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Collective Intelligence

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"*How can people and computers be connected so that – collectively – they act more intelligently than any individuals, groups, or computers have ever done before?*"[1]

1 Introduction – The "Wisdom of Crowds?"

Surowiecki's book *The Wisdom of Crowds* (2004) has received much attention in management practice. He vividly describes the phenomenon and highlights some of the potentially underlying mechanisms. A group of average people can – under certain conditions – achieve better results than any individual of the group. This seems to hold even if one member of the group is more intelligent than the rest of the group. Examples are the "Ask the audience" joker in the TV show "Who wants to be a millionaire", which leads to correct answers in 91% of the cases, or the case of localizing a missing submarine through averaging expert estimations from different disciplines, which lead to more precise results than any individual estimation (for more examples, esp. for IT-enabled examples see also Libert and Spector 2007; Tapscott and Williams 2008). Surowiecki defines various conditions for the successful application of the "Wisdom of Crowds", such as diversity in opinions, independence, and decentrality of group members or within a group. Thus, best collective decisions are not made by consensus building and compromises, but through a competition of heterogeneous independent opinions, i.e. through the usage of collective intelligence (Surowiecki 2004). But what does the term "collective intelligence" mean and what are areas of application and potentials for business, society, and politics?

2 Collective Intelligence – Approaches and Definitions of Prior Research

Collective intelligence is not a new phenomenon and has been in the focus of science and research (biology, social sciences, engineering, computer science, etc.) for many years. A widely used approach traces back the roots of collective intelligences to evolutionary processes and refers to intelligence in groups. In team sports and in music bands, e.g., each group member evaluates the overall situation (the match, the play/the music) and acts accordingly to achieve the overall goal (winning the match or achieving a good band performance). This behavior can also be found in fauna where animals coordinate themselves in order to achieve a common goal (e.g., for hunting or navigation purposes, also often referred to as swarm behavior). But also large groups of people can make decisions (e.g., in democratic elections).

Decomposing collective intelligence etymologically, the term "collective" describes a group of individuals who are *not* required to have the same attitudes or viewpoints. Different members can reveal different perspectives and approaches, and thus leading to better explanations or solutions to a given problem. "Intelligence" refers to the ability to learn, to understand, and to adapt to an environment by using own knowledge. This enables people to deal with changing and difficult situations. A widely accepted definition goes back to Wechsler (1964, p. 13) who defines intelligence as composed or global ability of an individual to act purposeful, think reasonably, and to effectively deal with its environment.

The MIT Center for Collective Intelligence (http://cci.mit.edu/) combines both terms to describe very broadly groups of individuals doing things collectively that seem intelligent. They present a framework for identifying underlying building blocks ("genes") that are at the heart of collective intelligence systems, the conditions under which each gene is useful, and the possibilities for combining and re-combining these genes to harness crowds effectively. The framework uses two pairs of questions (Malone et al. 2009):

- *What* is being accomplished? *How* is it being done?
- *Who* is performing the task? *Why* are they doing it?

The question "what" is being done can be divided into creating something new (*"create" gene*) or evaluating and selecting alternatives (*"decide" gene*). The "create" gene refers to actors in the system generating something new – a piece of software code, a blog entry, a T-shirt design (*collection*) – either by themselves or in a team (*collaboration*). The "decide" gene refers to actors evaluating and selecting alternatives – deciding whether a new module should be included in the next release of Linux, selecting which T-shirt design to manufacture, deciding on whether to delete a Wikipedia article or not. These decisions can either be made by a group (*group decision*) or by an individual (*individual decision*). The latter can use results from the group, but the decisions made do not have to be the same between all participants.

The question of who is performing the task carries two dominant genes: *hierarchy* and *crowd*. If a task is assigned to someone from a higher position, it is called a hierarchy. If a task is carried out

[1] http://cci.mit.edu/ (Core research question of the Center for Collective Intelligence, MIT).

Table 1 The Collective Intelligence Genome applied to Wikipedia (Malone et al. 2009)

Example	What	Who	Why	How	
Edit existing Wikipedia articles	Create	New version of article	Crowd	Love, Glory	Collaboration
	Decide	Whether to keep current version	Crowd	Love, Glory	Consensus
Decide what Wikipedia articles to include	Create	New article	Crowd	Love, Glory	Collection
	Decide	Whether to delete (preliminary)	Crowd	Love, Glory	Voting
	Decide	Whether to delete (final)	Wikipedia administrator	Love, Glory	Hierarchy

by (many) individuals voluntarily, without being assigned to a task, this is called a crowd.

Furthermore, it is necessary to understand why people perform tasks, what motivates them to participate, what incentives are at work. Motivation can be a financial benefit (*money*), but also other motives are possible. *Glory* or recognition is at hand if participants are motivated by the desire to be recognized by peers for their contributions. The *Love* gene can take several forms: people can be motivated by their intrinsic enjoyment of an activity, by the opportunities it provides to socialize with others, or because it makes them feel they are contributing to a deeper meaning. **Table 1** illustrates this framework applied to Wikipedia.

Analyzing the genes constitutes a foundation for a deeper understanding of the mechanisms and functionalities of collective intelligence and it allows us to analyze its potentials and areas of application. Thus, by analyzing the genes we can better decide whether a given task should be accomplished by a crowd or which incentives are necessary in order to get the task fulfilled. The most vivid way for describing the areas of application and potentials of collective intelligence in the context of IT is to consider the core research question of the MIT Center for Collective Intelligence: *How can people and computers be connected so that collectively they act more intelligently than any individual, group, or computer has ever done before?* (http://cci.mit.edu/).

3 Potentials and Areas of Application for Collective Intelligence through Social Web Applications

Collective Intelligence has received a new meaning in recent years, especially through the emergence of new (mostly Web 2.0) applications and user generated content. The diffusion of simple and easy-to-use technologies that enable users to interact and design web applications without programming skills led to vast, previously unknown amounts of user generated content. Users are now able to engage themselves more critically and more directly in activities on the Web, providing them with collective power. Examples range from product ratings to influencing public opinion making processes through collective action, and thus generating collective intelligence. This behavior, also called *Technology-Mediated Social/Civic Participation* (Preece and Shneiderman 2009), shows the ability of masses to achieve common goals through participation and collaboration on the Web – goals that no single individual or organization could achieve alone. Examples for this ability are the role of user generated content and its recombination during natural catastrophes, such as hurricane "Katrina", or the way how public opinion was developed on the Web during the electoral campaign of Barack Obama.

But also for companies there are various new potentials for improving their creativity and innovation capabilities. The challenge is to understand how to unleash the vastly unused knowledge or experience of their employees, customers, or partners, and thus leveraging their inherent collective intelligence. First design approaches (Gregg 2010) and areas of application are:

Decision support: Precise decisions require a high amount of information processing and the evaluation of potential solutions. For many years, companies have used teams and focus groups for executing these tasks. Now, however, it is possible to integrate the collective for supporting these processes (Bonabeau 2009). In general, decision support can be divided into (a) *generating* alternative solutions and (b) *evaluating* them.

The decision process can be influenced (or biased) by the participants' tendencies and preferences. Among other things, only data supporting the individual opinion might be used or just simple solutions might be preferred. These distortions can be diminished by the following collective intelligence approaches. For this purpose, Bonabeau (2009) distinguishes between *outreach*, *additive aggregation* and *self-organization*.

Outreach extends the number of participants involved in the process in order to identify more and other ideas or to avoid mistakes. Additive aggregation helps combining and condensing information from many users and self-organization enables peer to peer interactions for creating additional value. There are many examples for such a decision support. For example, IdeaExchange from Salesforce.com (http://sites.force.com/ideaexchange/) allows customers to propose new product solutions and to evaluate existing proposals.

Open Innovation: Another area of application of collective intelligence is the Open Innovation concept. It refers to the opening of companies' innovation processes by actively integrating the environment into these activities and thus extending its innovation capabilities for developing new products and services for wider areas of application (Chesbrough 2003). Companies can involve collective knowledge and innovation potential of Internet users in different stages of product development. LEGO, for example, advances its products with the help of its customers. The Lego Digital Designer (http://ldd.lego.com/) provides a toolkit for users for designing individual product models. Other companies, such as SAP (http://www.sapiens.info/) (Ebner et al. 2009), BMW (http://www.hyve-special.de/bmw/), and IBM (https://www.collaborationjam.com/), purposefully use the creativity of the collective for designing innovative products and services (Leimeister et al. 2009). By means of so called *open innovation business models*, Davenport (2005) shows the relevance of such new approaches for capturing customer knowledge and presents ideas for the survival of companies. He thus highlights these customer integration activities into innovation processes as a fruitful strategy.

Crowdsourcing: Based on the concept of outsourcing, the term crowdsourcing emerged, referring to the outsourcing of corporate activities to an independent mass of people ("*crowd*") (Howe 2009). The crowd collectively takes over tasks, such as solving research questions or pattern recognition that they can complete in a cheaper or better way than machines or experts. Prediction markets are good examples for this since they use opinions or expectations of masses for predicting occurrence probabilities for future events. In 2000, NASA started its Clickworker study for identifying craters on the surface of asteroids and planets. NASA uses the work of Clickworkers that mark edges of craters by clicking them on the Web. The aggregation of all results of many users allows NASA to correctly identify craters with high probability. Amazon's Mechanical Turk (http://www.mturk.com/) allows companies or individuals to offer tasks to a mass of users on the Web that can be solved for a small fee.

Social Collaboration: Further potentials of collective intelligence for companies result from social software applications for collaboration. Value creation develops through (small) contributions of the collective. Most popular examples are Wikis with Wikipedia (http://wikipedia.org/) being the most renown representative (Tapscott and Williams 2008). Providing more than four million English-language articles, it is the largest English-language encyclopedia worldwide and represents an example for successful social collaboration and collective intelligence. Although being freely editable, Giles (2005) stated in a heavily cited article in "Nature" that Wikipedia reaches the quality of Encyclopedia Britannica. This approach has been copied by companies (t-systems, web.de), state agencies (e.g., Intellipedia of the CIA), and individuals. For example, the project network Amazee (http://www.amazee.com/) represents a social collaboration platform where users can publish and work on projects collaboratively. Other approaches for this purpose are Social Sharing platforms that enable users to store, manage, and share contents, such as bookmarks, videos, photos, etc. Cross-references and categories are supported through tags that enable other users to better understand the user generated content.

For the successful design of collective intelligence applications in companies and organizations research has identified first success factors that I will outline briefly (Gregg 2010; Bonabeau 2009):

Control: Applying collective intelligence approaches at the same time means a loss of control since previously closed (hierarchical) structures are opened up and processes are outsourced. Loss of control can have different effects. Unintended or undesired objectives or solutions may result, the outcome of the activities may be unpredictable, and the accountability and responsibility remain unclear – especially in the case of bad results. The provision of internal information necessarily involves the question to what extend a company wants to open up to the environment or what kind of restrictions may be affected (e.g., from legal perspective).

Diversity vs. in-depth expertise: Every problem or task needs the right balance between diversity and in-depth expertise in the collective. A high amount of diversity can lead to a plethora of new ideas and approaches, but may also result in unfeasible solutions ("no amount of diversity will help if the participants are completely ignorant of the issues" Page 2007).

Engagement: The collective needs motivation for (active) participation. Incentives (monetary or non-monetary allowances) may help, but also other motives such as altruism, self-fulfillment, or group identification can be perceived as activation support (Leimeister et al. 2009).

Policing: The more participants are involved the higher is the probability of misconduct or malicious behavior. Punishment can reduce or end this behavior, but it can also have negative effects on other users, leading to a change in individual decision processes or making them leave the collective.

Intellectual Property: If the collective generates ideas and solutions, it is necessary to discuss if and how a company might acquire the intellectual property. Particularly, this involves the question on whether a participant is willing to hand over his or her intellectual property.

4 Importance for BISE and Consequences for Research

IT is a core enabler for new collective intelligence applications and its importance will highly increase in practice as well as in Business and Information Systems Engineering (BISE) research. A core driver for this is seen in more and more powerful Web 2.0 applications (Bächle 2008). This offers a high amount of research questions, ranging from different motives and incentives for active participation of different user and stakeholder groups in collective intelligence applications and respective contingency factors. The effects of different collective intelligence applications, especially for different target groups and tasks as well as the underlying mechanisms, require more in depth analyses. However, there are also many conceptual challenges, e.g., innovative IT tools for supporting mass collaboration processes. How can we design, deploy, and modify collective intelligence concepts and projects in a systematic, repeatable, effective, and efficient way? What kind of IT-enabled business models and value creation systems can be developed?

Research on IT-supported collective intelligence requires the integration of already existing knowledge and approaches from various scientific fields and disciplines. Offering this integration perspective and advancing this development is a promising opportunity for BISE research.

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