is positively related to competitive performance.

Figure 1 summarizes and visualizes the hypothesized relations among variables.

In the following chapter, we turn to empirical examination to find out more about the manifold connections described above. We believe that this helps to find patterns for which explanati-

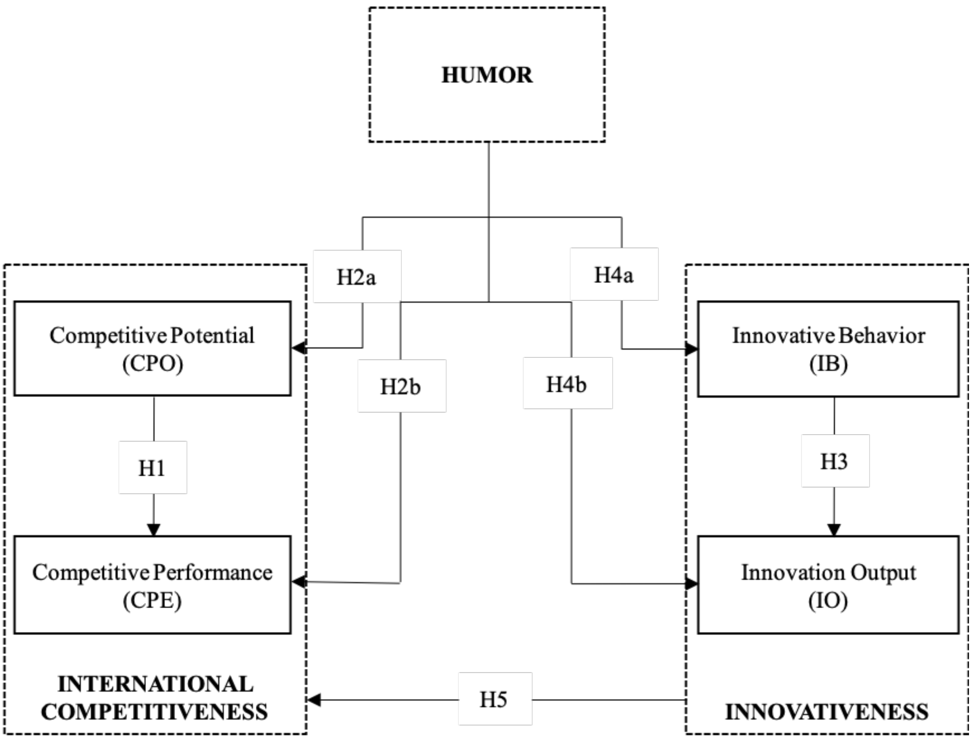


Fig. 1. Research model

ons can be searched, and that target managerial attention to those processes – especially the potentially contradictory one – where caution is needed.

3. Methodology

3.1. Sample and data

The data for this study were collected from individuals working in nine organizations using a questionnaire using a five-point Likert scale (1= totally disagree – 5= totally agree). The surveyed organizations represent different sectors, including one manufacturing organization, one media company, four organizations in leisure and recreation, and three other services organizations. For the purposes of this study, we distinguish manufacturing and service-oriented organizations, as innovation and international activities of these firms can differ (Hurmelinna-Laukkanen & Ritala, 2012; Maskus, 2008). For practical reasons, the dissemination of the survey questionnaires within the firms was done by the firm top managers. These organizations participated in a broader research project, meaning that the managers of the companies had incentives to get accurate information on the current situation, and we are relatively certain that they did their best to follow the instructions given by the researchers. To fairly assess the innovative work behavior of respondents, the survey was not restricted to a certain employee category. Eventually, we received 118 usable responses.

During the development and pretesting of the questionnaire, the procedural precautions suggested by Podsakoff, MacKenzie, Lee, and Podsakoff (2003) were followed to minimize the common method bias: the items were designed with established scales, the order of questions was counterbalanced, the independent variables were separated from the dependent ones, and the respondents were assured of confidentiality and anonymity. Furthermore, despite some criticisms of the procedures, Harman's one-factor (or single-factor) test was run at the analysis stage. The test indicates that the common method bias is not a problem, since the first factor accounted for 26% and 25% of the variance in humor use with ingroup and humor use with outgroup respectively. A non-response bias test, as suggested by Armstrong and Overton (1977), was also conducted, and it showed that early and late respondents had no significant difference in response. No problems relating to non-response were therefore detected.

3.2. Measures

For measure development, factor analysis was conducted first to test latent variables for the eight constructs related to humor types (affiliative/ aggressive/ coping/ reframing humor used in ingroup/ outgroup), international competitiveness (competitive potential and competitive performance) and innovativeness (innovative behavior and innovation output). Then reliability analysis was conducted to check the homogeneity between constructs.

Dependent variables. In order to scrutinize the two innovation process dimensions, innovative behavior was measured by a ten-item scale and innovation output was assessed with a nine-item scale based on the approach developed by de Jong and den Hartog (2010). For international studying advancements of international competitiveness, perceptions on competitive potential were evaluated using a six-item scale developed by Buckley et al. (1988; 1990). Respectively, competitive performance level was self-rated by ten items based on the work of Buckley et al. (1988) and Cetindamar and Kilitcioglu (2013) (See Appendix 1).

Independent variables. The four humor types were assessed with a 20 item scale, per Martin et al. (Martin et al., 2003) and Lang and Lee (Lang & Lee, 2010). Respondents were asked to evaluate humor use both within organizations (ingroup) and outside organizations (outgroup) separately. Five items measured affiliative humor; five items reflected aggressive humor; seven items captured coping humor; and three items comprised reframing humor (see Appendix 1). Especially, innovative behavior, innovation output, and competitive potential were used as independent variables in certain models.

Control variables. Age was controlled for because previous research suggests that older employees are more likely to exhibit higher innovative behavior (Ng & Feldman, 2013). Gender (1 = male, 0 = female) was also controlled since male and female respondents might be engaged in innovative work and international activities through different approaches (Ohlott, Ruderman, & Mccauley, 1994). In addition to gender, position (1 = managerial position, 0 = other) was included as leaders might function and perform differently from workers with regard to innovation, and evaluate these activities differently (Unsworth & Parker, 2003). Tenures (years) in organization and industry were also controlled following the idea by Carmeli and Spreitzer (2009) indicating that working experience might have an influence on innovativeness and the related perceptions on innovation in the organization. Moreover, experienced workers might be more likely to be engaged in international activities (Vance, 2005). Finally, industry (a dummy variable) was used to control the differences that resulted from industry types in international competitiveness and innovativeness (Castellacci, 2008). All variables used in this study and their detailed explanations can be found in Appendix 1.

3.3. Data analysis and results

Tables 1 and 2 below show the correlations for humor use in ingroup and outgroup contexts. Innovative behavior and innovation output have a positive relationship with each other, like competitive potential and competitive performance. The correlations between a specific humor type and innovation output exhibit similar relationships as those of humor type and innovative behavior. On the other hand, humor types have different correlations with competitive potential compared to competitive performance.

Following the examination of the correlation matrices, hierarchical regression analyses were used to explore the relationships among the constructs more closely. Prior to this, statistic criteria were checked to assure that there is no violation of underlying assumptions of regression analyses. Most values of the variable inflation factor (VIF) were found to be around 3 and all of them were below the threshold of 10 (see Hair, Anderson,Tathan, & Black, 1998). This suggests that there is no immediate multicollinearity issue. The scatter plots of the residuals, histograms, and normal probability plots were checked, and they showed normal distributions. The Breusch-Pagan test was also run, showing that heteroscedasticity was not present and that the residuals are normally distributed. Therefore, there is no immediate need to be concerned about heteroscedasticity and nonnormality.

Regression analyses of innovative behavior, innovation output, competitive potential, and competitive performance are reported in Table 3. In the hierarchical regression analyses, control

Table 1. Correlations for humor use with organization internal actors (ingroup).

Variable	Mean (S.D.)	1	2	3	4	5	6	7	8	9	10
1. Age	30.39 (12.83)										
2. Tenure in organization	4.17 (2.03)	.65**									
3. Tenure in industry	4.13 (1.93)	.62**	.77**								
4. Affiliative humor	3.61 (0.95)	-.18	-.04	-.02							
5. Aggressive humor	1.59 (.61)	-.20*	-.06	-.05	.30**						
6. Coping humor	3.67 (0.77)	-.16	-.03	-.03	.63**	.36**					
7. Reframing humor	2.41 (1.10)	.10	.21*	.23*	.37**	.38**	.51**				
8. Innovative behavior	3.05 (.92)	.26**	.21*	.25**	.27**	.09	.20*	.26**			
9. Innovation output	2.70 (1.32)	.22*	.28**	.31**	.10	-.06	.25**	.29**	.50**		
10. Competitive potential	2.59 (1.75)	.05	-.08	-.11	-.02	.06	.20	0.21	.20	.22	
11. Competitive performance	2.24 (1.59)	-.05	-.06	-.13	.15	.20	.18	.25*	.25*	.20	.78**

Notes: * p < .05; ** p < .01

ISSN 2183-0606
http://www.open-jim.org

Table 2. Correlations for humor use with external actors (outgroup).

Variable	Mean (S.D.)	1	2	3	4	5	6	7	8	9	10
1. Age	30.39 (12.83)										
2. Tenure in organization	4.17 (2.03)	.65**									
3. Tenure in industry	4.13 (1.93)	.62**	.77**								
4. Affiliative humor	2.71 (1.04)	.04	.03	.09							
5. Aggressive humor	1.26 (.50)	.02	.03	.02	.31**						
6. Coping humor	2.73 (.98)	.14	.13	.15	.68**	.42**					
7. Reframing humor	1.60 (1.00)	.26**	.25**	.30**	.42**	.42**	.68**				
8. Innovative behavior	3.05 (.92)	.26**	.21*	.25**	.33**	-.03	.24*	.21*			
9. Innovation output	2.70 (1.32)	.22*	.28**	.31**	.20*	.01	.27**	.23*	.50**		
10. Competitive potential	2.59 (1.75)	.05	-.08	-.11	.07	-.09	.24*	.20	.20	.22	
11. Competitive performance	2.24 (1.59)	-.05	-.06	-.13	.09	.04	.21	.21	.25*	.20	.78**

Notes: * $p < .05$; ** $p < .01$

ISSN 2183-0606
http://www.open-jim.org

variables were entered first before adding the main constructs. Proceeding with the testing, such constructs that were found significant in the preceding models were also included in the subsequent models. For example, Model 6, which tests humor types used with ingroup against innovative output, includes also innovative behavior, that was found to be related to innovative output in the earlier Model 5.

The hierarchical regressions were conducted as follows. To test for the relationship between innovative behavior and different humor types, the hierarchy consisted of two steps: (a) control variables (Table 3, Model 1), and (b) four types of humor used with ingroup (Model 2) and outgroup (Model 3). The regression results show that only one type of humor—affiliative humor—is significantly related to innovative behavior, thus Hypothesis 4a receives partial support. This applies to both ingroup and outgroup. Similarly, in the regressions with innovation output as the dependent variable, control variables were added first (Model 4) and then innovative behavior was entered (Model 5). The findings suggest that innovative behavior is positively related to innovation output, thereby supporting Hypothesis 3. Four humor types used with ingroup and outgroup were further added, constituting Models 6 and 7. Partial support is found for Hypotheses 4b: Humor types and innovation output seem to be related only when humor is used in the ingroup context, taking into account the effect of innovative behavior. Affiliative and aggressive types of humor are negatively related to innovation output, while coping humor shows a positive relationship.

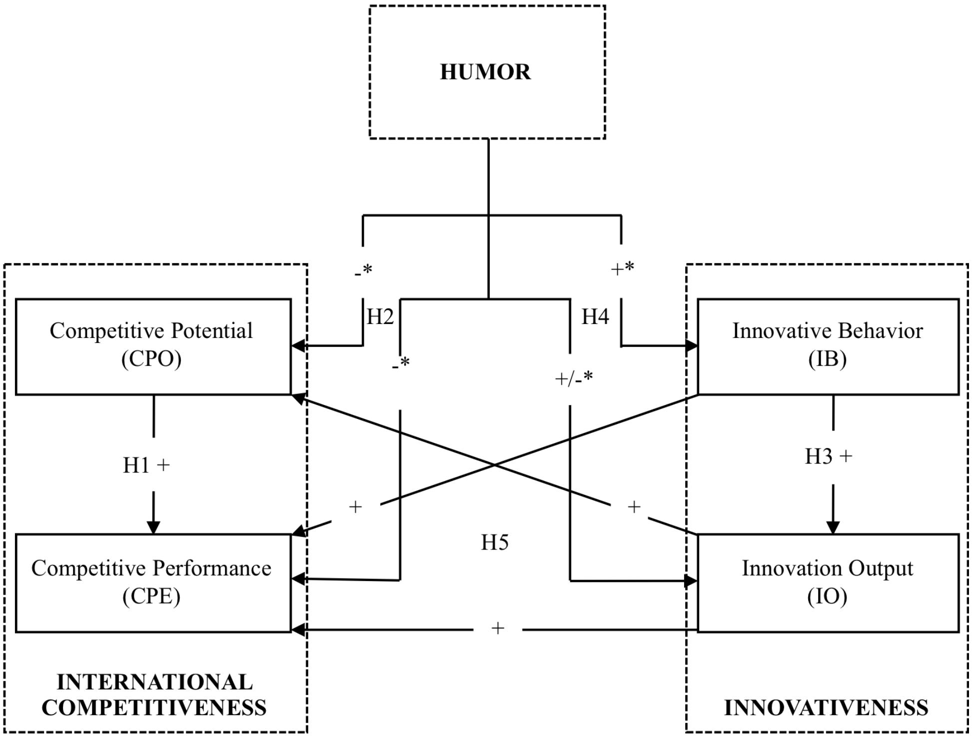
For the competitive potential analysis, innovative behavior was added (Model 9) subsequent to entering control variables (Model 8). However, no significant relationship was found. Therefore, no support was rendered to Hypothesis 5a. After replacing innovative behavior with innovation output as the second level of hierarchy (Model 10), a significantly positive relationship between innovation output and competitive potential was detected, which supports Hypothesis 5b. Humor was entered third (ingroup: Model 11; outgroup: Model 12). Partial support is found for Hypotheses 2a and 2b, as the results indicate that only specific humor types are significantly—and negatively—related to competitive potential (affiliative humor in ingroup, and aggressive humor in outgroup context) and to competitive performance (coping humor in ingroup). Moreover, humor explains competitive potential more than innovation output (when comparing Model 10 with Models 11 and 12).

The rest of the models (Models 13 to 19) analyzed the relationship between competitive performance and other variables. Levels constructing the hierarchy of the first four regression models are (1) control variables (Model 13), (2) innovative behavior (Model 14), innovation output (Model 15) and competitive potential (Model 16). The results indicate a positive relationship between innovative behavior and competitive performance (Model 14) (supporting Hypothesis 5c), between innovative output and competitive performance (Model 15) (supporting Hypothesis 5d), and between competitive potential and competitive performance (Model 16) (supporting Hypothesis 1). These findings were controlled as a set in the following tests, constituting the first level of the hierarchy of the remaining three regression models (see Model 17) where humor was added (ingroup: Model 18; outgroup: Model 19). According to Model 18, coping humor used with ingroup is found to be negatively related to international competitive performance, but no other relationships can be detected.

Results are summarized in Table 3, and findings are discussed in more detail in the next section.

4. Discussion

The objective of this paper was to explore the connections among humor, innovativeness, and international competitiveness. Considering the complexity of the setting, we drafted general hypotheses on the relationships and examined the empirical evidence on them. The empirical findings are visually summarized in Figure 2, and further details on humor types and their "locations" in ingroup or outgroup are illustrated in Table 4.



* Table 4 depicts the detailed relationships

Fig. 2. The relationships between humor, international advancements, and innovation processes.

The results of this study suggest that affiliative humor, that can be used to promote interpersonal relationship but increases the difficulty of getting heard in working interactions (Miczo & Welter, 2006; Rogerson-Revell, 2007), negatively relates to international competitive potential of firms, especially when used with ingroup. This is even more important to acknowledge, as the same, negative, relationship is present considering innovation output that, for its part, is positively related to both dimensions of international competitiveness. The negative connection of affiliative humor and international competitive potential extends the earlier understanding related to the

Table 3. Regression analyses: Innovative behavior, innovation output, competitive potential and competitive performance.

Variables	1. Innovative behavior			2. Innovation output				3. Competitive potential					4. Competitive performance						
		In-group	Out-group			In-group	Out-group				In-group	Out-group						In-group	Out-group
	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7	Model 8	Model 9	Model 10	Model 11	Model 12	Model 13	Model 14	Model 15	Model 16	Model 17	Model 18	Model 19
1. Age	.012 (.009)	.020** (.010)	.012 (.009)	.003 (.014)	-.005 (.013)	-.009 (.013)	-.006 (.013)	.026 (.019)	.024 (.019)	.025 (.019)	.023 (.020)	.019 (.019)	.000 (.012)	-.002 (.012)	.000 (.012)	-.010 (.009)	-.011 (.009)	-.005 (.010)	-.011 (.009)
2. Gender	.066 (.193)	-.087 (.202)	.047 (.203)	-.097 (.288)	-.139 (.261)	-.018 (.271)	-.089 (.288)	-.041 (.401)	-.052 (.402)	-.018 (.394)	-.009 (.421)	.276 (.425)	-.065 (.246)	-.080 (.242)	-.049 (.241)	-.049 (.193)	-.056 (.193)	-.221 (.202)	-.209 (.211)
3. Position	.493** (.207)	.472** (.202)	.482** (.201)	.396 (.309)	.082 (.288)	-.031 (.279)	.027 (.294)	1.010** (.430)	.929 (.444)	.916** (.427)	.838* (.424)	.797* (.423)	.880*** (.264)	.771*** (.267)	.815*** (.261)	.490** (.217)	.424* (.220)	.444** (.214)	.397* (.221)
4. Tenure in organization	-.045 (.073)	-.065 (.071)	-.024 (.070)	.020 (.109)	.049 (.099)	.051 (.096)	.053 (.100)	-.150 (.151)	-.142 (.152)	-.155 (.149)	-.163 (.148)	-.123 (.147)	-.030 (.093)	-.020 (.092)	-.033 (.091)	.028 (.074)	.031 (.073)	.013 (.072)	.022 (.073)
5. Tenure in industry	.066 (.072)	.053 (.070)	.037 (.070)	.154 (.108)	.112 (.098)	.107 (.095)	.105 (.100)	-.227 (.150)	-.237 (.151)	-.263* (.149)	-.252* (.149)	-.299** (.148)	-.238** (.092)	-.253*** (.091)	-.263*** (.091)	-.151** (.074)	-.168** (.075)	-.177** (.073)	-.168** (.076)
6. Industry	.205 (.254)	.149 (.246)	.184 (.249)	.339 (.379)	.209 (.344)	.184 (.331)	.105 (.355)	2.493*** (.527)	2.460 (.530)	2.412*** (.521)	2.428*** (.516)	2.153*** (.523)	3.385*** (.324)	3.340*** (.319)	3.330*** (.318)	2.424*** (.300)	2.423*** (.299)	2.355*** (.295)	2.450*** (.298)
7. Innovative behavior					.637*** (.137)	.637*** (.139)	.618*** (.147)		.164 (.211)					.221* (.127)			.140 (.112)	.063 (.116)	.150 (.118)
8. Innovation output										.239* (.142)	.159 (.149)	.186 (.143)			.162* (.087)		.032 (.078)	.069 (.080)	.034 (.079)
9. Competitive potential																.386*** (.064)	.370*** (.065)	.389*** (.067)	.388*** (.069)
10. Affiliative humor		.260** (.116)	.311*** (.111)			-.286* (.159)	-.096 (.164)				-.449* (.242)	-.203 (.233)						.181 (.125)	.043 (.121)
11. Aggressive humor		.054 (.163)	-.283 (.200)			-.425* (.219)	-.117 (.287)				-.107 (.345)	-.842* (.421)						.266 (.167)	.270 (.218)
12. Coping humor		-.008 (.154)	-.037 (.148)			.501** (.206)	.289 (.210)				.475 (.330)	.422 (.312)						-.287* (.162)	-.197 (.157)
13. Reframing humor		.064 (.096)	.019 (.122)			.154 (.130)	-.006 (.173)				.201 (.204)	.180 (.255)						.103 (.098)	.178 (.127)
F	2.960**	2.952***	3.214***	2.271**	5.448***	4.836***	3.693***	6.597***	5.701***	6.245***	4.531***	4.684***	25.630***	23.178***	23.433***	40.849***	32.418***	24.339***	22.956***
R^2	.155	.241	.257	.128	.293	.377	.316	.410	.416	.438	.489	.498	.730	.743	.745	.836	.844	.864	.856
R^2 Adj.	.102	.159	.177	.072	.239	.299	.230	.348	.343	.368	.381	.391	.701	.711	.714	.816	.818	.828	.819

Notes: * p < .10; ** p < .05; *** p < .01; St. Errors in parentheses

Table 4. Relationships of humor types with competitive potential (CPO), competitive performance (CPE), innovative behavior (IB), and innovation output (IO) for ingroup and outgroup.

"Location"	Humor types	CPO	CPE	IB	IO
Within firm (ingroup)	Affiliate humor	-		+	-
	Aggressive humor				-
	Coping humor		-		+
	Reframing humor				
External relationships (outgroup)	Affiliate humor			+	
	Aggressive humor	-			
	Coping humor				
	Reframing humor				

potential of affiliative humor purely enhancing innovative behavior (Hurmelinna-Laukkanen et al., 2016).

We also found that when aggressive humor is used in external relationships, problems emerge in terms of competitive potential. As tension surges and shared commitment drops, the ability of the firm to generate resources and the mutual willingness to share resources will be negatively influenced (Buckley et al., 1988). Thus, the international competitive potential of the firm is harmed. However, when aggressive humor is used with ingroup, international competitiveness does not seem to be influenced. It may be because of the dual role that aggressive humor plays in the workplace: it can hurt relationships or help build cohesive groups (Romero & Cruthirds, 2006). The findings strengthen further the earlier presented results that aggressive humor seems to be more suitable humor type for firms when it is used in ingroup compared to outgroup relationships (Hurmelinna-Laukkanen et al., 2016).

Interestingly, coping humor used with ingroup shows a significantly negative relationship with international competitive performance. Coping humor is conventionally believed to affect people in a positive way, helping them to psychologically distance from experiencing negative emotions and stressful stimuli (Abel, 2002; Kahn, 1989; Robert & Wilbanks, 2012). Thus, the negative connection of coping humor and international competitive performance extends the earlier understanding related to the positive findings related to coping humor absolutely enhancing innovative output within firm (Hurmelinna-Laukkanen et al., 2016). A plausible explanation can be found in existing discussions: When international competitiveness is viewed with a coping humor component, it may be rated as less stressful, potentially trivializing the competitiveness and negating valuable reactions (cf. Moran & Massam, 1999).

Like in the case of international competitiveness, connections of humor and innovativeness are somewhat obscure, with sparse studies in real organizational settings (Lehmann-Willenbrock & Allen, 2014). Our findings indicate that the use of affiliative humor with both ingroup and outgroup boosts innovative behavior. The benevolent joking and making fun of oneself likely enhances an open environment favorable for innovative behavior (Holmes, 2006; Robert & Wilbanks, 2012). Lyttle (2007), for example, has indicated that thoughtful and responsible use of humor may increase the credibility of an individual in the workplace. However, the influences of affiliative humor on innovative output, as mentioned above, are found to be negative. Our findings provide a more specific look into the different humor types, expanding the findings of Kusumawardani and Wulansari (2018) who have presented that humor, in general, is positively related to innovative outcomes in SME context.

Our findings emphasize generally that humor in its different forms seems to be more prominent when it is used within a firm. This is contradictory compared to Lussier et al. (2017) who found humor to be beneficial for customer relationships. However, they also noted that the effect was short-lived, and they did not specify any humor type. At the same time, our finding is in line with the notion of Rogerson-Revell (2007), who indicates that using humor across firm boundaries may also create a credibility problem. It could be the case in our data.

We also found that use of coping humor with ingroup promotes innovation output. It likely helps people to maintain a positive view to cope with challenges encountered in the innovation process and to finalize the work (Cooper et al., 2018), but when the innovations should be taken to international markets, the role of coping humor changes (as noted above).

On the other hand, when aggressive humor is present within the firm, it negatively influences innovation output (see also Janssen, 2004; Romero & Cruthirds, 2006). Being negatively judged may make recipients of aggressive humor less likely to bring forth innovation (Huo, Lam, & Chen, 2012; Yuan & Woodman, 2010), and the group cohesion may be replaced with competition over resources when the end-results of innovation processes start to form.

The final point is, that since innovativeness and international competitiveness seem connected, apart from competitive potential and innovative behavior, it may be that humor indirectly affects international competitive advancements. The "isolation" between the premises of competitiveness and innovation can actually help firm managers to use humor strategically—differently for different purposes—exploiting the varying effects of different humor types. At the same time, caution needs to be taken in separating the processes in order to avoid a collision. Further research on it is needed, however.

5. Conclusions

The above analysis indicates that humor, international competitiveness, and innovativeness are interconnected in intricate ways. Our study contributes especially to the literature of international business management where different ways of increasing international competitiveness and innovativeness have been discussed, including internal and external relationships and communication (e.g. Barnes et al., 2015; Buckley et al., 1990; Eng, 2005). It seems that humor is risky when applied to promote international competitiveness directly, but through enhancing innovation processes and knowledge sharing, the connection between improved innovative potential and output and competitiveness could be used to reach favorable advancements. This finding provides new insight into the scholarly discussion on the connections between internationalization and innovation, and shows the relevance of acknowledging the distinctions between different steps of the processes in these activities.

The findings also bear managerial relevance. Awareness of different types of humor and their varying roles in international competitiveness and innovation processes enables managers to analyze humor use in their organizations, and support and utilize humor in a purposeful manner (Romero & Cruthirds, 2006)—avoiding negative outcomes and promoting such connections that yield subsequent benefits for competitiveness. For example, coping humor—making fun or maintaining a humorous attitude to express or allay negative emotions like boredom, anxiety, frustration and anger (Abel, 2002; Kahn, 1989)—can be employed internally to facilitate innovation output. However, this type of humor might have a negative impact when competitive performance is pursued. Managers can set the example in their organizations with their own behavior in using humor, or allowing/denying the use of specific types of humor in different situations. They can monitor humor use, and develop company policies and practices according to what they observe. A real-life practical example is, that in one firm before any meeting, the participants are instructed whether or not to joke with particular clients they are going to meet, and what are the particular issues that cannot be approached with humorous references.

Humor, which is not really very costly, can be a valuable management tool (Cooper et al., 2018) when applied appropriately. What is important to acknowledge, however, is that humor that works in innovation activities—and thereby possibly eventually leads to improved competitiveness—does not necessarily work in international activities, processes, and communication where other aspects than R&D and innovation are in the focus. Employees could be trained for using humor through group interventions or even online self-administrative interventions (Ruch & Hofmann, 2017). Nevertheless, further research is needed to investigate more deeply what kind of specific interventions are prominent for contributing to individual performance and/or firm-level competitiveness and innovativeness.

Future studies can benefit from acknowledging the limitations of our study. First, the survey is conducted in a limited amount of organizations, coming originally from a single country. Therefore, the interplay of organizational and national cultures is not accounted for, although these issues may relate to humor use in international settings. Nevertheless, as our findings regarding relationships between innovativeness and competitiveness are similar to those in other studies, we believe that the findings are in line with a wider setting and that our notions extending the discussion to humor are meaningful. Other limitations are shared with most quantitative studies, for example, in terms of research design (cross-sectional rather than longitudinal study), sample size and quality (relatively small sample), measurement (the ability to capture relevant features is always uncertain, even if established measures are used and if thought is put in capturing relevant perceptions at different levels), and limitations with regard to building theory (see Shah & Corley, 2006); we cannot assert that the emergence of specific types of humor always yield the same results without having a deeper understanding of the mechanisms behind the relationships and interactions. Qualitative approaches are therefore encouraged to provide descriptions of why humor and its specific forms relate to international competitiveness and innovativeness in the way they do, and also provide interpretive frameworks (Van-Maanen, 1979).

Here, we have explored and found some patterns that hopefully provide some direction for subsequent research.

5. References

Abel, M. H. (2002). Humor, stress, and coping strategies. *International Journal of Humor Research*, *4*(2002), 365–381.

Alvarez, H., & Iske, P. (2015). Internal Capabilities and External Knowledge Sourcing for Product Innovation in LMT SMEs. *Journal of Innovation Management*, *3*(2), 55–70.

Andries, P., & Czarnitzki, D. (2014). Small firm innovation performance and employee involvement. *Small Business Economics*, *43*(1), 21–38.

Armstrong, J. S., & Overton, T. S. (1977). Estimating Nonresponse Bias in Mail Surveys. *Journal of Marketing Research*, *14*(3), 396–402.

Barczak, G., Lassk, F., & Mulki, J. (2010). Antecedents of Team Creativity: An Examination of Team Emotional Intelligence, Team Trust and Collaborative Culture. *Creativity and Innovation Management*, *19*(4), 332–345.

Barnes, B. R., Leonidou, L. C., Siu, N. Y. M., & Leonidou, C. N. (2015). Interpersonal Factors as Drivers of Quality and Performance in Western–Hong Kong Interorganizational Business Relationships. *Journal of International Marketing*, *23*(1), 23–49.

Barroso-Tanoira, F. G. (2017). Motivation for increasing creativity, innovation and entrepreneurship. An experience from the classroom to business firms. *Journal of Innovation Management*, *5*(3), 55–74.

Bartel, C. A., & Garud, R. (2009). The Role of Narratives in Sustaining Organizational Innovation. *Organization Science*, *20*(1), 107–117.

Bhawsar, P., & Chattopadhyay, U. (2015). Competitiveness: Review, Reflections and Directions. *Global Business Review*, *16*(4), 665–679.

Brännback, M., & Wiklund, P. (2001). A new dominant logic and its implications for knowledge management: a study of the Finnish food industry. *Knowledge and Process Management*, *8*(4), 197–206.

Buckley, P. J., Pass, C. L., & Prescott, K. (1988). Measures of international competitiveness: A critical survey. *Journal of Marketing Management*, *4*(2), 175–200.

Buckley, P. J., Pass, C. L., & Prescott, K. (1990). Measures of international competitiveness: Empirical findings from British manufacturing companies. *Journal of Marketing Management*, *6*(1), 1–13.

Buesa, M., & Molero, J. (1998). La regularidad innovadora en empresas españolas. *Revista de Economía Aplicada*, *Vol. 6*(Nº 17), 111–134. Access April 2019:
http://dialnet.unirioja.es/servlet/articulo?codigo=176802

Caloghirou, Y., Kastelli, I., & Tsakanikas, A. (2004). Internal capabilities and external knowledge sources: Complements or substitutes for innovative performance? *Technovation*, *24*(1), 29–39.

Carmeli, A., & Spreitzer, G. M. (2009). Trust, Connectivity, and Thriving: Implications for Innovative Behaviors at Work. *The Journal of Creative Behavior*, *43*(3), 169–191.

Castellacci, F. (2008). Technological paradigms, regimes and trajectories: Manufacturing and service industries in a new taxonomy of sectoral patterns of innovation. *Research Policy*, *37*(6–7), 978–994.

Cetindamar, D., & Kilitcioglu, H. (2013). Measuring the competitiveness of a firm for an award system. *Competitiveness Review*, *23*(1), 7–22.

Chikán, A. (2008). National and firm competitiveness: a general research model. *Competitiveness Review*, *18*(1/2), 20–28.

Cleveland, M., Laroche, M., & Papadopoulos, N. (2015). You are what you speak? Globalization, multilingualism, consumer dispositions and consumption. *Journal of Business Research*, *68*(3), 542–552.

Cooper, C. (2008). Elucidating the bonds of workplace humor: A relational process model. *Human Relations*, *61*(8), 1087–1115.

Cooper, C. D. (2005). Just joking around? employee humor expression as an ingratiatory behavior. *Academy of Management Review*, *30*(4), 765–776.

Cooper, C. D., Kong, D. T., & Crossley, C. D. (2018). Leader Humor as an Interpersonal Resource: Integrating Three Theoretical Perspectives. *Academy of Management Journal*, *61*(2), 769–796.

Damanpour, F., & Gopalakrishnan, S. (1998). Theories of organizational structure and innovation adoption: the role of environmental change. *Journal of Engineering and Technology Management*, *15*(1), 1–24.

de Jong, J., & den Hartog, D. (2010). Measuring Innovative Work Behaviour. *Creativity and Innovation Management*, *19*(1), 23–36.

Dey, T., & Mukhopadhyay, S. (2018). Linkage between contextual factors, knowledge-sharing mediums, and behaviour: Moderating effect of knowledge-sharing intentions. *Knowledge and Process Management*, *25*(1), 31–40.

Dorenbosch, L., van Engen, M. L., & Verhagan, M. (2005). On-the-job Innovation: The Impact of Job Design and Human Resource Management through Production Ownership. *Creativity and Innovation Management*, *14*(2), 129–141.

Eng, T.-Y. (2005). The Effects of Learning on Relationship Value in a Business Network Context. *Journal of Business-to-Business Marketing*, *12*(4), 67–101.

Ferreira, J. J. P., Mention, A.-L., & Torkkeli, M. (2015). Illumination in times of Uncertainty: Fifty Shades of Innovation for Societal Impact. *Journal of Innovation Management*, *3*(1), 1–4.

Galende, J., & De La Fuente, J. M. (2003). Internal factors determining a firm's innovative behaviour. *Research Policy*, *32*(5), 715–736.

Graham, E. E. (1995). The Involvement of Sense of Humor in the Development of Social Relationships. *Communication Reports*, *8*(2), 158–169.

Hair, J. F., Anderson, R. E., Tatham, R. L., & Black, W. C. (1998). *Multivariate data analysis with readings (5nd ed.)*. New Jersey: Prentice Hall.

Hassan, R., Razek, A.-, & Alharbi, F. B. (2017). Assessment of Technological Innovation Climate in Organizations. *Journal of Innovation Management*, *5*(3), 34–54.

Holmes, J. (2006). Sharing a laugh: Pragmatic aspects of humor and gender in the workplace. *Journal of Pragmatics*, *38*(1 SPEC. ISS.), 26–50.

Huo, Y., Lam, W., & Chen, Z. (2012). Am I the Only One This Supervisor is Laughing at? Effects of Aggressive Humor on Employee Strain and Addictive Behaviors. *Personnel Psychology*, *65*(4), 859–885.

Hurmelinna-Laukkanen, P., Atta-Owusu, K., & Oikarinen, E.-L. (2016). You are joking right? – connecting humor types to innovative behavior and innovation output. *International Journal of Innovation Management*, *20*(08), 1640021.

Hurmelinna-Laukkanen, P., & Ritala, P. (2012). Appropriability as the driver of internationalization of service-oriented firms. *The Service Industries Journal*, *32*(7), 1039–1056.

Janssen, O. (2004). How fairness perceptions make innovative behavior more or less stressful. *Journal of Organizational Behavior*, *25*(2), 201–215.

Jones, G. E., & Bear, S. E. (2018). Gender Differences and Perceived Efficacy of Humor Styles in the Workplace. In *Emerging Challenges in Business, Optimization, Technology, and Industry* (pp. 199–203). Springer, Cham.

Kafouros, M. I., Buckley, P. J., Sharp, J. A., & Wang, C. (2008). The role of internationalization in explaining innovation performance. *Technovation*, *28*(1–2), 63–74.

Kahn, W. A. (1989). Toward a Sense of Organizational Humor: Implications for Organizational Diagnosis and Change. *The Journal of Applied Behavioral Science*, *25*(1), 45–63.

Kakar, A. K. (2018). How do team cohesion and psychological safety impact knowledge sharing in software development projects? *Knowledge and Process Management*, *25*(4), 258–267.

Keogh, W. (1999). Understanding processes and adding value within innovative small firms. *Knowledge and Process Management*, *6*(2), 114–125.

Kesting, P., & Parm Ulhøi, J. (2010). Employee-driven innovation: extending the license to foster innovation. *Management Decision*, *48*(1), 65–84.

Kodama, M. (2017). Developing strategic innovation in large corporations-The dynamic capability view of the firm. *Knowledge and Process Management*, *24*(4), 221–246.

Kotro, T., & Pantzar, M. (2002). Product Development and Changing Cultural Landscapes - Is Our Future in "Snowboarding"? *Design Issues*, *18*(2), 30–45.

Kuiper, N. A., McKenzie, S. D., & Belanger, K. A. (1995). Cognitive appraisals and individual differences in sense of humor: Motivational and affective implications. *Personality and Individual Differences*, *19*(3), 359–372.

Kusumawardani, D., & Wulansari, N. A. (2018). The effect of humor and narcissistic personality on the innovative output with innovative work behavior and adaptability as variables of mediation. *Management Analysis Journal*, *7*(3), 352–362.

Lang, J. C., & Lee, C. H. (2010). Workplace humor and organizational creativity. *International Journal of Human Resource Management*, *21*(1), 46–60.

Lehmann-Willenbrock, N., & Allen, J. A. (2014). How fun are your meetings? Investigating the relationship between humor patterns in team interactions and team performance. *Journal of Applied Psychology*, *99*(6), 1278–1287.

Lussier, B., Grégoire, Y., & Vachon, M.-A. (2017). The role of humor usage on creativity, trust and performance in business relationships: An analysis of the salesperson-customer dyad. *Industrial Marketing Management*, *65*, 168–181.

Lyttle, J. (2007). The judicious use and management of humor in the workplace. *Business Horizons*, *50*(3), 239–245.

Malone, P. B. (1980). Humor: A Double-Edged Tool for Today's Managers? *The Academy of Management Review*, *5*(3), 357.

Martin, R. A., Puhlik-Doris, P., Larsen, G., Gray, J., & Weir, K. (2003). Individual differences in uses of humor and their relation to psychological well-being: Development of the humor styles questionnaire. *Journal of Research in Personality*, *37*(1), 48–75.

Maskus, K. E. (2008). The Globalization of Intellectual Property Rights and Innovation in Services. *Journal of Industry, Competition and Trade*, *8*(3–4), 247–267.

Mcfadzean, E. (1998). Enhancing creative thinking within organisations. *Management Decision*, *36*(5), 309–315.

Mesmer-Magnus, J., Glew, D. J., & Viswesvaran, C. (2012). A meta-analysis of positive humor in the workplace. *Journal of Managerial Psychology*, *27*(2), 155–190.

Miczo, N., & Welter, R. E. (2006). Aggressive and Affiliative Humor: Relationships to Aspects of Intercultural Communication. *Journal of Intercultural Communication Research*, *35*(1), 61–77.

Moran, C. C., & Massam, M. M. (1999). Differential Influences of Coping Humor and Humor Bias on Mood. *Behavioral Medicine*, *25*(1), 36–42.

Ng, T. W. H., & Feldman, D. C. (2013). A meta-analysis of the relationships of age and tenure with innovation-related behaviour. *Journal of Occupational and Organizational Psychology*, *86*(4), 585–616.

Ohlott, P. J., Ruderman, M. N., & Mccauley, C. D. (1994). Gender Differences in Managers' Developmental Job Experiences. *Management Journal*, *37*(1), 46–67.

Oura, M. M., Zilber, S. N., & Lopes, E. L. (2016). Innovation capacity, international experience and export performance of SMEs in Brazil. *International Business Review*, *25*(4), 921–932.

Özçelik, E., & Taymaz, E. (2004). Does innovativeness matter for international competitiveness in developing countries?: The case of Turkish manufacturing industries. *Research Policy*, *33*(3), 409–424.

Pascucci, F. (2018). The export competitiveness of Italian coffee roasting industry. *British Food Journal*, 120(7), 1529-1546.

Peneder, M., & Rammer, C. (2018). *Measuring Competitiveness.* ZEW-Gutachten und Forschungsberichte.

Perry-Smith, J. E., & Shalley, C. E. (2003). The social side of creativity: A static and dynamic social network perspective. *The Academy of Management Review*, *28*(1), 89–106.

Podmetina, D., & Smirnova, M. (2013). R&D Cooperation with External Partners and Implementing Open Innovation. *Journal of Innovation Management*, *1*(2), 103–124.

Podsakoff, P. M., MacKenzie, S. B., Lee, J. Y., & Podsakoff, N. P. (2003). Common method biases in behavioral research: a critical review of the literature and recommended remedies. *Journal of Applied Psychology*, *88*(5), 879–903.

Prajogo, D. I., & Ahmed, P. K. (2006). Relationships between innovation stimulus, innovation capacity, and innovation performance. *R and D Management*, *36*(5), 499–515.

Ramamoorthy, N., Flood, P. C., Slattery, T., & Sardessai, R. (2005). Determinants of Innovative Work Behaviour: Development and Test of an Integrated Model. *Creativity and Innovation Management*, *14*(2), 142–150.

Robert, C., & Wilbanks, J. E. (2012). The Wheel Model of humor: Humor events and affect in organizations. *Human Relations*, *65*(9), 1071–1099.

Rogerson-Revell, P. (2007). Humour in business: A double-edged sword. A study of humour and style shifting in intercultural business meetings. *Journal of Pragmatics*, *39*(1), 4–28.

Romero, E. J., & Cruthirds, K. W. (2006). The Use of Humor in the Workplace. *Academy of Management Perspectives*, *20*(2), 58–69.

Romero, E., & Pescosolido, A. (2008). Humor and group effectiveness. *Human Relations*, *61*(3), 395–418.

Ruch, W., & Hofmann, J. (2017). Fostering Humour. In C. Proctor (Ed.), *Positive Psychology Interventions in Practice*, (pp. 65–80). Cham: Springer.

Scott, S. G., & Bruce, R. A. (1994). Determinants of innovative behaviour: A path model of individual innovation in the workplace. *Academy of Management Journal*, *37*(3), 580–607.

Shah, S. K., & Corley, K. G. (2006). Building Better Theory by Bridging the Quantitative – Qualitative Divide. *Journal of Management Studies*, *Volume 43*(8), 1821–1835.

Skoric, M. M., & Park, Y. J. (2014). Culture, technologies and democracy: A cross-national analysis of political development. *Telematics and Informatics*, *31*(3), 364–375.

Tajfel, H. (1982). Social Psychology of Intergroup Relations. *Annual Review of Psychology*, *33*(1), 1–39.

Unsworth, K. L., & Parker, S. K. (2003). Proactivity and innovation: Promoting a new workforce for the new workplace. In D. Holman, T. D. Wall, C. W. Clegg, P. Sparrow, & A. Howard (Eds.), *The New Workplace: A Guide to the Human Impact of Modern Working Practices* (pp. 175–196). Chichester, England: Wiley.

Van-Maanen, J. (1979). Reclaiming Qualitative Methods for Organizational Research: A Preface. *Administrative Science Quarterly*, *24*(4), 520–524.

Vance, C. M. (2005). The personal quest for building global competence: A taxonomy of self-initiating career path strategies for gaining business experience abroad. *Journal of World Business*, *40*(4), 374–385.

Yuan, F., & Woodman, R. W. (2010). Innovative Behavior in the Workplace: The Role of Performance and Image Outcome Expectations. *Academy of Management Journal*, *53*(2), 323–342.

ISSN 2183-0606
http://www.open-jim.org

Appendix 1: Explanation of variables.

Variables	**Explanation**
Age	The age of respondents
Gender	Dummy variable: 1 if respondent is male, 0 if respondent is female
Position	Dummy variable: 1 if respondent is in managerial position, 0 if respondent is not
Tenure in organization	How long have you been working in this organization?
Tenure in industry	How long have you been working in this industry?
Industry	Dummy variable:1 if organization works in manufacturing industry, 0 if organization does not
Affiliative humor*	Five-point Likert scale; 1. I usually joke around much with people 2. I usually like to tell jokes and amusing stories to others 3. I enjoy making people laugh 4. I usually think of witty things to say when I'm with other people 5. I make other people laugh by telling funny stories about myself
Aggressive humor*	Five-point Likert scale; 1. If I don't like someone, I often use humor or teasing to put them down 2. If something is really funny to me, I will laugh or joke about it even if someone will be offended 3. If someone makes a mistake, I will often tease them about it 4. I like it when people use humor as a way of criticizing or putting something down 5. I participate in laughing at others if everyone is doing it
Coping humor*	Five-point Likert scale; 1. Frequent laughter is used to make work more pleasant 2. Funny stories are always told to brighten up a bad day with a good laugh 3. Sensitive organizational issues are usually handled by joking about them 4. Funny stories and jokes are welcome in most meetings 5. Humorous stories help to ease tension situations 6. Jokes are frequently shared to loosen up a stressful work environment 7. Silly jokes or ridiculous stories are rarely heard

ISSN 2183-0606
http://www.open-jim.org

Variables	Explanation
Reframing humor*	Five-point Likert scale; 1. Silly jokes are used to question old mindsets and practices 2. Counter-intuitive jokes are encouraged to help us see things in new light 3. Funny stories and jokes that help us see old problems in new light are common
Innovative behavior	Five-point Likert scale; 1. I often generate original solutions for problems 2. I often pay attention to issues that are not part of my daily work 3. I often strive to convince people to support an innovative idea 4. I often contribute to the implementation of new ideas 5. I often search out new working methods, techniques, or instruments 6. I often make important organizational members enthusiastic for innovative ideas 7. I often see how things can be improved 8. I often systematically introduce innovative ideas into work practices 9. I often put effort in the development of new things 10. I often find new approaches to execute tasks.
Innovation output	Five-point Likert scale; 1. Implementation of completely new production or delivery methods/techniques 2. Implementation of new ways of organizing relations with external stakeholders 3. Implementation of new methods of organizing work responsibilities and decision making 4. Improvement in current production or delivery methods/techniques 5. Improvement of current products/services 6. Significant changes to the design or packaging of products/services 7. Development of completely new products/services. 8. Implementation of new methods for marketing products/services 9. Implementation of new methods for organizing routines/procedures
Competitive potential	Five-point Likert scale; 1. Quality of products/services on international markets 2. Development of new products/services with international business partners 3. Satisfaction of international customers/clients 4. Ability to attract new customers/clients from other countries 5. Development of brand or corporate image on international markets 6. Development of international know-how

Variables	Explanation
Competitive performance	Five-point Likert scale; 1. We collaborate with organizations from other countries 2. Our products/services are patronized by customers/clients from other countries 3. We actively seek for customers/clients from other countries 4. Our foreign sales contribute a significant percentage of total sales 5. We perform key aspects of our operations in other countries 6. Employees spend significant part of their time on international activities 7. Ability to gain market access in other countries 8. International sales volume 9. International market share 10. International profitability * Use asked in relation to *Ingroup* (Information provided to the respondents in the questionnaire is as follows: Immediate Co-workers; “Refers to your co-workers who are members of your workgroup or team” – cf. Other Co-workers; “Refers to your co-workers who are NOT members of your workgroup or team”), and *Outgroup* (External relations; “Refers to outside actors (e.g. customers, suppliers, other stakeholders) who have a business relationship with your organization”). Note: Original scales were relied on to a large extent to maintain some comparability with earlier studies; at the same time, individual and organizational views were pursued simultaneously by instructing respondents and top-managers answering the questionnaire. Aggregated perceptions of the individual respondents for each firm were also reflected to public information on the respective organization’s innovation and international activity to verify that individual perceptions matched the actual situation to an adequate extent.

Biographies

Jialei Yang. Jialei Yang received her M.Sc. degree in economics and business administration from University of Oulu, Finland (got full marks for her master's thesis), and the B.Ec. degree in international trade and economics from Jiangxi University of Finance & Economics, China (ranked 1st among 180 students in the program). She is currently pursuing the Ph.D degree in economics and business administration (management) at Oulu Business School, University of Oulu, Finland. Her research interests include innovation management, international business, and network management. Mrs. Yang's awards and honors include Outstanding Undergraduate (Chinese Scholarship Council), the Provincial Silver Medal in Science and Technology Innovation and Vocational Skills Demonstration (Competition) and Pacemaker to Merit Student (JUFE).

Pia Hurmelinna-Laukkanen. Dr. Pia Hurmelinna is a Professor of Marketing, especially International Business at the Oulu Business School, University of Oulu, and an Adjunct Professor (Knowledge Management) at the Lappeenranta University of Technology, School of Business and Management. She has published about 70 refereed articles in journals such as Journal of Product Innovation Management, Industrial and Corporate Change, Industrial Marketing Management, International Business Review, R&D Management, and Technovation. She has contributed to book chapters, over 140 conference papers, and other scientific and managerial publications. She is a member of editorial boards of Industrial Marketing Management, Journal of Innovation Management, Journal of Service Management, and ISPIM scientific panel. She also has been serving as a quest editor and a reviewer for many journals and conferences. Most of her research has involved innovation management and appropriability issues, including examination of different knowledge protection and value capturing mechanisms. The research covers varying contexts like internationalization and inter-organizational collaboration.

Eeva-Liisa Oikarinen. Eeva-Liisa Oikarinen received the M.Sc. in Biophysics from University of Oulu, Finland, in 2002, and Ph.D. degree (Econ. & Bus. Adm.) in Marketing from Oulu Business School, University of Oulu, in 2018. Since 2018, she has been an Assistant Professor in Marketing at Oulu Business School. She is the author of more than 50 publications. Her research has been focused on human aspects such as: humor, storytelling, and emotions, in business interactions. Currently, her main research interest is focused on recruitment advertising, wellbeing and ethics, digital marketing and human-robot service interactions. She has published in Journal of Service Management, Journal of Retailing and Consumer Services, International Journal of Innovation Management, Corporate Reputation Review, and Australasian Marketing Journal, among others. Dr. Oikarinen received Outstanding Elsevier Reviewer Recognition in Journal of Retailing and Consumer Services in October 2018 and she was a recipient of The 5th Nordic Retail and Wholesale Conference (NRWC2016) best paper award.

ISSN 2183-0606
http://www.open-jim.org