Is Organizational Innovation a Technology? Evidence from Patent Data[1]

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ABSTRACT

Organization theorists have long claimed that organizational innovations are nontechnological, in part, because they are unpatentable. The claim rests on the assumption that organizational knowledge is embodied in persons and contexts rather than in context-free practical tools. However, over the last three decades information and communication technologies gradually expanded the universe of tools for embodying organizational knowledge which, in principle, can be patented. We show that patentability is indeed a key indicator of successful embodiment. To provide the first empirical evidence regarding the patentability of organizational innovations, we construct sequentially three datasets: (1) a population of 114 organizational innovations since the early 20th century; (2) a sample of 300 US patent applications from 1970-2020, successful or not, that feature 58 of these innovations and serve as seeds for an algorithmic search for similar innovations; (3) a population of 67,240 patent applications from the same period, the output of Google's patent landscaping algorithm, which coverage extends up to 95 organizational innovations. Empirical analyses of these datasets yield two mutually reinforcing findings: (1) Organizational innovations of the 20th century prompt US patent applications in the 21st century, and more so if they propose a practical tool in addition to abstract knowledge; (2) The probability of patent allowance is higher for applications that emphasize a tool rather than knowledge. In sum, the present-day digital transformation places organizational innovations in the realm of high tech and turns the debate about organizational technologies into the challenge of designing practical organizational tools on the basis of abstract organizational knowledge. We outline an agenda for patent-based research on OrgTech as an emerging phenomenon.

INTRODUCTION

Organization theorists have long drawn a sharp distinction between organizational and technological innovation under the assumption that organizational knowledge is embodied in persons and contexts while technological knowledge has to be embodied in practical tools (Birkinshaw, Hamel, and Mol 2008; Chandler 1977; Damanpour 2014, 2020; Teece 1980; Williamson 1975).

The distinction reflects the underlying tension between the technocentric and human-centric views of organization that persisted throughout the 20th century (Scott and Davis 2015: 85-86). Taylor's (1911) scientific management, Fayol's ([1919]1949) administrative science, and Weber's rational bureaucracy (1978[1922]) are the classical attempts to explicate, understand, optimize, and codify organizational knowledge, so as to make organizational practices reliably reproducible across individuals and organizations. While engineers Taylor and Fayol developed and enthusiastically promoted their technocentric views, social scientist Weber documented the emergence but opposed the "bureaucratic machinery in order to keep a portion of mankind free from parceling-out of the soul" (quoted from Coleman 1990: 95). The discoveries of the Hawthorne Effect (Mayo 1933; Roethlisberger and Dickson 1939) and informal organizational structures (Barnard 1938) led to the establishment of the human relations school of management that demonstrated "loose controls on human action in a firm that are afforded by technology" (Nelson and Winter 1982: 405).

In support of the human-centric views of organizational innovations, today's organization theorists often invoked the questionable patentability of an organizational innovation (Alänge, Jacobsson, and Jarnehammar 1998; Birkinshaw, Hamel, and Mol 2008; Damanpour 2020; Teece 1980; Williamson 1975). Since patents are widely accepted evidence of technological innovation and the primary source of data on the flows of scientific knowledge and technologies (Jaffe and de Rassenfosse 2019), it is puzzling that the patentability of organizational innovations has never received empirical scrutiny.

Moreover, continuing advances in information and communication technologies drive profound changes in organizations and organizing and offer new tools for embodying organizational knowledge: Platforms, clouds, machine-learning algorithms, chatbots, robots, and other digital devices appear to enact organizational structures, processes, and policies independently of humans

(Berg et. al. 2018; Guinan, Parise, and Rollag 2014; Joseph and Gaba 2020; Lanzolla et. al. 2020; Schafheitle et. al. 2020; Lindebaum, Vesa, and den Hond 2020). These developments are reorienting the academic field of organizational design from producing knowledge to designing tools (Simon 1996; Puranam 2018). One can envision R&D and patenting of organizational technologies and thus the emergence of OrgTech as a new distinctive domain of technological innovation akin to BioTech or FinTech.

The paper explores this possibility theoretically and empirically. Theoretically, we explicitly state the problem of embodiment of abstract knowledge in practical tools as central to the debate on organizational innovation as a technology. Empirically, we analyze the patentability of an organizational innovation as a key indicator of solving this problem. Our analysis rejects the claim that organizational innovations are unpatentable but does show that claiming an organizational innovation in a patent application decreases the likelihood of getting a patent in comparison with claiming a new digital tool in an otherwise similar application. We conclude that OrgTech is an emerging technological domain and propose a research program on its evolution that develops further the theoretical framework, data, and methods introduced in this paper.

DEFINITIONS AND CONCEPTUAL CLARIFICATIONS

We start with the definitions of the paper's key terms – organization, organizational innovation, and organizational technology. All three have been around since the first attempts to articulate and diffuse best organizational practices at the dawn of the large industrial enterprise, but the triad organization - innovation - technology escaped a systematic inquiry. There is a vast literature on each of these terms as well as on two dyads: organizational innovation and technological innovation. These are the literatures we review and build on in order to define precisely organizational innovation and organizational technology, articulate our argument about the relationship between them, and explore it empirically with patent data.

Organization

We define organization as a goal-directed system of structures and processes for mobilizing individual and group actors in pursuit of the system's goals (cf., Scott and Davis 2015: 28-33). To describe an organization means describing its goals, structures, and processes which vary in the degree of their explicitness or codification. This variation is reflected in the other classical distinction between formal organizations and informal organizations (Burns & Stalker 1961; Weiss & Jacobson 1955; Oeser & Harary 1962; for review, see Scott and Davis 2015).

Defining organization broadly is intentional: We expect and want to encompass innovations in both organizational structures and organizational processes, rather than to choose between organization as a structure and organizing as a process (Weick 1969). Digital transformation offers technologies for redefining organizational goals and redrawing organizational boundaries, structural changes that would be missed if we focused on processes alone (Schafheitle et. al. 2020).

Moreover, both structures and processes are needed for solving the two fundamental problems of organizing: division of labor and integration of effort (March and Simon 1958, Mintzberg 1979). Puranam, Alexy, and Reitzig (2014: 165) make further distinctions between task division and task allocation within division of labor; and among provision of information, provision of rewards, and exception management within integration of effort. These become "the five universal problems of organizing" which solutions do not usually operate alone or in arbitrary combinations but constitute a comprehensive set called a form of organizing (Ibid: 163-164).

Implementing our broad definition of organization in this paper as a system of structures and processes that in turn can be formal, imposed top-down, and informal, emerging bottom-up, we do not take organizational goals and boundaries, including human and material resources, as given but keep our framework open to innovations in structures and processes that define and acquire them. Among other things, this means that people management practices, such as hiring, training, and motivation, are legitimate organizational practices. While motivation is a generalization of the provision of rewards, hiring and training of people and delivery of material resources are distinctive problems of organizing that we call the provision of resources.

Our basic unit of analysis in this paper is the organizational practice defined as any repeatedly enacted combination of formal and informal organizational structures and processes that solve at least one of the following six organizational problems: task division, task allocation, the provision of resources, the provision of information, motivation, and exception management.

Organizational Innovation

Following Puranam, Alexy, and Reitzig (2014), we define organizational innovation as any organizational practice that offers a novel solution to one or more of the six fundamental organizational problems identified above. Since organizational goals are not necessarily exogenous to organizing but might emerge bottom-up in the process of organizing (Ibid: 164), we allow for the possibility of organizational innovations in strategic planning, organizational practices for defining strategic goals and monitoring their achievement. Our units of innovation are single organizational practices rather than forms of organizing as bundles or systems of such practices. Whether an innovation in one practice prompts or requires innovations in others because of their interdependencies is a separate important empirical question.

Major organizational innovations are known as organizational knowledge, big ideas first and foremost. Puranam, Alexy, and Reitzig (2014) gave many examples of historically innovative solutions to the problems of organizing as ideas of workflow diagrams, business process mapping, value chains, engineering drawings for task division; role descriptions and employment contracts for task allocation; employment contracts and incentive schemas for the provision of rewards; "rich face-to-face- or electronic communication" (Ibid: 166) for the provision of information.

The caveat is that ideas for organizing are rarely completely novel. Organizational practices oscillate between persistent opposites: formal vs informal organization, hierarchical vs network structures, extrinsic vs intrinsic motivation, and so on. These opposites go back to the confrontation between the scientific management and the human relations schools and reappear under new labels in new contexts. More often than not, "management ideas are old wine in new bottles," a repackaging of

old ideas for new contexts, times, and audiences (Mol and Birkinshaw 2007: 2). This repackaging is our first indication that organizational innovations differ from technological ones.

Organizational versus Technological Innovation

The vast literature on technology offers multiple treatments of its subject matter that vary in their emphasis on abstract ideas versus concrete tools. To explore organizational innovations as high tech, we define technology as knowledge embodied in tools that create economic value (cf., Damanpour 2020; Lipsey, Carlaw, and Bekar 2005; Merges 1999; Simon 1996, Tushman and Anderson 1986). Tools ensure transferability of knowledge which means that actors other than the inventor can reliably and productively employ the tool as a "black box," without necessarily understanding the embodied knowledge.

Tools do not figure as prominently in the research on organizational innovations as knowledge does; where tools do appear they are mostly treated as context-specific details. After all, one cannot create a universally applicable workflow diagram or business process map. Mol and Birkinshaw (2007), probably the most concerted attempt to map organizational innovations, mentions the word "idea"116 times while the word "tool" only 59 times. Even in their empirical case studies, Puranam, Alexy, and Reitzig (2014: 168) mention only "virtual support infrastructure and tools" as a solution to the provision of information problem relevant to both traditional and innovative forms of organizing, albeit to varied degree. Ignoring tools all this time prevented researchers from fully exploring the embodiment problem separating organizational innovations from technologies and patents in both organizational and legal theorizing.

THE PROBLEM OF EMBODIMENT

In his influential account of the emergence of big business in America, Chandler (1977: 101-104) identified Daniel McCallum, the top manager of the New York and Erie railroads in the 1850s, as the inventor of "the six basic principles of general administration" and the tools for implementing them, such as daily reports and an organization chart. About three decades later, these ideas diffused into

manufacturing and laid the foundation for Taylor's scientific management, although no manufacturer involved in their development mentioned the railroad managers' contribution (Chandler 1977: 274) and the tools that embodied those ideas were very different for factories versus railroads. Even within manufacturing, "no factory owner, even those who consulted Taylor or his disciples, adopted the Taylor system without modifying it" (Chandler 1977: 277). Thus, the problem of embodiment surfaced already in the earliest organizational innovations.

Today, only few specialists remember the numerous tools invented by Taylor. His scientific management is known as a set of ideas that gave rise to operations management in the 1940s-early 1950s but failed as too mechanistic in people management (Guillen 1994). Instead, government intervention during the war led to the bureaucratization of people management as an alternative technological approach to efficiency and control, with its roots in Weber's rational-legal authority (Baron, Dobbin, and Jennings 1986; Weber 1978[1922]).

Max Weber was arguably the first social scientist who looked at organization as a technology in his analysis of rational bureaucracy, an innovative form of organization at the time:

> "From a purely technical point of view, a bureaucracy is capable of attaining the highest degree of efficiency, and is in this sense formally the most rational known means of exercising authority over human beings. It is superior to any other form in precision, in stability, in the stringency of its discipline, and in its reliability. It thus makes possible a particularly high degree of calculability of results for the heads of the organization and for those acting in relation to it. It is finally superior both in intensive efficiency and in the scope of its operations and is formally capable of application to all kinds of administrative tasks." (Weber 1978[1922]: 223)

Weber sees bureaucracy as the efficient and reliable means of exercising authority to fulfil the purpose of economic production, state governance, or any other organized human activity. The emphasis on the "application to all kinds of administrative tasks" positions bureaucracy as a comprehensive solution to the fundamental problems of organizing. Although Weber's reference to calculability of results anticipates the critical role of computers and data processing in modern

organizational innovations, human bureaucrats rather than tools embody such calculations in his model. Continuous training, tenure for life, and other attributes of a bureaucratic career ensure that humans exercise authority in an impartial and disciplined manner.

The limits of the bureaucracy as a solution to the problem of embodiment became clear from Blau's (1955) *The Dynamics of Bureaucracy* and Dalton's (1959) *Men Who Manage* which documented bureaucratic management's inability to sustain on its own either a private or public organization; organizational knowledge remained embodied in emerging bottom-up, immaterial and context-specific tools of organizing: social relations (Granovetter 1985, Powell 1990), heuristics and routines (Nelson and Winter 1982), or organizational culture (Schein 1990).

Nelson and Winter (1982) attempted the only explicit treatment of organizational innovations on par with other technological domains. They defined organizational technologies as information-processing capabilities that businesses routinely employ in making decisions, processing market transactions, exercising internal control, keeping records, and other non-trivial and costly activities (Ibid: 66-71). "Routinely" is the key word here: capabilities turn into technologies when they are repeatedly and productively used by even those organization members who have little understanding of the capabilities, take them for granted and exercise on autopilot. Nelson and Winter (1982: 70) claimed that any change in organizational routines must fall under the "technological change" rubric, just as any improvement in production processes would, and should be treated as a technological innovation. Moreover, they claimed that such a "new technology needs to be embodied in new, specially designed equipment" (Ibid: 236). At the same time, their treatment of human skills as computer programs (Ibid: 74-76) suggests that they saw organizational knowledge as embodied in both persons and tools.

Lipsey, Carlaw, and Bekar (2005) developed this insight into a comprehensive theoretical framework: Organizational routines are embedded partly as skills in human memory and partly in organizational communication structures, "which is one reason why the ICT revolution caused such large changes in the internal organization of firms" (Ibid: 74). Technology is "the set of ideas specifying all activities that create economic value," whether it does so by being embodied in persons

or tools (Ibid: 58). However, the embodiment in tools facilitates the introduction and diffusion of new organizational routines, which is exactly what organizational innovation is all about (Ibid: 75).

Lipsey, Carlaw, and Bekar (2005: 98) reserved the term "generic technology" for any product, process, or organizational form that evolved over time through repeated embodiments in new tools but remained recognizable as the same generic thing, or as Birkinshaw et. al.'s "old wine in new bottles" mentioned above. If a generic technology evolves and improves through a variety of usage over long periods of time and has many spillover effects, it is a general-purpose technology (GPT). Lipsey et. al. (2005) identified 24 GPTs, including three organizational ones: the factory system, mass production, which is essentially scientific management, and lean production (Ibid: 203-210).

Lipsey et. al.'s framework accommodated those organization and management scholars who maintained emphasis on organizational technologies as big ideas that deliver economic value. Hamel (2007) characterized modern management as a "mature technology," a bundle of well-established principles of hierarchy, standardization, financial controls, performance incentives, and so on, which undoubtedly proved their utility by their contribution to human prosperity. Puranam (2018: preface) proposed a microstructural approach to "organizing as an applied technology" that focused on the features of an organization's design as antecedents of performance. Both scholars wrote about organization and management as general-purpose technologies.

At the same time, organization theory kept ignoring the framework's major claim that to reliably deliver the promised value across organizations and countries, ideas have to be embodied in tools (Lipsey, Carlaw, and Bekar 2005: 59-63). Researchers stayed focused on new management ideas, practices, and even ideologies (e.g., Birkinshaw, Hamel, and Mol 2008; Damanpour 2020; Guillen 1994; Mol and Birkinshaw 2007; Puranam, Alexy, and Reitzig 2014) but never on new tools and retained the distinction between technological and nontechnological innovations.

In the most recent comprehensive overview of the innovation management literature, Damanpour (2020) defined organizational innovations broadly, as any innovations in product, business model, or organization, but then split these into technological and nontechnological innovations, where the latter comprises exactly the innovations for which we reserve the term

organizational innovations in this paper (Damanpour 2020: 71). Damanpour built on prior work (e.g., Damanpour 2014, Evan 1966, Georgantzas and Shapiro 1993, Sanidas 2005, Tether and Tajar 2008) claiming that organizational innovations are disembodied because they do not produce physical and thus measurable changes, are "intangible, less observable, more abstract and difficult to grasp" (Damanpour 2020: 67).

In support of this assertion, Damanpour brought up the well-documented global effort to define organizational innovations as nontechnological, in contrast to technological product and process innovations, and to standardize their measures undertaken by the Organization for Economic Cooperation and Development (OECD/Eurostat 2005). However, the OECD eventually rejected this approach in favor of treating organizational innovation as a case of business process innovation defined as "a new or improved … business process for one or more business functions" (OECD/Eurostat 2018: 21), where one of six business functions was called "Administration and management" (Ibid: 73). The OECD justified this by noting the accelerating change in organizations and their business models supported by new information technologies as well as by the goal of "measuring the process of digital transformation" (Ibid: 3).

Indeed, information and communication technologies offer a variety of new potential solutions to the embodiment problem, the first ones appearing about thirty years ago with the arrival of automatic workforce management systems capable of handling many key managerial tasks (Baker 2008, Grant and Higgins 1989; Netessine and Yakubovich 2012; Stanton 2000). This development has entered a qualitatively new stage due to the digital transformation of core operations driven by the emergence of tools based on big data, machine learning (ML), and artificial intelligence (AI) (Agrawal, Gans, and Goldfarb 2018; Adner, Puranam, and Zhu 2019). Accordingly, the terminology quickly evolved from management by the numbers to algorithmic management to AI-augmented management (Adner, Puranam, and Zhu 2019; Agrawal, Gans, and Goldfarb. 2018; Lindebaum, Vesa, and den Hond 2020; Raisch and Krakowski forthcoming; Tambe, Cappelli, and Yakubovich 2019).

These tools arguably belong to the high tech of today and therefore warrant the name organizational technology (OrgTech). The question is whether they simply automate routine

managerial tasks or embody innovative organizational knowledge. Patent data are extensively used in studies of knowledge flows and innovations within and across industries (Jaffe, Trajtenberg, and Henderson 1993; Jaffe, Trajtenberg, and Fogarty 2000; Jaffe and Trajtenberg 2002; Jaffe and de Rassenfosse 2017) but, to the best of our knowledge, received zero attention in the literature on organizational innovation. Organizational theorists presumed that organizational innovations are unpatentable because they are disembodied from machine-like physical tools (Alänge, Jacobsson, and Jarnehammar 1998; Birkinshaw et. al. 2008; Damanpour 2020; Teece 1980). We revisit both these claims using US patent data.

PATENTABILITY OF ORGANIZATIONAL INNOVATIONS

A patent grants the inventor short-term monopoly rights to the use of the invention and thus motivates the inventor both to invent and to share information about the invention without delay. In turn, this facilitates both radical and incremental innovations which translate into technological progress, increasing productivity and, ultimately, socio-economic development (Hall and Harhoff 2012).

Researchers widely shared the received wisdom that organizational innovations are unpatentable for a number of reasons. First, there is lack of incentives on the part of businesses to publicly disclose them. While business consultants reap high fees for sharing innovative organizational knowledge that they themselves embody, organizational technologies make such knowledge transferrable impersonally and thus threaten to render consulting services obsolete.

While this might have been a valid point in theory, it did not stand in practice. Organizational patents in the US go back at least to the beginning of the 1970s. For example, the patent application for "Network Plotting System," submitted in October 1970, claimed to provide managers with "considerable assistance in controlling and directing resources to accomplish a particular objective" (Schaffner 1972). Within this paper's theoretical framework, it represents a practical tool that embodies the abstract innovative idea of "networked organization."

The arrival of the Internet in the 1990s and the digital transformation of the 2010s gradually created a market for data-driven organization and management tools, for example, people analytics,

machine learning algorithms, and artificial intelligence (Lanzolla et. al. 2020). Major digital players, such as Amazon, Google, IBM, Oracle, and SAP use for themselves and sell to others organizational technologies, and thus do have monetary incentives for patenting their commercial products. They hire data scientists and social scientists to run behavioral experiments in newly created R&D labs specialized on organizational technologies.

In 1997, the US Patent and Trademark Office (USPTO) announced a new Business Methods (BM) patent class for "machinery, equipment, or apparatus uniquely designed for or utilized in the practice, administration, or management of an enterprise" (USPTO 2012). The year of the announcement as well as the positioning of this class under the category "Calculators, Computers, or Data Processing Systems" support our assertion that information technologies made possible business process patents, in general, and organizational patents, in particular. Since 2013, the USPTO and its European counterparts have been sharing the cooperative patent classification (CPC) which includes class G06Q "Data processing systems or methods, specially adapted for administrative, commercial, financial, managerial, supervisory or forecasting purposes." There is some empirical evidence that firms profitably monetize business method patents (Desyllas and Sako 2013).

Following Williamson (1975), Damanpour (2014) argued that even if businesses wanted to disclose their innovations for profit and enforce the patent protection of their monopoly rights, competitors could easily undermine such a monopoly by making a non-substantial modification of the innovations. As with the public disclosure argument, this one remains valid for innovations embodied in persons and contexts but less so for those embodied in tools which are easier to document and compare.

The desirability of public disclosure and availability of patent protection create opportunities for patenting organizational innovations but do not imply that every organizational innovation is patentable. An inventor has to make a case to patent examiners and other stakeholders that the proposed innovation meets the same patentability requirements as any other technology: novelty, usefulness, and non-obviousness (see articles 101-103 of *United States Code Title 35 - Patents* 2019).

In the next section, we show that meeting these requirements is equivalent to demonstrating how an organizational invention solves the embodiment problem.

The Problem of Embodiment and the Patent Law

A year after the creation of the Business Methods patent class, a patent for an organizational innovation embodied in a computer algorithm was successfully defended in the US Court of Appeals for the Federal Circuit. In the 1998 case *State Street Bank v. Signature Financial Group*, the court reviewed a data processing system for implementing an investment structure that combines two organizational forms, mutual fund and partnership. In its pivotal decision, the court concluded that mathematical algorithms are not patentable only when they are "disembodied" and thus lack a useful application (Hall 2003). In other words, the court concluded that a mathematical algorithm of a novel organizational form embodied in a computer code can be recognized as a technological innovation. The recognition hinged on the embodiment turning abstract knowledge into a "useful process, machine, manufacture, or composition of matter" (USPTO 2019a). This ruling opened the floodgate for business method patents, in general, and organizational patents, in particular.

Legal scholars promptly raised concerns about this expansionist view of patentability by reinstating the embodiment problem. From their standpoint, the loss of material, physical qualities made challenging the determination whether an invention includes an embodying tool at all: "Computer software -… or a written code that does machine-like work – clouded and confused our working definition of technology" (Merges 1999: 586). Scholars of Law and Economics provided empirical evidence that many software and business-method patents were just "mental correlations" rather than tangible "assets that can be clearly defined with unambiguous boundaries" to their property rights (Bessen and Meurer 2008: 27). Heated debates and court proceedings challenged multiple business method patents so that they were "seven times more likely to be litigated" than other patents because they were abstractions (Bessen and Meurer 2008: 22). These challenges led to the 2014 US Supreme Court ruling in *Alice Corp. v. CLS Bank*: "Adding on a computer to an abstract idea does not make it patentable" (Supreme Court of the US 2014).

The *Alice* ruling was a major setback for proponents of organizational patents in particular because it singled out "methods of organizing human activity," including "commercial and legal interactions" and "managing personal behavior or relationships or interactions between people" as rather obvious, impractical, abstract ideas which thereby did not meet the patentability requirements (USPTO 2019b: 15). The Court explained that claims of new "methods of organizing human activities" were still eligible for patenting but only if they contained "an inventive concept sufficient to transform the ineligible … abstract idea into a patent-eligible application" (Menell, Lemley, and Merges 2016: 324-325). As a result, the rejection rate due to "patent ineligible subject matter" for affected technologies increased by 31% in the aftermath of the *Alice* decision (Toole and Pairolero 2020: 1).

To remedy the situation, the USPTO issued new guidelines accompanied by 6 detailed examples of the proper transformation of abstract ideas into practical applications "by use of a particular machine" (USPTO 2019b: 18) which, in our terms, clearly implies that an organizational innovation is patentable if it solves the embodiment problem. It follows that *organizational innovations that include specific tools are more patentable than those that do not*. The USPTO's patent classification system allows inventors to signal that their innovation is primarily a digital tool and thus a solution to the embodiment problem.

Knowledge vs Tool in Patent Classification

After a patent application is filed, the USPTO must classify the subject matter of the invention. The currently used Collaborative Patent Classification System (CPC) consists of five levels: section, class, subclass, group, and subgroup. Business Method patents belong to subclass G06Q "Data processing systems or methods, specially adapted for administrative, commercial, financial, managerial, supervisory or forecasting purposes." Within this subclass, the group G06Q10 "Administration and Management" is the primary but not exclusive designation for OrgTech as defined in this paper. For example, subgroup G6Q50/01 «Social Networking» could contain tools for the network organization which is a popular organizational innovation.

In turn, the Business Methods subclass belongs to class G06 "Computing; Calculating; Counting" nested in section G "Physics." The nestedness of Business Method patents within computer patents is consistent with the dominant role played by information and communication technologies in solving the embodiment problem. Moreover, it conveys that business methods are digital tools and makes it easier for an inventor to place their innovation at some other subclass of G06, in particular since organization is ubiquitous in all domains of human activities.

At first glance, the nestedness of computing in physics appears strange and, in any case, tenuous at best for our purposes. However, the first calculation devices were analogous rather than digital (Daston 2018), and observers see a role for both in future generations of artificial intelligence (Dyson 2019). The CPC subgroup G06Q90/00 is a designation for "systems or methods specially adapted for administrative, … managerial, supervisory or forecasting purposes, not involving significant data processing." For us, all these are further indications that the CPC classification system can be used to present even computational tools as material, physical embodiments of immaterial, abstract ideas.

Since a patent application usually makes multiple claims and each claim must be classified, an application receives multiple inventive and additional classifications (USPTO 2019a). The latter are used only for searching related prior art while the former indicate what exactly the invention is about. The first inventive classification signals where the invention claims a contribution first and foremost (USPTO 2019a) and therefore is the focus of our analysis.

There is plenty of evidence that inventors often attempt to classify their inventions strategically to avoid the categories with low patent allowance rates (e.g., Barber and Diestre 2020; Corsino, Mariani, and Torrisi 2019; Lemley and Sampat 2012). The Business Methods (BM) subclass is one of the most notorious among them (Wagner 2006). Legitimate opportunities for avoiding this class are abundant exactly because business method inventions rely on computers and other digital technologies covered by plenty of other classes.

Beyond computing per se, the CPC includes other classes, such as G09 "Education; Cryptography; Display; Advertising; Seals", or H04 "Electric communication technique" which,

arguably, solve at least one of our six fundamental organizational problems. Designating one of them as an invention's first inventive classification, the inventor signals that their contribution is only about a tool, a practical solution to the embodiment problem, and sidesteps completely the question whether the tool embodies an abstract organizational idea. We expect that organizational innovations with a non-BM first inventive classification have a higher probability of patent allowance than an OrgTech classification.

To summarize, our discussion transforms the theoretical problem of embodiment into an empirical question: Is an organizational innovation patentable? Getting a patent indicates that the innovation successfully embodies its abstract idea in a practical tool and thus becomes a technology. Moreover, the discussion identifies two determinants of patentability of an organizational innovation: the inclusion of a specific practical tool and a non-OrgTech category as its first inventive classification.

EMPIRICAL STRATEGY AND DATA

In view of the exploratory, theory-building goal of our study, we proceeded with answering our empirical question in four stages: First, we mapped organizational innovations over the last hundred years using academic and practitioner sources. Our final OrgInn population consists of 114 innovations ranging from scientific management of the early 20th century to holacracy of the early 21st.

The next two stages projected the population of innovations into the database of the USPTO patent applications. The publicly available USPTO database contains all the patents issued since 1790, and all the published patent applications since 2001. On the second stage, we searched the entire database and identified 11,126 patent applications by the presence of at least one out of the 114 innovation names in an application's title or abstract, and randomly sampled from them 814 applications for manual coding. This resulted in 300 applications which membership in OrgTech we determined with certainty. We call this sample OrgInnSeeds to emphasize its role on the third research stage as the input into Google's machine-learning (ML) algorithm for patent landscaping

(Abood and Feltenberger 2018). The landscaping identified 67,240 applications in the USPTO patent database as our population of OrgTech patent applications.

As with the outcome of any other ML algorithm, any patent application included in the OrgTech population is an organizational innovation only probabilistically. On the fourth analytical stage of our study, we constructed necessary measures and their potential covariates to assess the likelihood of patent allowance for the OrgTech population of patent applications from the 2001-2020 period. As a robustness check, we replicated the same analysis on the OrgInnSeeds sample and obtained consistent findings across the two populations, which increased our confidence in the findings and conclusions despite the inherent random noise in the data.

The outlined "sequential" research design did not separate neatly data gathering from data analysis. At each stage, we carried out a descriptive analysis of the gathered data in order to provide insights into the patentability of organizational innovations as well as to prepare for the next stage of data gathering. Accordingly, we designate for each stage a separate section below.

OrgInn: The Population of Organizational Innovations, 1900 - 2020

To assemble a dataset of organizational innovations over the last century, we started from the list of the "top 50" management innovations from 150 compiled by Mol and Birkinshaw (2007). The authors defined management innovations broadly as "… the invention and implementation of a management practice, process, structure, or technique that is new to the state of the art and is intended to further organizational goals" (Birkinshaw, Hamel, and Mol 2008: 825). Many names on the list sound these days like the brick-and-mortar of management: scientific management, moving assembly line, total quality management, cost accounting, direct marketing, and so on. Others, such as lean production, six sigma, and agile manufacturing, are still state-of-the-art. The authors classified these innovations into seven areas: Process, Money, People, Structure, Interfaces, Strategy, and Information.

Taken together, the definition and areas of management innovations indicate that organizational innovations form their subset. To identify this subset, we asked only one question: Does a management innovation address any of the six fundamental organizational problems: task

division and allocation, provision of resources and information, motivation, and exception management? The answer was not always straightforward. In particular, the area Interfaces covers marketing and supply chain management which often cross organizational boundaries today, for example, when firms use employee branding practices or engage their customers and suppliers in crowdsourcing. Likewise, an overlap among the Process, People, and Structure areas inside a firm reflects blurred boundaries between operations management and people management. Practices associated with scientific management and the moving assembly line are the best-known examples of this blurriness. Information is the hardest area to demarcate since arguably any organizational practice presumes information processing.

We reviewed Mol's and Birkinshaw's introduction to the discussion of each area of management innovation where they presented a number of candidates for the Top 50 list that they considered but ultimately rejected. We included them on our list in order to be as comprehensive as possible. Whenever the authors decomposed innovations into a few more narrowly defined management practices, we listed those practices as distinctive innovations as well, since our unit of analysis in this paper is a practice. This procedure increased our list from 50 to 158 management innovations of the 20th century.

We applied to each management innovation our definition of organizational innovation as a solution to at least one of the fundamental organizational problems. In all questionable cases, our bias was towards as comprehensive a coverage as possible, and therefore we treated as organizational innovation any novel management practice or set of such practices which met the criterion even slightly. All 32 practices from the People and Structure areas, 11 out of 21 from the Strategy area, and 4 out of 11 Information practices turned out to be organizational innovations. On the contrary, no practices from the Money and Interfaces area met the criterion.

The Process area deserves a separate discussion. In conventional terms, it is arguably identical to operations management which is always about task division and task allocation and is often about the provision of resources and motivation. Major organizational innovations, such as scientific management and lean production, belong to this area. However, operations management

often reaches beyond organizational boundaries, as in the case of supply chain management. We accepted as organizational innovations only those 18 innovative processes that operate primarily within organizational boundaries. Our final version of Mol's and Birkinshaw's (2007) list of organizational innovations included 65 items.

To bring the list up to date, we applied our definition of organizational innovation to organizational practices described in the 2001-2020 issues of *Harvard Business Review* and the comprehensive book by Damanpour (2020), which yielded 49 additional innovations. Thus, our final population of organizational innovations contained 114 organizational innovations which are analyzed below and listed in Appendix A. While we are confident that the described procedure identified all noteworthy organizational innovations in the US economy as of today, we do not make a strong claim of representativity, an impossible claim to make for innovations in any domain.

Table 1 presents the main characteristics of the OrgInn population of 114 organizational innovations of the relevant period, 1900-2020, distributed among five areas: Process, People, Structure, Strategy, and Information. The first four areas are of comparable size, between 24-33 innovations or 21-29%. The small size of the Information area, 4 innovations in total, should not mislead the reader. As Nelsen and Winter (1982) convincingly argued, organizations are inherently information-processing actors; 85% of the innovations in the OrgInn population address the provision of information problem one way or another. The four innovations in question - Material Requirements Planning, Manufacturing Resource Planning, Expert System, and Enterprise Resource Planning - solve only the provision of information problem across the other four areas.

[Table 1 about here]

According to our interpretation of the innovations' content, the percentages of innovations solving the problems of task division and allocation, resource allocation, and motivation are all about the same at 54-55%, while only 21% of the innovations address the problem of exception management. Puranam, Alexy, and Reitzig (2014) argued that innovative forms of organizing should consist of bundles of organizational practices in order to address multiple problems. While we intentionally set up our analysis at the level of single organizational practices, only 18 out of our list

of 114 innovations address one problem, the average number of problems being 3.3. The four innovations that claim to address all six organizational problems - Kaizen, Rendanheyi, SCRUM Methodology, and Expert System - are broad sets of ideas, if not full-fledged ideologies (cf., Guillen 1994).

To make an initial assessment of the scope of the embodiment problem, we coded all the 114 organizational innovations in our OrgInn sample by whether they are presented in our sources to some degree as a new tool that embodies the idea. For example, Taylor's scientific management is known today as a set of ideas about division of labor, employee training and motivation which revolutionized management at the beginning of the 20th century. At the same time, multiple accompanied tools invented by Taylor for implementing these ideas are largely forgotten. Instead, numerous managers and consultants have been experimenting with their own toolkits until today. This tinkering sometimes led to major breakthroughs, such as lean production, justly seen as a descendant of scientific management with its rather famous toolkit. In particular, kanban is widely known as a tool that embodies some key ideas of lean production and, in fact, an innovation in its own right adopted by other organizational innovations such as project management and agile. The variable Tool in Table 1 indicates that only 18 innovations in OrgInn are about tools.

OrgInnSeeds: Sampling Organizational Innovations from US Patent Applications, 1970-2020

The few existing papers on business method patents, in general, and financial and Internet patents, in particular, list a number of obstacles to identifying populations of such patents: the sheer volume of unstructured text data to be processed; unreliable classification systems designed for searching prior art but not helpful with the precise matching of patents to technologies and related concepts in science or engineering; regular changes in the classification system; ad hoc keywords and references. As a result, the strict demands of academic study force researchers to read patents and code them manually according to their conceptual schemas (Allison and Tiller 2003; Chan et. al. 2018; Hall 2003; Lerner 2002; Lerner and Seru 2017).

There is an additional challenge with identifying OrgTech: The very notion of organization pertains to a variety of technological domains: humans organize and manage computer systems, buildings, electricity and communication networks, and other artifacts as well as living systems from cells and microorganisms to populations of mammals. Accordingly, these domains share the principles of hierarchy, functional division, formal structure, self-organization, and so on with organization science. In fact, physics, chemistry and other sciences inspired many developments in organization theory. For all these reasons, the boundary between OrgTech and other technological domains is inherently blurred.

Likewise, it is hard to distinguish intraorganizational activities within business activities. Ultimately, organizational goals are about some output: product or service, monetary or in kind. Managers participate in the production of this output when they analyze markets, determine prices, engage in public relations, and so on. However, such activities shape the division of labor and integration of effort among the organization's members and thus blur the boundary between production and organization. External actors, such as suppliers, consultants, or customers, do the same as they engage in the production process and thereby become informal intermittent members of the organization. Their interactions with formal members often contribute to solutions of fundamental organizational problems.

Not surprisingly, earlier researchers concluded that the only reliable way to determine whether a patent application belongs to a given technological domain is to read the application (e.g., Allison and Tiller 2003). However, even this does not prevent omissions due to the kind of strategic or inadvertent misclassification described above.

The increasing power and precision of machine learning (ML) algorithms for natural language processing (NLP) turn computers into fast readers capable, at least in principle, of finding all relevant patents whether they are classified correctly or not (Abbas, Zhang, and Khan 2014). One critical precondition to accomplishing this goal is our ability to train the computer to recognize OrgTech patents, which still requires some human reading and coding of patent applications in order

to create a sample of definite OrgTech "seeds" which, planted by the algorithm, will grow into the OrgTech sample.

To find the seeds, we created a list of keywords from the names of the 114 innovations in the OrgInn population and their synonyms used in the original sources of the OrgInn data. To maximize our chances of finding exactly the innovations with the same names, we searched for these keywords in the titles and abstracts rather than full texts in the USPTO patent database, since there are many other reasons for a term's appearance in the full text: the mention of a related innovation, description of a larger context, and so on. The procedure yielded 11,126 patent applications.

The table in Appendix B presents all the innovations ordered by the frequencies of their mention in the data patent database with four top winners mentioned more than a thousand times: cellular organization - 2,356 mentions, moving assembly line - 1,367 mentions, expert system - 1,197 mentions, and modularization - 1,007 mentions. The next 10 organizational innovations mentioned a hundred times or more include project management, executive coaching, employee benefit, and other terms familiar to laypeople, as well as the more academically sounding cellular manufacturing and just-in-time. 38 organizational innovations, more than a third of the OrgInn population, are missing in the titles and abstracts of the USPTO patent applications, including ones quite popular among managers today blue ocean strategy, people analytics, scrum, or holacracy. However, this only means that inventors do not use these terms in the titles and abstracts of their patent applications. Whether they will appear in applications from the final OrgTech sample will be an informative measure of the value-added of our ML-based research strategy.

Likewise, the appearance of an innovation's name in an application's title or abstract does not mean that the application is about the corresponding innovation; one can establish this as a fact only by reading the application itself. To make this task manageable while preserving the representation of organizational innovations and patent applications, we drew a stratified random sample of 814 unique applications with the probability approximately proportional to size, where each stratum corresponds to one of the 76 names of organizational innovations found in the title and abstracts of the USPTO database. We ignored a slight overlap among the strata due to 80 applications with multiple keywords.

"Approximately proportional" means that we drew 5% of applications from the 11 strata of size larger than 200, 10 applications from the 24 strata of size between 10-200, and all the applications from the remaining 41 strata, as shown in the column Sample Size of the table in Appendix B.

The second author of this paper and a research assistant on the project read the title, abstract and, if uncertainty remained, the full text of all the 814 sampled applications and determined independently if an application indeed describes the quoted or any other innovation from OrgInn and addresses at least one of the six fundamental organizational problems. The first author made the final determination in the few cases of disagreement. The composition of the resulting OrgInnSeeds sample of 300 unique patent applications is described in the Number of Seeds column of the table in Appendix B. Its comparison with the Sample Size column points to reasons for the seemingly low return on our effort: Organization is omnipresent in nature, economy, society, and thus in all technological domains. For example, cellular organization is an established term in biology and, accordingly, in biotechnology patents; only 1 out of the 107 applications with this keyword claim an organizational innovation. Even among the 64 reviewed applications with the very managerial term moving assembly line, only 4 or 6.25% are organizational innovations. By contrast, all 10 of the applications for inventions that mention project team or business process reengineering are organizational innovations. Overall, the OrgInnSeeds sample covers 58 or 50.9% of innovations from the OrgInn population in comparison with 76 names identified in the titles and abstracts of the US patent database. The remaining 18 names either did not represent organizational innovations to start with or did not make it into the random sample.

OrgTech: The Sample of Organizational Innovations in US Patent Applications, 1970-2020

The OrgInnSeeds sample serves as an input into Google's patent landscaping algorithm (Abood and Feltenberger 2018). The first step of the algorithm creates an expansion of the seed sample using forward and backward citations, and highly-relevant patent classification codes that are identified in at least 5% of the seeds and are 50 times more common in the seed sample than in all other patents. The resulting expansion is an over-inclusive set of "probably-related" patents. In our case, it included 85,925 records of patent applications, both granted as well as pending and abandoned.

The second step of patent landscaping prunes the over-inclusive expansion with a wide-and-deep LSTM (long-short-term-memory) neural network model. The model's inputs include CPC codes, citations, and high-dimension vectors that codify the content of patents' titles and abstracts and are the outcome of word2vec, a natural language processing (NLP) method of "meaning extraction" (Mikolov et. al. 2013). We trained four models on the OrgInnSeeds patents and 20,000 "anti-seed patents" chosen randomly from the patent applications left out of the expansion, and tested the model performance on a set of manually coded OrgInn patents. The four models differed in the dropout rate, a technical characteristic used to avoid overfitting the algorithm to the training sample. 20% is a suggested dropout rate, while a much higher rate of 90% forces the neural network to rely more on text features and thereby avoid the over-reliance on CPC codes and citations. Table 2 presents the measures of accuracy of the four models and shows that Model 1 with all three dropout rates equal to 20% performs the best. To filter the expansion, we used this model's score which can be interpreted as the probability that an application does not belong to OrgTech. We retained for further analysis the 93,248 publications with the score lower than 0.5. They represented 67,240 patent applications which constituted our OrgTech dataset for further analysis.

[Table 2 about here]

Important caveats of our approach are the errors of commission and omission due to the inherent blurriness of the boundary between OrgTech and other technological domains discussed above. The OrgTech dataset is likely to include patent applications that have nothing to do with the 114 organizational innovations as well as miss other applications that are relevant. The Google

algorithm mitigates this problem by taking into account the classification codes of the seed applications but cannot eliminate it completely.

Another blurred boundary lies between organizational innovations and organizational routines. Conceptually, Nelson and Winter's (1982) definition of technology as routine knowledge exposed this blurriness long ago. The USPTO's and the courts' arguments against abstract ideas in patent applications exacerbate it by forcing inventors to simplify their ideas in patent applications.

For example, one innovation among the 33 additional names of organizational innovations found by our algorithm is holacracy (Robertson 2015), a combination of the ideas of network organization and self-organization made popular by Zappo's (Gelles 2015). Robertson, Moquin, and Powell (2007) submitted a patent application for this invention but avoided using its name anywhere but in the references. As a result, we did not find this application by searching the titles and abstracts in the USPTO patent database, but the Google algorithm correctly identified it using our 300 seeds that do not contain the term holacracy at all. Thus, the algorithm found something else in common between the applications for organizational innovations represented by the seeds and the application for holacracy, which is good news. The bad news is that, apparently, Robertson tried to present his innovation as down-to-earth practical tools while deemphasizing his big ideas behind it. The more inventors do the same, the more likely it is that our algorithm includes in OrgTech applications for digital tools that merely automate routine tasks, such as scheduling a meeting with a few mouse clicks, but do not carry organizational knowledge of any significance. Robertson abandoned his application in 2009 which further validates our concern about bias against truly innovative ideas in the patenting process which in turn introduces errors into the OrgTech dataset. To minimize the impact of such errors, we replicate the results of our analysis on the OrgInnSeeds dataset as one of our robustness checks.

FINDINGS

With the construction of the three datasets completed, we are well equipped to explore our main empirical question concerning the patentability of organizational innovations by making two

sequential queries: Do inventors and other stakeholders attempt to patent organizational innovations? If so, are they successful?

Patenting Activities Around Organizational Innovations

Table 3 summarizes the coverage of organizational innovations in both samples we used for analysis. The texts of the patent applications in the OrgTech dataset mention at least once 97 names or 85.1% of the 114 organizational innovations in the OrgInn population (See Appendix C for details). Out of the 17 remaining innovations, 10 have the 2001-2020 issues of Harvard Business Review as the original source and thus are relatively new; it might take more time for them to become represented by patent applications. The other 7 are from the book by Mol and Birkinshaw (2007) where they are mentioned in the text but excluded from the Top 50 list: Scanlon Plan, Survey of Management Practice, Global Matrix Structure, Global Account Structure, Transnational Model, Spaghetti Organization, and Connect and Develop model.

Similar to the OrgInnSeeds sample above, finding an innovation's name in the corpus of the OrgTech patent applications does not guarantee that the application represents the innovation, but verifying the coverage manually in the case of more than 60,000 applications is infeasible. Since we have already confirmed with certainty the coverage of 58 innovations by the OrgInnSeeds sample, we focused on only those applications that contained the other 39 innovation names identified in the OrgTech sample. For each name, we sampled and read the corresponding applications until a definitely relevant one was found or the applications were exhausted. We found at least one application for all but two organizational innovations, workout group and cultural innovation. This allows us to claim the coverage of 95 innovations or 83.3% of our OrgInn population of 114 organizational innovations from 1900-2020.

[Table 3 about here]

Our theoretical arguments above suggest that the success of this effort hinges on inventors solving the embodiment problem which is a contested terrain: Patent examiners and courts question whether writing up an abstract idea about organizing in a computer code is a true innovation. We see

two immediate ways in which inventors can demonstrate that their inventions solve the embodiment problem.

First, inventors can focus on 18 organizational innovations in the OrgInn population that include a practical tool as its constituent part. Of the 18, we identified 10 with certainty in the OrgInnSeeds data and 13 tentatively in the OrgTech data, which implies 56-72% coverage of tool-specific organizational innovations, as shown in Table 3. This is comparable with the 51-85% coverage of the OrgInn as a whole.

If a submitted invention includes a tool as an embodiment of the invention rather than as its intrinsic component, the inventor might signal the tool as the main innovation through classification. Table 4 describes the distribution of the CPC classification codes for three groups within the OrgTech sample: 1,238 patents prior to 2001, 34,446 unpatented applications and 31,556 patents in 2001-2020. We split the 3,376 primary codes used into three categories: OrgTech that includes 65 codes of the subgroups within the G06Q Business Methods (BM) subclass which names signal a solution to at least one fundamental organizational problem (see Appendix D for details); Non-OrgTech BM that includes all the other 217 codes from the G06Q subclass; and Non-BM that includes all the remaining 3,094 codes. The frequencies for these three categories in Table 4 cover all the applications and sum up to 100%. Within each category, we report only the five most frequent codes for illustrative purposes.

[Table 4 about here]

31% of patents prior to 2001 as well as 48% of patents and applications in 2001-2020 have a primary classification other than the G06Q10 group or OrgTech. A smaller subset of them belong to the G06Q30 “Marketing” and G06Q40 “Finance” groups which boundaries with organizational innovations are inherently blurred. At the same time, about 32% of patent applications do not even belong to the G06Q subclass of Business Method (BM) patents. Consistent with our prediction above, the five non-BM subclasses listed are associated with digital tools: three subclasses of the G06 “Computing” class, and two subclasses of the H04 “Electric communication technique” class.

What kinds of actors seek patents for organizational innovations? Table 5 slices the OrgTech sample of patent applications by the type of the assignee, small or large business, with the 20 most frequent assignees listed individually. Overall, the largest assignees are exactly the most important actors in digital transformation, in general, and in the digital organization and management, in particular. The predominance of IBM, Microsoft and Google is an indication that patenting organizational innovations is about digital tools and solving the embodiment problem. That SAP takes third place is not surprising since the company started with the implementation of Enterprise Resource Planning, one of our organizational innovations, and then established itself as the leader in digital HR. All these businesses, as well as the other famous hardware and software brands in the table, sell their digital tools. It is reasonable to assume that they use patents to protect and monetize their inventions. It is feasible that financial businesses innovate at the intersection of FinTech and OrgTech while manufacturing companies invent in the domain of operation management.

[Table 5 about here]

Another question to ask in order to understand OrgTech-relevant stakeholders and their activities is whether competitors and other counterparts care about OrgTech patents. Figure 1 reports the number of court cases on the infringement of OrgTech patents and the number of patents involved over the 2003-2016 observation period for which such information is available. The lines increase together from 10 cases and 13 patents to 67 cases and 63 patents until 2010 when the number of cases starts rising much faster until reaching its peak of 288 cases and 130 patents in 2013. Probably, this was the trend that compelled the Supreme Court to announce its landmark decision in the *Alice* case the following year. The drastic decrease in litigation in the aftermath of this decision indicates the possible emergence of "the rules of the game" and thus some degree of institutionalization of the OrgTech domain.

[Figure 1 about here]

Our findings so far clearly demonstrate a plentitude of activities around organizational innovations in the first two decades of the 21st century: Between one half and four fifths of the major organizational innovations since 1900 are represented in patent data; individual inventors, small and

medium-size businesses, and major corporate players patent organizational innovations; such patents are contested in the court of law. All these activities contribute to the emergence of OrgTech as a real and consequential phenomenon. Next, we evaluate the patentability of organizational innovations as an outcome, the rate of successful patenting and its covariates.

Patenting Outcomes for Organizational Innovations

The first estimate of the probability of the successful completion of the patenting process - patent allowance - can be obtained from the descriptive data in Table 4 as the ratio of the number of patents to the total of patents and unpatented applications. Between 2001 and 2020, the probability of patenting for the OrgTech-classified applications is 42% in contrast to 58% for the Non-BM classified applications. The lower rate of success for the applications classified as OrgTech is consistent with our theoretical premise that organizational innovations struggle with the embodiment problem and therefore are relatively harder to patent. This said, we should not draw far-reaching conclusions from distributions, since they might vary over time, in particular with landmark events such as the US Supreme Court decision in the *Alice* case and the subsequent change in the USPTO's patent examination guidelines.

To account for dynamics in the OrgTech patenting process, we use survival analysis of patent applications (Barney 2002). Tables 6a summarizes descriptive statistics for the OrgTech subsample of patent applications for 2001-2020 that we use in this analysis. The sample is smaller, containing 59,722 patent applications, because we exclude patents granted before 2001 as well as unpublished applications and patents published before publication.

[Tables 6a about here]

We distinguish among three patenting outcomes or states: Pending, Abandoned, and Patented. As soon as a patent application is published, usually about 18 months after submission, it is considered pending for our analysis. A permanent patent examiner, an expert in the Art Unit that the application is assigned to, scrutinizes the application according to the USPTO's guidelines, asks the inventor for clarifications and justifications, proposes relevant prior art, and issues decisions (USPTO

2019a). The examiner makes rejection or allowance decisions through one or more rounds of amendments and negotiations with the inventor. A final allowance decision will result in a Patented application, while a rejection decision is technically never final since it can be appealed. If the applicant fails to respond to the decision or expressly requests abandonment, the application is considered Abandoned (Carley, Hedge, and Marco 2015). The frequency distributions for the variable *Application State* in Table 6a show the 13% share of pending applications and about equal 43.3% and 43.7% of patented and abandoned applications, accordingly.

Figure 2 presents the Kaplan-Meier survival curves that plot over time the probability of the Pending state by an application's primary classification: OrgTech, non-OrgTech business method (BM), or non-BM. A visibly steeper decrease of this probability for non-BM applications means their higher rate of exiting into the Patented state, while abandoned applications are treated as censored and removed from the calculation of the survival probabilities. The curves for the applications classified as OrgTech and non-OrgTech BM do not look much different, which suggests that the paper's argument about the liability of OrgTech generalizes to all business methods.

[Figure 2 about here]

The distribution of Primary Classification reported in Table 6a is identical to the one in Table 4; thus, there is no bias in this regard in the sample for survival analysis. The variable OrgInn Name is a dummy equal to 1 if the application mentions at least once an innovation from OrgInn, which is the case for 22.1% of the applications in the sample. Among them, 4,820 applications or 8.1% of the sample mention the name of a tool-specific innovation, as depicted by the variable OrgInn Tool. Finally, the variable N of OrgInn Occurences and its logarithm capture the number of such mentions which is very skewed with a mean of two and a maximum of 638.

Table 6b reports the same descriptive statistics separately for four periods defined by the US Supreme Court's decision in the *Alice* case taken on June 19, 2014. Following Toole and Pairolero (2020), we take the 18 months in the aftermath of the *Alice* case as the period when USPTO examiners, lacking new guidelines, should have enforced the court decision rather indiscriminately. The 18 months prior to the decision is a reasonable reference period while the earliest period between

January 2001 - December 2012 and the latest one between January 2016 - April 2020 are informative comparisons.

[Tables 6b about here]

Table 6b reveals some interesting dynamics across these periods: The share of patented applications decreases from 46-47% before the *Alice* decision to 41% in its aftermath to 35% in the last four years and four months of the observation window. At the same time, we see a redistribution of the patent applications' primary classifications from OrgTech to Non-BM codes: The share of the former monotonically decreases by almost half from 65% to 38%; the share of the latter monotonically increases by more than twice from 19% to 46%; and the share of the Non-OrgTech BM category remains stable at 15-16%. Evidently, inventors experience problems with patenting OrgTech innovations and increasingly classify them as something other than OrgTech.

The Cox regression models in Table 7 capture simultaneously all the variations in the patenting rates explored separately earlier. The findings pertaining to the time-varying covariate Period in Model 1 are consistent with our expectations about the variation due to the US Supreme Court's decision in the *Alice* case: The negative effect of the earliest period means that the patenting rate for OrgTech applications grew before the landmark court decision. The decision itself is associated with an approximately 14% (=1-exp(-0.151)) drop in the hazard rate of patenting, which in turn recovered about half of that loss after the introduction of the USPTO's new guidelines.

[Table 7 about here]

Model 2 introduces the three variables that capture an application's coverage of the OrgInn population. As we expected, the effect of *OrgInn Name* is negative; having in the application text the name of any organizational innovation from the OrgInn population of 114 decreases the patenting rate by 15% (=1-exp(-0.158)) with substantively negligible further decreases with additional mentions. Conditionally on one or more names being mentioned, the effect of one of these names belonging to a tool-specific innovation increases the patenting rate by 12% (=exp(0.117)-1), which compensates for two thirds of the loss due to having the innovation mentioned in the first place. Model 3 shows that the applications classified as OrgTech have about 50% the rate of patenting (1-exp(-

0.095)/exp(0.599)) of those classified outside the Business Methods subclass, primarily, as digital tools for computing and information processing. These three findings speak directly to our core argument: An application that emphasizes its novelty as a practical tool rather than an abstract organizational idea has a higher rate of patent allowance. Therefore, patent allowance is a recognition that the invention solves the embodiment problem and thus is a technology.

Another noticeable finding in Model 3 is that the hazard rate of patenting in the most recent period, from January 2016 to April 2020, becomes indistinguishable from the reference period. Apparently, the previously higher value of this rate is due to the increased classification of OrgTech applications as non-BM applications. Inventors learned their lesson from the *Alice* case. Model 4 shows that all the described effects hold when tested together albeit with minor changes in magnitude.

DISCUSSION

The first significant finding of our empirical analysis is the strong presence of organizational innovations in patent applications: The US patent data cover at least 83.3% of the widely diffused organizational innovations since 1900; a diverse range of inventors, from individuals to brand-name corporations, submit patent applications for organizational innovations; their inventions face challenges and reversals in the court of law. All these activities leave a trace in the USPTO patent database which allows researchers to study organizational innovations in the same way they study any other high tech of today. To emphasize this new opportunity, we use the term OrgTech as the label for the emerging domain of organizational technologies represented by patent applications.

The process of demarcation of organizational innovations in the US patent data is another contribution of this paper. We proceeded in three steps: From assembling from multiple sources a dataset of 114 key organizational innovations since the dawn of professional management in the late 19th century to identifying 300 patent applications that represent 58 out of 114 innovations to using these applications as seeds for Google's machine learning algorithm that found 67,240 patent applications with 97 out of the 114 innovation names mentioned in their texts.

As the first exploratory study of organizational innovation that uses patent data, our paper translates into the language of patents the old question from organization science: Is organization a technology? The translation proceeds in two steps: First, we use a precise definition of technology as abstract knowledge embodied in practical tools, where embodiment means the transferability of the knowledge-tool combination across individuals and organizations. Accordingly, the question of technology is equivalent to the question of embodiment and, as we show, organization scientists labeled organizational innovations as nontechnological exactly because they failed to solve the embodiment problem. Second, using landmark court cases and the US government's patenting guidelines, we show that the USPTO grants patents to organizational innovations following the logic of embodiment. Thus, patent allowance bestows on the organizational practice the status of technology from the standpoints of both scholars and practitioners.

The 25,864 patents granted to 59,722 OrgTech applications submitted between January 2001 and April 2020 implies a 43.3% patenting rate. Using survival analysis, we show how this rate varies with the degree to which an OrgTech patent application emphasizes the practical tool rather than the abstract idea behind it. Three alternative operationalizations of this emphasis give consistent results: The probability of patent allowance is higher if the innovative idea itself includes its implementation tool, if the invention is classified as digital rather than administrative, and if the application lists fewer, if any, names of organizational innovations. In other words, our survival model captures the problem of embodiment as central to patentability, and patent allowance is a strong indicator that the patented innovative organizational practice is a technology by the definition of organization science.

Positioning the embodiment problem as a "gatekeeper" on the transformation path from an organizational innovation to an innovative technology informs the century-long debate between technocentric and human-centric views of organizational practices that we engaged with throughout the paper. By offering new solutions to the embodiment problem, the ongoing digital transformation upholds the technocentric view albeit partially. While about 83% of the major organizational innovations since 1900 find their way into patent applications, only about 43% of those applications

get patented which, as we show, means that they are the ones that solved the embodiment problem and thus are technologies.

More than a half of the OrgTech applications do not receive patent allowance and thereby uphold the alternative human-centric view: Organizational knowledge always remains to some degree tacit, as well as person- and context-specific. Tools augment humans but do not replace them, and this is another reason why the distinction between organizational innovations that are technologies and those that are not is a question of degree rather than kind. The overarching contribution of the paper is in showing that this degree can be estimated and interpreted using patent data.

Moreover, our effort to conceptualize and measure organizational technologies using patent data points to an alternative path to reconciling the treatment of organizational and management innovations as nontechnological in the innovation literature (Chandler 1977; Damanpour 2014, 2020) with the long-standing claims that organization and management are technologies (Taylor 1911, Fayol 1949[1919], Weber 1978[1922]; Hamel 2007; Puranam 2018). For this, we need the concept of generic organizational technology as organizational knowledge that remains recognizable as such while evolving through the embodiment in a variety of persons, contexts, and tools over its lifetime (Lipsey, Carlow, and Beker 2005). This concept does not cover a one-time change in one organization but does allow for a system of novel organizational ideas to evolve into a technology as it diffuses across organizations and countries and gets embodied in a variety of persons and tools. And if it continues like this for long periods of time and impacts other technologies, it becomes a general-purpose technology (GPT). Lipsey, Carlow, and Beker (2005) identified as such the factory system, mass production, and lean production. We conjecture that networked organization, project management, and agile are GPTs as well. The empirical strategy of this paper offers a test whether an organizational innovation is a generic technology and GPT, which we sketch below as the first item of an OrgTech Research Program.

THE ORGTECH RESEARCH PROGRAM

As a unit of analysis of embodied organizational technologies in this paper, a patent application typically covers one or just a few organizational practices. By contrast, a study of generic organizational technologies, which we propose as the next step, would require that the unit of analysis be an organizational innovation. We propose using the prior art citations among the patent applications in the OrgTech sample to map a network of ideas among the 95 organizational innovations in the OrgInn sample covered by the patents. For example, it is a well-documented fact that scientific management inspired lean production which in turn led to agile. Will we see these interdependencies in the data and, if so, how do we determine which innovative ideas constitute the same generic technology, and which ones among them are general-purpose technologies? These are novel, important, and interesting questions that should allow us to reconcile the inconsistencies between studies of organizational innovations and studies of organizational technologies, as well as to develop a comprehensive theoretical treatment of this subject for the era of digital transformation.

The arguments and data explored in the paper open venues for research on organizational technologies as another domain of high tech. The vast literature on technology innovation and technology strategy have been using patent data to map knowledge flows in other technological domains: nanotech (Kaplan and Vakili 2015), biotech (Gittelman and Kogut 2003), and so on. Typical research questions in this literature deal with the characteristics of influential innovations and innovators, as measured by their positions in citation networks, and the impact of R&D on firm performance (Hausman, Hall, and Griliches 1984; Hall, Jaffe, and Trajtenberg 2005; Jaffe and de Rassenfosse 2019).

Since large commercial players are prominent patent assignees in our data, researchers can explore the impact of R&D in organization and management on such players' performance: Do companies like IBM, SAP, Oracle, or even Amazon and Facebook monetize their OrgTech? Do they develop OrgTech innovations in-house or by acquiring smaller companies or the inventions of individuals? Chan et. al. (2018) show the value of Business Method inventions in general for manufacturers. However, OrgTech is a minority within the subclass of Business Method patents,

where FinTech and marketing patents dominate. A study focused on OrgTech patents would not only stand on its own but would give new impetus to research on the economic value of high-performance HR practices (for a review, see Boxall and Macky 2009) which inventions are covered by OrgTech.

In addition to replicating major studies of technological innovations and their consequences in the OrgTech domain, we propose to go much further in understanding OrgTech as an emergent phenomenon. So far, our evidence suggests that organizational innovations, defined in terms of novel knowledge, are less likely to become patented technologies than routine operations automated by new digital tools. What about academic knowledge specifically? A patent application cites the published sources of its innovative ideas which researchers could identify and code as academic versus practitioner publications as well as by academic disciplines. Drawing the distinction between organization science and computer science is particularly interesting since the two have been in an ongoing conversation that gave rise to the open systems view of organizations (Scott and Davis 2015: 87).

To better delineate the blurred boundary between innovative and routine knowledge behind organizational patent applications, we propose to implement a similar data construction process but in the opposite direction: from patent applications to organizational innovations. To start, we would compile a dataset of all the patent applications which classification indicates an organizational practice. From thousands of such applications, we would draw a few hundred and verify manually whether indeed they solve at least one of the six fundamental organizational problems. Those that do would become our seeds for the same Google patent landscaping algorithm used in the paper. Its output will constitute patent applications for organizational routines (OrgRoutines), and its overlap with the OrgTech should be the blurred boundary between the two. The term boundary implies that this overlap should be small relative to the size of its constituent datasets. The non-overlapping parts would be quite distinct *cores* of OrgTech and OrgRoutines. Following the logic of this paper, we expect the latter to focus entirely on digital tools and thus have a higher rate of patenting than the former. A deeper analysis of the combined OrgTech&OrgRoutines dataset using network and natural

language processing methods could yield novel insights into the coevolution of organizational knowledge and tools along the innovation - routine continuum.

ORGTECH IN PRACTICE

Critics of the paper's equating organizational technologies with technologies in other domains might point to a major distinction: While natural scientists generate knowledge about nature's "tools" that then get embodied in human tools, organization and management scientists generate knowledge about human organization as tools. They do not invent new organizational tools but study how organizations and managers innovate themselves (e.g., Birkinshaw, Hamel, and Mol 2008; Kimberly 1982; Puranam, Alexy, and Reitzig 2014) and advise them to do more of it (Hamel 2006; Kimberly 1982).

However, big data or "digital exhaust" (Neef 2014) generated by organizations as a byproduct of their everyday operations together with all but unlimited computer power open new opportunities for cost-effective prototyping and experimentation with new organizational tools. This is a different facet of the same digital transformation that turns organizational innovations into technologies. Our findings are another encouragement for organization scholars to "stop studying innovations in organizing and start creating them" (Puranam 2017).

One obstacle to turning ideas from organization science into practical tools is the concern on the part of organizations and society at large about data privacy and confidentiality (Lazer et al. 2020). Organizations feel safer bringing freshly minted PhDs and mature researchers in-house in order to embark on data-driven innovative organization and management (Bock 2015). People analytics is the organizational innovation from our OrgInn population that covers these developments and, in fact, blurs the boundary between academia and industry. The emergence of the patentable OrgTech, documented in this paper, could protect the interests of researchers and practitioners and create additional incentives for innovative partnerships between the two.

Such partnerships would be well-equipped to realize the emerging prospect of a foolproof robot-manager or even robot-leader. Various prototypes of such robots are being tested in hiring (Balck and van Esch 2020), talent development (Tambe, Cappelli, and Yakubovich 2019), design and

innovation (Timoshenko and Hauser 2019). Organization theorists speculate on the prospect of "teams of robots or mixed teams of humans and robots designed to accomplish particular goals" (Puranam 2018: 9). Aware of human managers' mental biases and self-centeredness that result in bad decisions and toxic behaviors, the public wonders whether even imperfect robots could do better (Chamorro-Premuzic 2016). Whatever the merits of robot-managers, our paper points to one major challenge facing them: They have to be able to learn the whole universe of organizational tools but apply them in a context-sensitive manner, taking into account the entirety of feedback loops received from human and non-human colleagues and the larger environment. While still a science-fiction scenario, this would be the most comprehensive way to solve the embodiment problem and thus close the loop on our inquiry in this paper.

LIMITATIONS AND ROBUSTNESS CHECKS

The emerging nature of OrgTech imposes some limitations on our study, the first of which having to do with the representation of organizational innovations in patent data. One of the main functions of patent protection is to incentivize organizations to disclose their innovations. However, many organizations change their organizational practices purely for internal purposes without any intention of sharing them with others, in particular, if they have to pay six figures in legal fees for patenting. They are better off protecting their innovations as trade secrets subject to non-disclosure agreements, even more so today when organizational and management innovations are increasingly viewed as the main source of sustainable competitive advantage (Damanpour 2014, 2020; Tschang and Mezquita 2020).

While it is possible that there exist undisclosed tools that embody the same innovations, it is quite unlikely that something totally novel is being invented. The broad overall coverage of organizational innovations in the OrgTech dataset, together with the extensive OrgTech portfolios of IBM, Microsoft, SAP, Google and other leaders of digital transformation that innovate for profit, ensure that the paper adequately represents the scope of organizational innovations. This said, the same factor might lead to an overestimation of the chances of patent allowance in our data;

unobserved in-house inventors would likely find patenting organizational innovations more challenging.

Another limitation of this paper is the aforementioned blurred boundaries of the OrgTech phenomenon which implies persistent errors of commission and omission: We cannot be sure that our OrgTech sample includes all the relevant patent applications and excludes irrelevant ones. While this is an inherent problem with any technology due to its applied interdisciplinary nature, emerging technologies currently lack a widely shared classification system that would mitigate the problem.

We addressed this limitation by replicating our results on two additional samples. The OrgInnSeeds sample is a small but random and certain representation of organizational innovations in the patent data. Our regression models tested on this sample yield the same substantive results, although the positive effect of a tool as a component of the organizational innovation loses its statistical significance due to the small sample size (see Table 1 in Appendix E). Also, the patenting rate continues to decrease in the most recent period which implies that the USPTO's new Guidelines in the aftermath of the *Alice* ruling discriminated against true organizational innovations in favor of organizational routines.

To explore this possibility further, we replicated the same analyses on the subsample of the OrgTech sample that includes only the patent applications that mention the names of the 97 organizational innovations. Table 2 in Appendix E confirms our speculation: the negative effect for the Jan 2016 – April 2020 period exists, but it is smaller than on the OrgInnSeeds sample. In fact, it represents the effect of the interaction between the USPTO Guidelines issued in the wake of *Alice* and the OrgInn Name variable, estimated on the full OrgTech sample.

The availability of secondary inventive classifications of patent applications offers an additional way to doublecheck our findings. If signaling a practical tool as an invention's main value is the only thing that matters, adding an OrgTech code as its secondary classification should not be a similar liability. The findings in Table 3 of Appendix E deliver a mixed message regarding this conjecture: On one hand, the effect of OrgTech is positive; it is better to signal OrgTech than any other Business Method as the secondary inventive classification. On the other hand, this positive gain

in the patenting chances is small in comparison with the gain from having non-BM, even as a secondary classification.

In sum, these additional findings reinforce the punchline of the paper: Innovative organizational practices are turning into technologies although solving the embodiment problem is a challenge for them. The robustness checks instill confidence that this conclusion is robust to OrgTech identification errors. At the same time, a more precise demarcation of the OrgTech domain in patent data is an item on our research program.

CONCLUSION

This paper offers the first systematic conceptual, theoretical, and empirical treatment of organizational practices as technologies. While patent data are the standard source of information on the flows of scientific knowledge and technological innovations, organizational scholars have never made use of them under the deep-seated assumption that organizational innovations are unpatentable. This assumption has gradually lost validity over the past thirty years of digital transformation that brought new tools for embodying organizational knowledge, the very definition of technology. Our novel data show that US patent applications cover a large majority (83%) of the 114 widely known organizational innovations since 1900. That said, up until now only 43% of relevant applications (25,864 out of 59,722) have received patents and thus formal recognition as OrgTech. This is a modest number in comparison with conventional technologies and thus an indicator that OrgTech is an emerging phenomenon. The probability of patent allowance depends first and foremost on the practicality of the proposed tool rather than the novelty of the underlying organizational knowledge. Ours is the first empirical illustration of the embodiment problem that truly innovative ideas about organizing have to overcome in order to become recognized as technologies. The concepts, arguments, and data developed in the paper open a pathway for a comprehensive treatment of the relationship between organizational innovations and technologies for the era of digital transformation.

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TABLES

Table 1. Descriptive Statistics for the OrgInn Population of Organizational Innovations
Sample Size = 114 innovations

	Categorical Variables	**N**	**%**	1	2	3	4	5	6	7	8	9	10	11	12	13	14
	Area																
1	Process	24	21														
2	People	33	29	-0.33*													
3	Structure	24	21	-0.27*	-0.33*												
4	Strategy	29	25	-0.30*	-0.37*	-0.30*											
5	Information	4	4	-0.10	-0.12	-0.10	-0.11										
6	Tool	18	16	0.07	0.04	-0.16	-0.14	0.44*									
	Organizational Problem Solved																
7	Task Division	63	55	0.20*	-0.24*	0.25*	-0.12	-0.12	0.00								
8	Task Allocation	63	55	0.20*	-0.20*	0.25*	-0.16	-0.12	0.00	0.96*							
9	Resource Allocation	63	55	0.08	-0.44*	0.20*	0.12	0.17	-0.05	0.57*	0.57*						
10	Information Allocation	97	85	-0.09	-0.38*	0.22*	0.24*	0.08	-0.02	0.17	0.17	0.17					
11	Motivation	62	54	-0.35*	0.43*	-0.05	-0.03	-0.11	-0.04	0.03	0.03	-0.19*	-0.09				
12	Exception Management	24	21	0.31*	-0.09	-0.11	-0.10	0.02	0.07	0.08	0.03	-0.10	0.10	-0.22*			
	Presence in the US Patents Database																
13	All Patents: T&A[1]	76	67	0.18	0.00	-0.23*	-0.01	0.13	-0.05	0.04	0.04	0.00	-0.03	-0.01	0.09		
14	OrgInnSeeds: T&A	58	51	0.16	0.01	-0.14	-0.11	0.19*	-0.01	-0.04	-0.04	-0.11	-0.17	0.02	0.16	0.72*	
15	OrgTech: Texts	97	85	0.03	0.05	-0.15	0.02	0.08	-0.16	0.02	0.02	-0.03	0.03	0.06	0.10	0.54*	0.43*

	Continuous Variable	**Mean**	**SD**	**Min**	**Max**														
16	N of Problems Solved	3.26	1.54	1	6	0.11	-0.26*	0.23*	-0.03	-0.03	-0.01	0.89*	0.88*	0.65*	0.39*	0.20*	0.22*	0.04	-0.05	0.06

[1]T&A - Title and Abstract
*$p < 0.05$ significance level

Table 2. Measures of Accuracy of the Neural Network Models Trained for Patent Landscaping*

	Model1	**Model2**	**Model3**	**Model4**
	$Dropout_{cpc\ codes}$= 20% $Dropout_{citations}$= 20% $Dropout_{text}$= 20%	$Dropout_{cpc\ codes}$= 90% $Dropout_{citations}$= 20% $Dropout_{text}$= 20%	$Dropout_{cpc\ codes}$= 20% $Dropout_{citations}$= 90% $Dropout_{text}$= 20%	$Dropout_{cpc\ codes}$= 90% $Dropout_{citations}$= 90% $Dropout_{text}$= 20%
Recall	0.934	0.922	0.911	0.862
Precision	0.859	0.856	0.875	0.884
F1	0.895	0.888	0.892	0.873

*See page 20 for more information about the construction of the neural network models.

Table 3. The Coverage of Organizational Innovations in the OrgInnSeeds and OrgTech Samples*

Sample	**OrgInnSeeds**				**OrgTech**			
	Title & Abstract		**Full Text**		**Title & Abstract**		**Full Text**	
	N	**%**	**N**	**%**	**N**	**%**	**N**	**%**
OrgInn (114 total)	58	50.9	64	56.1	63	55.3	97	85.1
OrgInn Tool (18 total)	9	7.9	10	8.8	9	7.9	13	11.4

*The coverage refers to the number and percentage of organization innovations identified in patents' texts and abstracts or full texts.

Table 4. The Distribution of CPC Primary Classifications in the OrgTech Sample

Sample Size = 67,240 patent applications

Class Code	Class Definition	1970-2001 N Patents	%	N Unpatented Applications	%	2001-2020 N Patents	%	Total	%
OrgTech Total		**856**	**69**	**19,948**	**58**	**14,532**	**46**	**34,480**	**52**
G06Q10/00	Administration; Management	9	1	2,086	6	1,517	5	3,603	5
G06Q10/06	Resources, workflows, human or project management	452	37	5,058	15	4,424	14	9,482	14
G06Q10/0631	Resource planning, allocation or scheduling for a business operation	2	0	363	1	200	1	563	1
G06Q10/06313	Resource planning in a project environment	0	0	428	1	147	0	575	1
G06Q10/10	Office automation	350	28	6,697	19	5,152	16	11,849	18
Non-OrgTech BM Total		**133**	**11**	**5,848**	**17**	**4,475**	**14**	**10,323**	**16**
G06Q30/02	Marketing	14	1	809	2	605	2	1,414	2
G06Q40/00	Finance; Insurance; Tax strategies; Processing of taxes	3	0	153	0	187	1	340	1
G06Q40/04	Exchange	7	1	203	1	219	1	422	1
G06Q40/06	Investment	9	1	672	2	406	1	1,078	2
G06Q40/08	Insurance	6	0	347	1	333	1	680	1
Non-BM Total		**249**	**20**	**8,650**	**25**	**12,549**	**40**	**21,199**	**32**
G06F	Electric digital data processing	113	9	3,685	11	5,499	17	9,184	14
H04L	Transmission of digital information	24	2	1,539	4	2,602	8	4,141	6
G16H	Healthcare informatics	2	0	493	1	288	1	781	1
G06N	Computer systems based on specific computational models	8	1	431	1	396	1	827	1
H04W	Wireless communication networks	0	0	150	0	257	1	407	1
Total		**1,238**	**100**	**34,446**	**100**	**31,556**	**100**	**66,002**	**100**

Table 5. Assignees of OrgTech Patent Applications
Sample Size = 67,240 patent applications

Assignee Name / Type	Unpatented Appl.		Patents		Total	
	N	%	N	%	N	%
IBM	1,703	4.9	2,596	7.9	4,299	6.4
Microsoft	1,002	2.9	963	2.9	1,965	2.9
SAP	282	0.8	612	1.9	894	1.3
Google Inc	166	0.5	413	1.3	579	0.9
Oracle Int Corp	202	0.6	312	1.0	514	0.8
Accenture	291	0.8	202	0.6	493	0.7
Fujitsu Ltd	264	0.8	173	0.5	437	0.6
Hitachi Ltd	150	0.4	228	0.7	378	0.6
Bank Of America	219	0.6	159	0.5	378	0.6
General Electric	206	0.6	170	0.5	376	0.6
Facebook Inc	94	0.3	256	0.8	350	0.5
Hewlett Packard Development Co	67	0.2	223	0.7	290	0.4
Xerox Corp	110	0.3	177	0.5	287	0.4
Amazon Tech Inc	37	0.1	228	0.7	265	0.4
Salesforce Com Inc	178	0.5	60	0.2	238	0.4
Samsung Electronics Co Ltd	136	0.4	96	0.3	232	0.3
Boeing Co	65	0.2	159	0.5	224	0.3
Siemens AG	109	0.3	102	0.3	211	0.3
AT&T IP I Lp	48	0.1	158	0.5	206	0.3
Fuji Xerox Co Ltd	100	0.3	83	0.3	183	0.3
Other	8,764	25.4	18,468	56.3	27,232	40.5
Large Entities Total	**14,193**	**41.2**	**25,838**	**78.8**	**40,031**	**59.5**
Small Entities	**1,994**	**5.8**	**5,278**	**16.1**	**7,272**	**10.8**
Unknown Entities	**18,259**	**53.0**	**1,678**	**5.1**	**19,937**	**29.7**
Total	**34,446**	**100**	**32,794**	**100**	**67,240**	**100**

Table 6a. Descriptive Statistics for Variables of Interest

Sample Size = 59,722 OrgTech patent applications

	Categorical Variables	**N**	**%**	1	2	3	4	5	6	7	8	9
	Application State											
1	Patented	25,864	43.3									
2	Abandoned	26,111	43.7	-0.77*								
3	Pending	7,747	13.0	-0.34*	-0.34*							
	Primary Classification											
4	OrgTech	31,244	52.3	-0.13*	0.21*	-0.12*						
5	Non-OrgTech BM	9,296	15.6	-0.04*	0.03*	0.02*	-0.45*					
6	Non-BM	19,182	32.1	0.18*	-0.25*	0.11*	-0.72*	-0.30*				
7	OrgInn Name	13,194	22.1	-0.03*	0.04*	-0.01*	0.08*	-0.01*	-0.08*			
8	OrgInn Tool	4,820	8.1	0.00	0.00	-0.01	0.05*	-0.03*	-0.03*	0.56*		

	Continuous Variables	**Mean**	**SD**	**Min**	**Max**								
9	N of OrgInn Occurrences	1.95	12.09	0	638	-0.02*	0.02*	-0.01	0.02*	0.01*	-0.03*	0.30*	0.14*	
10	Ln(1+ N of OrgInn Occurrences)	0.33	0.78	0	6.46	-0.04*	0.05*	-0.02*	0.08*	-0.01	-0.08*	0.80*	0.66*	0.44*

*$p < 0.05$ significance level

Table 6b. Descriptive Statistics for Variables of Interest by Time Period
Sample Size = 59,722 OrgTech patent applications

	Jan. 2001 – Dec. 2012 (34,458 Total)		Jan. 2013 – June 2014 (19,765 Total)		June 2014 – Dec. 2015 (19,158 Total)		Jan. 2016 – Apr. 2020 (25,656 Total)	
Categorical Variables	**N**	**%**	**N**	**%**	**N**	**%**	**N**	**%**
Application State								
Patented	16,014	46	9,235	47	7,949	41	8,985	35
Abandoned	18,151	53	10,027	50	10,271	54	8,924	35
Pending	293	1	503	3	938	5	7,747	30
Primary Classification								0
OrgTech	22,420	65	11,021	56	9,326	49	9,835	38
Non-OrgTech BM	5,424	16	3,137	16	2,910	15	3,977	16
Non-BM	6,614	19	5,607	28	6,922	36	11,844	46
OrgInn Name	8,103	24	4,421	22	4,160	22	5,280	21
OrgInn Tool	3,055	9	1,582	8	1,501	8	1,861	7
Continuous Variables	**Mean**	**SD**	**Mean**	**SD**	**Mean**	**SD**	**Mean**	**SD**
N of OrgInn Occurrences	2.09	12.26	1.91	12.69	1.86	12.34	1.68	10.74
Ln(1+ N of OrgInn Occurrences)	0.36	0.81	0.33	0.77	0.32	0.76	0.30	0.73

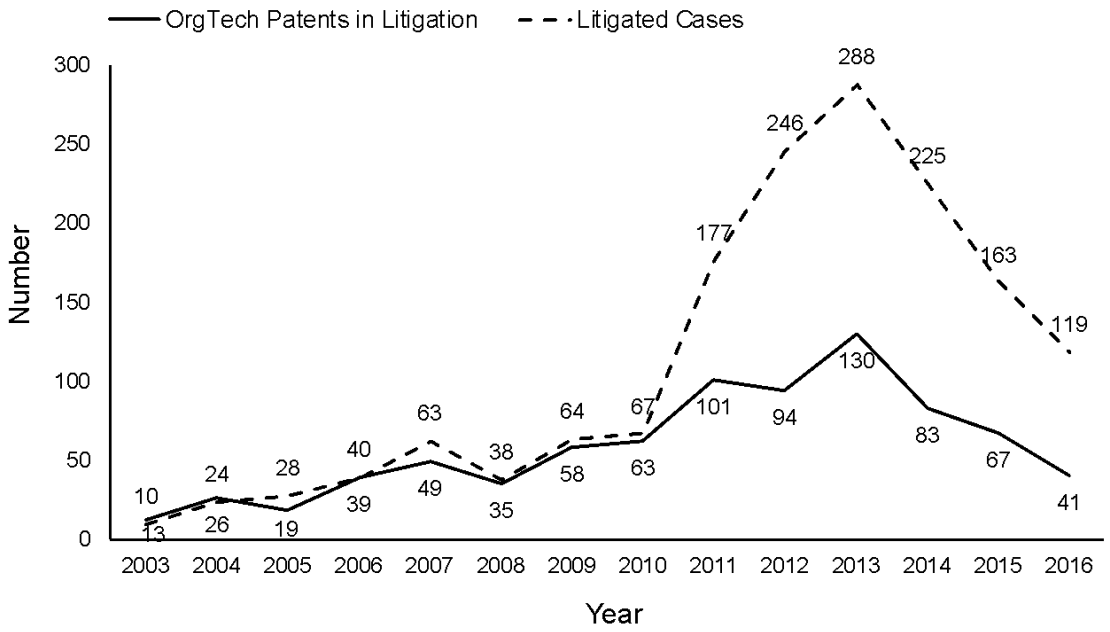
Table 7. Cox Regression for the Likelihood of Patent Allowance
Sample Size = 59,722 OrgTech patent applications

	Model 1		Model 2		Model 3		Model 4	
Variables	**Coef**	**SE**	**Coef**	**SE**	**Coef**	**SE**	**Coef**	**SE**
Period								
Jan. 2001-Dec. 2012	-0.651***	0.019	-0.648***	0.019	-0.578***	0.019	-0.575***	0.019
Jan. 2013-June 2014[1] (Ref.)								
June 2014-Dec. 2015	-0.151***	0.024	-0.151***	0.024	-0.184***	0.024	-0.185***	0.024
Jan. 2016-Apr. 2020	0.101***	0.019	0.099***	0.019	-0.005	0.019	-0.005	0.019
OrgInn Name			-0.158***	0.029			-0.130***	0.028
OrgInn Tool			0.117***	0.028			0.104***	0.028
Ln(1+N of OrgInn Occurrences)			-0.034*	0.014			-0.020	0.014
Primary Classification								
OrgTech					-0.095***	0.019	-0.092***	0.019
Non-OrgTech BM (Ref.)								
Non-BM					0.599***	0.019	0.594***	0.020
Equality Constraint Test	**F**		**F**		**F**		**F**	
June 2014-Dec. 2015=Jan. 2013-June 2014	602.11***		591.70***		368.31***		362.95***	
June 2014-Dec. 2015=Jan. 2016-Apr. 2020	153.07***		151.59***		78.59***		78.43***	
Non-BM = OrgTech					2473.80***		2405.10***	
Likelihood Ratio (df)	2,926 (3)***		3,066 (6)***		5,436 (5)***		5,513 (8)***	

[1]The *Alice* case on patent eligibility was decided in June 2014; the 18 months prior to the decision is the reference period. For more information, see page 27.
***p < 0. 001, **p <0.01, *p < 0.05

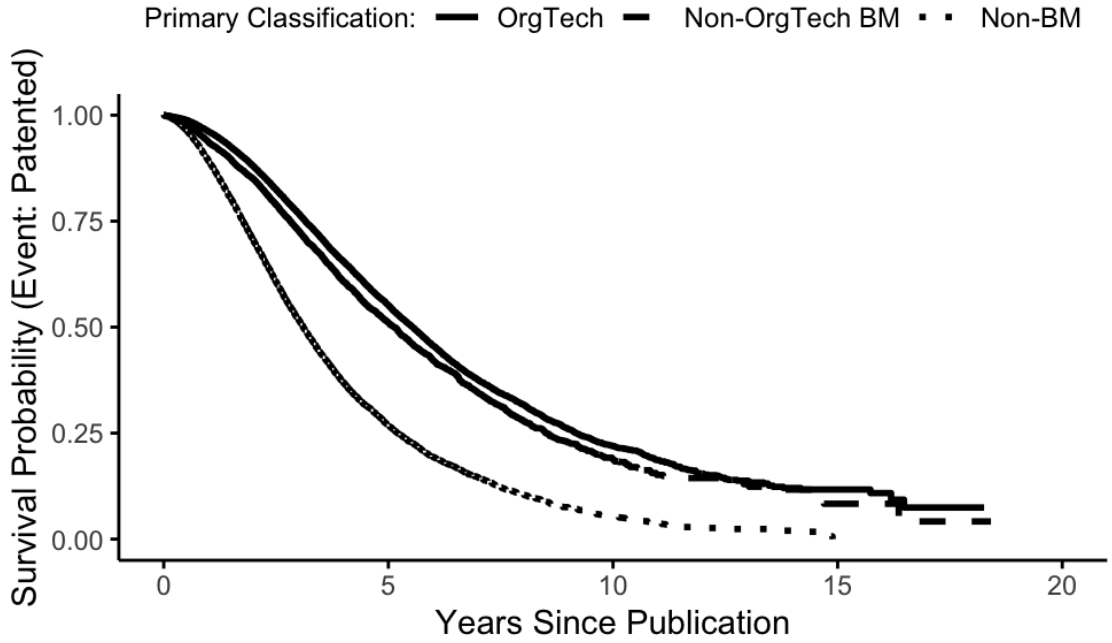
FIGURES

Figure 1: The Litigation of Patents in the OrgTech Sample*



*The patent litigation data is only available from 2003 to 2016; the total number of court cases during this period is 1,550 and the total number of patents involved is 484.

Figure 2. The Kaplan-Meier Curve for the Subset of OrgTech Sample
Sample Size = 59,722 patent applications included in survival analysis



APPENDICES

Appendix A. The Population of Organizational Innovations

Area	OrgInn Name	Tool	Problem Solved[1]					
			TD	TA	RA	IA	M	EM
Process	Scientific Management	0	1	1	1	1	1	0
	Moving Assembly Line	1	1	1	1	0	0	0
	Lean	1	1	1	1	1	0	1
	Kanban	1	1	1	0	1	0	1
	Just-In-Time	0	1	1	1	1	0	1
	Total Quality Management	0	1	1	0	1	0	1
	Zero Defect	0	0	0	0	1	0	1
	Quality Circle	0	0	0	0	1	0	1
	Cross-Functional Team	0	1	1	0	1	1	0
	ISO	1	0	0	0	1	0	0
	Continual Improvement Process	0	1	1	1	1	0	1
	Kaizen	0	1	1	1	1	1	1
	Cellular Manufacturing	0	1	1	1	0	0	0
	Flexible Production System	0	1	1	1	0	0	0
	Modularization	0	1	1	1	0	0	0
	Concurrent Engineering	0	1	1	1	1	0	0
	Business Process Re-Engineering	0	1	1	1	1	0	0
	Six Sigma	0	1	1	1	1	0	1
	DMAIC	0	0	0	0	1	0	1
	Cradle-To-Cradle	0	1	1	0	1	0	0
	Rendanheyi	1	1	1	1	1	1	1
	Industrial Symbiosis	0	1	1	1	1	0	0
	Parallel Play	0	0	0	1	1	0	0
	Empowered Factory Team	0	0	0	0	0	1	0
People	Open Book Management	0	0	0	0	1	1	0
	Corporate Welfarism	0	0	0	0	0	1	0
	Pension	0	0	0	0	0	1	0
	Healthcare Programme	0	0	0	0	0	1	0
	Company Housing	0	0	0	0	0	1	0
	Employee Benefit	0	0	0	0	0	1	0
	Professional Manager	0	1	1	1	1	0	0
	Business Education	0	0	0	0	1	1	0
	Performance-Related Pay	0	0	0	0	0	1	0
	Scanlon Plan	1	0	0	0	0	1	0
	Assessment Center	0	0	1	0	1	0	0
	T-Groups	0	0	0	0	1	1	0
	Socio-Technical System	0	1	1	0	1	1	0
	Stratified System	0	1	1	0	1	1	0
	Quality Of Work Life	0	0	0	0	1	1	0
	Mentoring	0	0	0	0	1	1	1
	Executive Coaching	0	0	0	0	1	1	1
	Leadership Development	0	0	0	0	1	1	1
	360-Degree Feedback	0	0	0	0	1	1	0
	Survey Of Management Practice	1	0	0	0	1	1	0
	Flexible Employment	0	1	1	1	1	1	0

	Participative Management	0	0	0	0	1	1	0
	Self-Managed Teams	0	1	1	1	1	1	0
	Colleague Letters of Understanding	1	1	1	0	1	1	0
	Lead Link	1	1	1	0	1	1	0
	People Points	1	1	1	0	1	1	0
	Collective Management	0	1	1	1	1	1	0
	Talent On Demand Model	0	1	1	1	0	0	1
	Recruitment Process Outsourcing	0	1	1	1	0	0	1
	People Analytics	0	1	1	1	1	1	0
	Gainsharing	0	0	0	0	0	1	0
	Profit Sharing	0	0	0	0	0	1	0
	Employee Stock Ownership	1	0	0	0	0	1	0
Structure	Divisional Structure	0	1	1	1	1	0	0
	Strategic Business Units	0	1	1	1	1	0	0
	Matrix Organization	0	1	1	1	1	0	1
	Global Matrix Structures	0	1	1	1	1	0	0
	Global Account Structures	0	1	1	1	1	0	0
	Workout Group	0	0	0	0	1	0	1
	Town Meeting	0	0	0	0	1	0	0
	Transnational Model	0	0	0	0	1	0	0
	Spaghetti Organization	0	1	1	1	1	0	0
	Communities Of Practice	0	0	0	0	1	1	0
	Tech Club	0	0	0	0	1	1	0
	Open Source Software Communities	0	1	1	1	1	0	0
	Cellular Organization	0	1	1	1	1	0	0
	Business Model Innovation	0	1	1	1	1	1	0
	Business Ecosystem	0	1	1	1	1	0	0
	Holacracy	1	1	1	1	1	1	0
	Podularity	0	1	1	0	1	1	0
	Adhocracy	0	1	1	1	1	1	0
	Networked Organization	0	1	1	1	1	1	0
	Co-Opetition	0	1	1	1	1	1	0
	Hackathon	0	1	1	1	1	1	0
	Agile	0	1	1	1	1	1	0
	Scrum Methodology	0	1	1	1	1	1	1
	Teal Organization	0	1	1	1	1	1	0
Strategy	Blue Ocean Strategy	0	0	0	1	1	0	0
	Pioneer-Migrator-Settler Map	1	0	0	1	1	0	0
	Knowledge Management	0	0	0	0	1	1	0
	Research Laboratory	0	1	1	1	1	1	0
	Skunk Work	0	1	1	1	1	1	0
	Stagegate Model	0	1	1	1	1	1	0
	Tiger Team	0	1	1	1	1	1	0
	Corporate Venturing	0	0	0	1	1	0	0
	Center Of Excellence	0	0	0	1	1	1	0
	Open Innovation	0	1	1	1	1	1	0
	Connect And Develop Model	0	1	1	1	1	1	0
	Open Source Development	0	1	1	1	1	1	0

	Management By Objectives	0	0	0	0	1	0	0
	Objectives And Key Results System	0	0	0	0	1	0	0
	Strategy Workshop	0	0	0	0	1	0	0
	Scenario Planning	0	0	0	0	1	0	0
	Project Evaluation And Review Technique	1	1	1	0	1	0	1
	Social Innovation	0	1	1	1	1	1	0
	Stretch Goal	0	0	0	0	1	1	0
	Frugal Innovation	0	0	0	1	1	0	0
	Sharing Economy	0	0	0	1	1	0	0
	Cultural Innovation	0	0	0	1	1	0	0
	Discovery-Driven Planning	0	0	0	1	1	0	0
	Design Thinking	0	0	0	0	1	0	1
	Brainstorming	0	0	0	0	1	1	1
	TRIZ	0	1	0	0	1	0	1
	Project Management	0	1	1	1	1	1	0
	Project Team	0	1	1	1	1	1	0
	Evidence-Based Management	0	1	1	1	1	1	0
Information	Materials Requirement Planning	1	0	0	1	1	0	0
	Manufacturing Resource Planning	1	0	0	1	1	0	0
	Expert System	1	1	1	1	1	1	1
	Enterprise Resource Planning	1	0	0	1	1	0	0

[1]"TD", "TA", "RA", "IA", "M", and "EM" denote the fundamental organizational problem of task division, task allocation, resource allocation, information allocation, motivation, and exception management respectively.

Appendix B. The Composition of the OrgInnSeeds Sample

OrgInn Name	N Patent Applications	Sample Size	N Seeds
Cellular Organization	2,356	118	1
Moving Assembly Line	1,364	68	4
Expert System	1,197	60	23
Modularization	1,007	50	1
Project Management	780	39	36
Just-In-Time	736	37	4
Matrix Organization	660	33	1
Executive Coaching	587	29	9
Open Innovation	466	23	16
Knowledge Management	367	18	19
Enterprise Resource Planning	340	17	11
Employee Benefit	219	11	10
Cellular Manufacturing	179	10	1
Pension	112	10	7
Project Team	78	10	11
Mentoring	68	10	6
Profit Sharing	52	10	6
Research Laboratory	52	10	0
Networked Organization	48	10	0
Business Process Re-Engineering	41	10	10
Scenario Planning	40	10	5
Six Sigma	37	10	15
Flexible Employment	35	10	0
Brainstorming	28	10	7
Kanban	27	10	5
Performance-Related Pay	29	10	2
Communities Of Practice	24	10	11
Lean	21	10	7
Healthcare Programme	22	10	3
Concurrent Engineering	22	10	6
Assessment Center	21	10	10
Collective Management	17	10	0
Agile	14	10	7
Gainsharing	13	10	2
Manufacturing Resource Planning	11	10	10
Sharing Economy	10	10	0
Employee Stock Ownership	8	8	3
Total Quality Management	8	8	6
Leadership Development	7	7	7
Materials Requirement Planning	7	7	4
T-Group	8	8	1
Divisional Structure	6	6	0
ISO	6	6	2
Zero Defect	8	8	0
Business Ecosystem	5	5	5

Flexible Production System	5	5	1
Kaizen	5	5	4
Lead Link	5	5	0
Stratified System	5	5	0
Socio-Technical System	4	4	4
360-Degree Feedback	3	3	3
Business Education	3	3	2
Continual Improvement Process	3	3	3
Cradle-To-Cradle	3	3	0
Scientific Management	3	3	0
Center Of Excellence	2	2	0
Cross-Functional Team	2	2	2
Frugal Innovation	2	2	0
Management By Objectives	2	2	2
Parallel Play	2	2	0
Professional Manager	2	2	0
Self-Managed Teams	3	3	2
TRIZ	2	2	2
Adhocracy	1	1	1
Business Model Innovation	1	1	1
Co-Opetition	1	1	1
Corporate Venturing	1	1	0
Corporate Welfarism	1	1	1
Design Thinking	1	1	1
DMAIC	1	1	1
Evidence-Based Management	1	1	1
Open Source Development	1	1	0
Project Evaluation And Review Technique	1	1	0
Social Innovation	2	2	1
Strategic Business Units	1	1	1
Stretch Goal	1	1	1
Blue Ocean Strategy	0	0	0
Colleague Letters Of Understanding	0	0	0
Company Housing	0	0	0
Connect And Develop	0	0	0
Cultural Innovation	0	0	0
Discovery-Driven Planning	0	0	0
Empowered Factory Team	0	0	0
Global Account Structure	0	0	0
Global Matrix Structure	0	0	0
Hackathon	0	0	0
Holacracy	0	0	0
Industrial Symbiosis	0	0	0
Objectives And Key Results System	0	0	0
Open Book Management	0	0	0
Open Source Software Communities	0	0	0
Participative Management	0	0	0
People Analytics	0	0	0

People Points	0	0	0
Pioneer-Migrator-Settler Map	0	0	0
Podularity	0	0	0
Quality Circle	0	0	0
Quality Of Work Life	0	0	0
Recruitment Process Outsourcing	0	0	0
Rendanheyi	0	0	0
Scanlon Plan	0	0	0
Scrum Methodology	0	0	0
Skunk Work	0	0	0
Spaghetti Organization	0	0	0
Stagegate Model	0	0	0
Strategy Workshop	0	0	0
Survey Of Management Practice	0	0	0
Talent On Demand Model	0	0	0
Teal Organization	0	0	0
Tech Club	0	0	0
Tiger Team	0	0	0
Town Meeting	0	0	0
Transnational Model	0	0	0
Workout Group	0	0	0
Total with duplicates	**11,213**	**877**	**329**
Total without duplicates	**11,126**	**814**	**300**

Appendix C. The Names of Organizational Innovations in the OrgInnSeeds and OrgTech Samples

	Innnovation Name	OrgInnSeeds				OrgTech			
		Title & Abstract		Full Text		Title & Abstract		Full Text	
		N	%	N	%	N	%	N	%
1	Project Management	36	12.0	68	22.7	597	0.9	3,466	5.2
2	Expert System	23	7.7	33	11.0	133	0.2	1,649	2.5
3	Knowledge Management	19	6.3	30	10.0	149	0.2	1,200	1.8
4	Open Innovation	16	5.3	20	6.7	106	0.2	499	0.7
5	Six Sigma	15	5.0	19	6.3	25	0.0	386	0.6
6	Project Team	11	3.7	37	12.3	61	0.1	1,168	1.7
7	Enterprise Resource Planning	11	3.7	22	7.3	180	0.3	2,891	4.3
8	Communities Of Practice	11	3.7	12	4.0	19	0.0	94	0.1
9	Employee Benefit	10	3.3	20	6.7	108	0.2	731	1.1
10	Business Process Re-Engineering	10	3.3	12	4.0	39	0.1	305	0.5
11	Manufacturing Resource Planning	10	3.3	11	3.7	11	0.0	159	0.2
12	Assessment Center	10	3.3	10	3.3	17	0.0	79	0.1
13	Executive Coaching	9	3.0	28	9.3	85	0.1	967	1.4
14	Brainstorming	7	2.3	18	6.0	16	0.0	423	0.6
15	Pension	7	2.3	16	5.3	47	0.1	791	1.2
16	Lean	7	2.3	15	5.0	10	0.0	104	0.2
17	Agile	7	2.3	8	2.7	8	0.0	55	0.1
18	Leadership Development	7	2.3	8	2.7	7	0.0	46	0.1
19	Mentoring	6	2.0	12	4.0	18	0.0	409	0.6
20	Profit Sharing	6	2.0	11	3.7	22	0.0	245	0.4
21	Concurrent Engineering	6	2.0	7	2.3	10	0.0	67	0.1
22	Total Quality Management	6	2.0	6	2.0	6	0.0	76	0.1
23	Kanban	5	1.7	10	3.3	12	0.0	117	0.2
24	Scenario Planning	5	1.7	9	3.0	18	0.0	368	0.5
25	Business Ecosystem	5	1.7	6	2.0	5	0.0	52	0.1
26	Just-In-Time	4	1.3	15	5.0	39	0.1	1,053	1.6
27	Moving Assembly Line	4	1.3	10	3.3	37	0.1	784	1.2
28	Materials Requirement Planning	4	1.3	7	2.3	4	0.0	175	0.3
29	Kaizen	4	1.3	7	2.3	4	0.0	38	0.1
30	Socio-Technical System	4	1.3	5	1.7	4	0.0	12	0.0
31	Continual Improvement Process	3	1.0	4	1.3	3	0.0	74	0.1
32	360-Degree Feedback	3	1.0	4	1.3	3	0.0	43	0.1
33	Employee Stock Ownership	3	1.0	4	1.3	3	0.0	35	0.1
34	Healthcare Program	3	1.0	3	1.0	10	0.0	151	0.2
35	Cross-Functional Team	2	0.7	8	2.7	2	0.0	125	0.2
36	Business Education	2	0.7	6	2.0	3	0.0	149	0.2

37	ISO	2	0.7	3	1.0	2	0.0	175	0.3
38	Management By Objectives	2	0.7	3	1.0	2	0.0	30	0.0
39	Performance-Related Pay	2	0.7	2	0.7	4	0.0	143	0.2
40	Gainsharing	2	0.7	2	0.7	6	0.0	37	0.1
41	TRIZ	2	0.7	2	0.7	2	0.0	21	0.0
42	Self-Managed Teams	2	0.7	2	0.7	3	0.0	9	0.0
43	DMAICX	1	0.3	6	2.0	1	0.0	36	0.1
44	Modularization	1	0.3	3	1.0	5	0.0	285	0.4
45	Cellular Organization	1	0.3	2	0.7	5	0.0	437	0.6
46	Matrix Organization	1	0.3	2	0.7	9	0.0	126	0.2
47	Cellular Manufacturing	1	0.3	2	0.7	7	0.0	39	0.1
48	Design Thinking	1	0.3	2	0.7	1	0.0	12	0.0
49	T-Groups	1	0.3	1	0.3	1	0.0	49	0.1
50	Strategic Business Units	1	0.3	1	0.3	1	0.0	28	0.0
51	Business Model Innovation	1	0.3	1	0.3	1	0.0	15	0.0
52	Social Innovation	1	0.3	1	0.3	2	0.0	12	0.0
53	Stretch Goal	1	0.3	1	0.3	1	0.0	11	0.0
54	Corporate Welfarism	1	0.3	1	0.3	1	0.0	9	0.0
55	Co-Opetition	1	0.3	1	0.3	1	0.0	5	0.0
56	Flexible Production System	1	0.3	1	0.3	1	0.0	4	0.0
57	Evidence-Based Management	1	0.3	1	0.3	1	0.0	1	0.0
58	Adhocracy	1	0.3	1	0.3	1	0.0	1	0.0
59	Zero Defect	0	0	3	1.0	0	0	24	0.0
60	Center Of Excellence	0	0	2	0.7	0	0	61	0.1
61	Project Evaluation And Review Technique	0	0	1	0.3	0	0	86	0.1
62	Flexible Employment	0	0	1	0.3	1	0.0	54	0.1
63	Town Meeting	0	0	1	0.3	0	0	28	0.0
64	Scrum Methodology	0	0	1	0.3	0	0	2	0.0
65	Research Laboratory	0	0	0	0	1	0.0	135	0.2
66	Networked Organization	0	0	0	0	3	0.0	45	0.1
67	Open Source Development	0	0	0	0	0	0	29	0.0
68	Collective Management	0	0	0	0	2	0.0	27	0.0
69	Corporate Venturing	0	0	0	0	0	0	26	0.0
70	Professional Manager	0	0	0	0	0	0	21	0.0
71	Sharing Economy	0	0	0	0	1	0.0	14	0.0
72	Skunk Work	0	0	0	0	0	0	10	0.0
73	Open-Source Software Communities	0	0	0	0	0	0	8	0.0
74	Quality Circle	0	0	0	0	0	0	8	0.0
75	People Points	0	0	0	0	0	0	7	0.0
76	Hackathon	0	0	0	0	0	0	6	0.0
77	Scientific Management	0	0	0	0	0	0	6	0.0
78	Divisional Structure	0	0	0	0	0	0	5	0.0
79	Cradle-To-Cradle	0	0	0	0	0	0	5	0.0

80 Tiger Team	0	0	0	0	0	0	5	0.0
81 People Analytics	0	0	0	0	0	0	4	0.0
82 Stratified System	0	0	0	0	0	0	4	0.0
83 Company Housing	0	0	0	0	0	0	3	0.0
84 Lead Link	0	0	0	0	0	0	3	0.0
85 Quality Of Work Life	0	0	0	0	0	0	3	0.0
86 Workout Group	0	0	0	0	0	0	2	0.0
87 Participative Management	0	0	0	0	0	0	2	0.0
88 Frugal Innovation	0	0	0	0	0	0	2	0.0
89 Recruitment Process Outsourcing	0	0	0	0	0	0	2	0.0
90 Cultural Innovation	0	0	0	0	0	0	1	0.0
91 Industrial Symbiosis	0	0	0	0	0	0	1	0.0
92 Tech Club	0	0	0	0	0	0	1	0.0
93 Blue Ocean Strategy	0	0	0	0	0	0	1	0.0
94 Holacracy	0	0	0	0	0	0	1	0.0
95 Open Book Management	0	0	0	0	0	0	1	0.0
96 Stagegate Model	0	0	0	0	0	0	1	0.0
97 Strategy Workshop	0	0	0	0	0	0	1	0.0

The 17 organizational innovations not identified in any section of the patent text include *parallel play, colleague letters of understanding, discovery-driven planning, connect and develop model, empowered factory team, global account structure, global matrix structure, objectives and key results system, pioneer-migrator-settler map, podularity, rendanheyi, scanlon plan, spaghetti organization, survey of management practice, talent on demand model, teal organization,* and *transnational model.*

Appendix D. The OrgTech CPC Classification Codes[1]

Class Code	Class Definition	Area	Organizational Problems Solved[2]	OrgInnSeeds		OrgTech	
				N Applications	%[3]	N Applications	%
G06Q10/00	Administration; Management	General	TD, TA, RA, IA, M, EM	9	6.6	3,603	10.4
G06Q10/06	Resources, workflows, human or project management	General	TD, TA, RA, IA, EM	41	30.1	9,482	27.5
G06Q10/063	Operations research or analysis	General	TD, TA, RA, IA, EM	1	0.7	215	0.6
G06Q10/0631	Resource planning, allocation or scheduling for a business operation	General	TD, TA, RA, IA	3	2.2	563	1.6
G06Q10/06311	Scheduling, planning or task assignment for a person or group	People	TD, TA			156	0.5
G06Q10/063112	Skill-based matching of a person or a group to a task	People	TA	2	1.5	186	0.5
G06Q10/063114	Status monitoring or status determination for a person or group	People	TA	1	0.7	212	0.6
G06Q10/063116	Schedule adjustment for a person or group	People	TA			59	0.2
G06Q10/063118	Staff planning in a project environment	People	TD, TA	2	1.5	79	0.2
G06Q10/06312	Adjustment or analysis of established resource schedule	Process	RA			95	0.3
G06Q10/06313	Resource planning in a project environment	Process	RA	3	2.2	575	1.7
G06Q10/06314	Calendaring for a resource	Process	RA			18	0.1
G06Q10/06315	Needs-based resource requirements planning or analysis	Process	RA	1	0.7	181	0.5
G06Q10/06316	Sequencing of tasks or work	Process	TD	2	1.5	185	0.5
G06Q10/0633	Workflow analysis	Process	TD, TA, RA, IA	3	2.2	292	0.8
G06Q10/0635	Risk analysis	Process	EM	1	0.7	195	0.6
G06Q10/0637	Strategic management or analysis	Strategy	TD, TA, RA, IA, M, EM	5	3.7	475	1.4
G06Q10/06375	Prediction of business process outcome or impact based on a proposed change	Strategy	IA, EM	2	1.5	112	0.3
G06Q10/0639	Performance analysis	General	IA, EM	1	0.7	106	0.3
G06Q10/06393	Scorecarding, benchmarking, or key performance indicator analysis	General	IA, EM	2	1.5	533	1.5

G06Q10/06395	Quality analysis or management	General	IA, EM	1	0.7	85	0.2
G06Q10/06398	Performance of employee with respect to a job function	People	IA, EM	5	3.7	449	1.3
G06Q10/067	Business modeling	Information	IA	1	0.7	447	1.3
G06Q10/08	Logistics	Process	RA, EM			285	0.8
G06Q10/083	Shipping	Process	RA			60	0.2
G06Q10/0831	Overseas transactions	Process	RA			5	
G06Q10/0832	Special goods or special handling procedures	Process	RA			11	
G06Q10/0833	Tracking	Process	RA, EM			51	0.1
G06Q10/0834	Choice of carriers	Process	RA			3	
G06Q10/08345	Pricing	Process	RA			6	
G06Q10/0835	Relationships between shipper or supplier and carrier	Process	RA			28	0.1
G06Q10/08355	Routing methods	Process	RA			23	0.1
G06Q10/0837	Return transactions	Process	RA			4	
G06Q10/0838	Historical data	Information	RA, EM			20	0.1
G06Q10/087	Inventory or stock management	Process	RA, EM	3	2.2	520	1.5
G06Q10/0875	Itemization of parts, supplies, or services	Process	RA			20	0.1
G06Q10/10	Office automation	Process	TD, TA, RA, IA, M, EM	30	22.1	11,849	34.4
G06Q10/101	Collaborative creation of products or services	Structure	TD, TA, RA, IA	2	1.5	437	1.3
G06Q10/103	Workflow collaboration or project management	Structure	TD, TA, RA, IA, EM	6	4.4	483	1.4
G06Q10/105	Human resources	People	TA, RA, IA, M			58	0.2
G06Q10/1053	Employment or hiring	People	TA, RA, IA	1	0.7	180	0.5
G06Q10/1057	Benefits package	People	M	3	2.2	62	0.2
G06Q10/107	Computer aided management of electronic mail	Information	IA			171	0.5
G06Q10/109	Time management	Information	TA, EM			199	0.6
G06Q10/1091	Recording time for administrative purposes	Information	EM			16	
G06Q10/1093	Calendar-based scheduling for a person or group	People	TA	2	1.5	34	0.1

G06Q10/1095	Meeting or appointment	People	TA			156	0.5
G06Q10/1097	Task assignment	People	TA			42	0.1
G06Q50/00	Systems or methods specially adapted for specific business sectors	Process	TA, RA, IA, M, EM			49	0.1
G06Q50/01	Social networking	Process	TA, RA, IA	1	0.7	474	1.4
G06Q50/04	Manufacturing	Process	TD, TA, RA, IA, EM			98	0.3
G06Q50/10	Services	Process	RA, IA, EM			55	0.2
G06Q50/18	Legal services; Handling legal documents	Process	RA, IA, EM			200	0.6
G06Q50/182	Alternative dispute resolution	Process	IA, EM			19	0.1
G06Q50/184	Intellectual property management	Process	IA, EM			199	0.6
G06Q50/186	Estate planning	Process	RA, IA, EM			15	
G06Q50/188	Electronic negotiation	Process	IA, EM			35	0.1
G06Q50/20	Education	Process	M, M			71	0.2
G06Q50/205	Education administration or guidance	Process	M			48	0.1
G06Q50/2053	Education institution selection, admissions, or financial aid	Process	M			47	0.1
G06Q50/2057	Career enhancement or continuing education service	Process	M	1	0.7	25	0.1
G06Q50/26	Government or public services	Process	IA, EM			68	0.2
G06Q50/265	Personal security, identity or safety	Process	IA, EM			87	0.3
G06Q90/00	Systems or methods specially adapted for administrative, commercial, financial, managerial, supervisory or forecasting purposes, not involving significant data processing	Process	IA, EM	1	0.7	56	0.2
G06Q90/20	Destination assistance within a business structure or complex	Process	IA, EM			4	
Total				**136**	**100**	**34,480**	**100**

[1]65 codes which titles indicate a solution to one of the six fundamental organizational problems.
[2] "TD", "TA", "RA", "IA", "M", and "EM" denote the fundamental organizational problem of task division, task allocation, resource allocation, information allocation, motivation, and exception management respectively.
[3]Percentages less than 0.1% are not reported.

Appendix E. Robustness Checks

Table 1. Cox Regression for the Likelihood of Patent Allowance
Sample Size = 250 OrgInnSeeds patent applications

	Model 1		Model 2		Model 3		Model 4	
Variables	**Coef**	**SE**	**Coef**	**SE**	**Coef**	**SE**	**Coef**	**SE**
Period								
Jan. 2001-Dec. 2012	-1.073***	0.298	-1.096***	0.299	-1.058***	0.300	-1.051***	0.300
Jan. 2013-June 2014[1] (Ref.)								
June 2014-Dec. 2015	-1.024*	0.561	-1.033*	0.561	-0.986*	0.562	-1.006*	0.563
Jan. 2016-Apr. 2020	-0.643**	0.328	-0.649**	0.329	-0.634**	0.331	-0.648**	0.332
OrgInn Tool			0.251	0.242			0.229	0.242
Ln(1+N of OrgInn Occurrences)			-0.017	0.098			0.058	0.102
Primary Classification								
OrgTech					-0.059	0.383	-0.040	0.385
Non-OrgTech BM (Ref.)								
Non-BM					0.589*	0.370	0.642*	0.381
Equality Constraint Test	**F**		**F**		**F**		**F**	
June 2014-Dec. 2015= Jan. 2013-June 2014	0.01		0.01		0.02		0.01	
June 2014-Dec. 2015= Jan. 2016-Apr. 2020	0.49		0.50		0.44		0.46	
Non-BM = OrgTech					6.93***		7.19***	
Likelihood Ratio (df)	11.97 (3)***		13.03 (5)**		19.84 (5)***		21.26 (7)***	

[1]The *Alice* case on patent eligibility was decided in June 2014; the 18 months prior to the decision is the reference period. For more information, see page 27.
***p < 0. 01, **p <0.05, *p < 0.1

Table 2. Cox Regression for the Likelihood of Patent Allowance
Sample Size = 13,194 OrgTech patent applications with OrgInn Name == 1

	Model 1		Model 2		Model 3		Model 4	
Variables	**Coef**	**SE**	**Coef**	**SE**	**Coef**	**SE**	**Coef**	**SE**
Period								
Jan. 2001-Dec. 2012	-0.648***	0.041	-0.649***	0.041	-0.593***	0.041	-0.594***	0.041
Jan. 2013-June 2014[1] (Ref.)								
June 2014-Dec. 2015	-0.233***	0.053	-0.235***	0.053	-0.247***	0.053	-0.248***	0.053
Jan. 2016-Apr. 2020	-0.052	0.043	-0.053	0.043	-0.133**	0.043	-0.133**	0.043
OrgInn Tool			0.111***	0.028			0.101***	0.028
Ln(1+N of OrgInn Occurrences)			-0.037**	0.014			-0.023	0.014
Primary Classification								
OrgTech					-0.113**	0.042	-0.118**	0.042
Non-OrgTech BM (Ref.)								
Non-BM					0.602***	0.044	0.592***	0.044
Equality Constraint Test	**F**		**F**		**F**		**F**	
June 2014-Dec. 2015= Jan. 2013-June 2014	82.73***		82.57***		57.75***		57.72***	
June 2014-Dec. 2015= Jan. 2016-Apr. 2020	15.20***		15.26***		6.07*		6.12*	
Non-BM = OrgTech					523.97***		517.33***	
Likelihood Ratio (df)	431 (3)***		454 (5)***		943 (5)***		958 (7)***	

[1]The *Alice* case on patent eligibility was decided in June 2014; the 18 months prior to the decision is the reference period. For more information, see page 27.
***p < 0. 001, **p <0.01, *p < 0.05

Table 3. Cox Regression for the Likelihood of Patent Allowance
Sample Size = 59,722 OrgTech patent applications

	Model 1		Model 2	
Variables	**Coef**	**SE**	**Coef**	**SE**
Period				
Jan. 2001-Dec. 2012	-0.627***	0.019	-0.569***	0.019
Jan. 2013-June 2014[1] (Ref.)				
June 2014-Dec. 2015	-0.157***	0.024	-0.184***	0.024
Jan. 2016-Apr. 2020	0.078***	0.019	0.000	0.019
OrgInn Name	-0.162***	0.029	-0.125***	0.028
OrgInn Tool	0.113***	0.028	0.102***	0.028
Ln(1+N of OrgInn Occurrences)	-0.035*	0.014	-0.019	0.014
Primary Classification				
OrgTech			-0.159***	0.020
Non-OrgTech BM (Ref.)				
Non-BM			0.582***	0.020
Secondary Classification				
OrgTech	0.390***	0.024	0.096***	0.025
Non-OrgTech BM (Ref.)				
Non-BM	0.331***	0.030	0.273***	0.030
Unassigned	0.262***	0.029	0.297***	0.029
Equality Constraint Test	**F**		**F**	
June 2014-Dec. 2015=Jan. 2013-June 2014	531.14***		352.43***	
June 2014-Dec. 2015=Jan. 2016-Apr. 2020	134.01***		82.33***	
Primary: Non-BM = OrgTech			2127.80***	
Secondary: Non-BM = OrgTech	7.76**		62.73***	
Likelihood Ratio (df)	3,374 (9)***		5,681 (11)***	

[1]The *Alice* case on patent eligibility was decided in June 2014; the 18 months prior to the decision is the reference period. For more information, see page 27.
***p < 0. 001, **p <0.01, *p < 0.05