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Innovation Consensus: Collective decision making support system for innovation management.

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Abstract

CID, for Cells of Innovation Development, is an online system created to facilitate the participation of professionals in the decision making processes of innovation development. The system has been designed, implemented and tested with 6 cases, involving different kind of companies in the region of Barcelona.

The innovation model and its online tool version have been proposed and created, to handle a Real Time Delphi participation of designers, experts and managers in the evaluation and discussion of all the relevant topics of an innovation project oriented towards the creation of a new product and/or service.

The first part of the paper is devoted to expose the theoretical backgrounds that define the interdisciplinary research field of this work. In the second part of the paper Innovation Consensus Model is presented and the functionalities and characteristics of the CID online tool explained.
In the last part the results of the experience are summarised.

The final conclusion is that it's relevant and very useful to get professionals efficiently and effectively involved and participating in the processes of decision making in innovation project management. The online strategy proposed in this work is feasible and accepted by participants who have expressed high levels of satisfaction.

***Keywords**: Innovation, Innovation Management, Participation, Collaboration, Real Time Delphi and Collective Intelligence.*

Introduction

Collective Intelligence

Collective intelligence may be defined as the ability of a group of individuals that collaborate and share efforts in order to collectively perform intellectual tasks. According to Pierre Lévy (1999), collective intelligence is a form of universally distributed intelligence that may be constantly enhanced, coordinated in real time, and resulting in the effective mobilization of skills. The current emergence of collective intelligence in professional environments is based on the possibilities of combining expert knowledge and experience applying ICT enhanced ways of processing information.

Although the idea of collective intelligence is not new, its tools and models to facilitate participation are growing thanks to the resources provided by a networked society and a continuous enrichment and enhancement of human interaction. There is nowadays extensive evidence that outcomes collectively produced by sets of connected people may be as important as knowledge produced within formal organizations: open source software, social networks or Wikipedia are just some of the most know cases, and this is just the beginning.

The Collective IQ, term proposed by Engelbart (1995), refers to the measure of a group's collective capacity, and it should be, in the near future, a key determinant of how effectively a particular challenge can be understood and effectively addressed by an organization. One of the most important advantages of collective intelligence is the impact of collective learning by employing best practices and tools to facilitate the expression of collective capabilities. All this happens in a fertile dynamic knowledge ecosystem that evolves into better and better tools and practices. And, as Engelbart states (1992), further facilitates this evolution.

Online collective intelligence

Anyone can witness that the online-bound humankind is already a reality, and besides the former and casual social networks, more specific and formal networks with professional focus are arising, facilitating collective intelligence in many forms. Collective work strategies, based on face to face meetings, have limitations in terms of time, costs and amount of people that may be involved with it. So, traditional participative processes

are not appropriated if the number of participants is high, resources limited and time is short.

New and more efficient ICT's, particularly the internet, overcome many of the constraints related to the space-time and costs contingencies. Online technology allows to articulate mechanisms that facilitate the participation of large groups of people, be them professionals involved in the creation of products or services in a company or even customers.

The design and development of online collective intelligence solutions are evolutionary, and ground founded, with a lot of trial and error in the process of combining knowledge, design, technology, management and social interaction. Social network proliferation and its use in professional or academic environments have increased the culture of participating and feeling of belonging.

Innovation management through collective intelligence

As Buchanan (2010) points out, innovation projects are multifactorial and cannot be solved from a single discipline approach. The higher the diversity of people that contributes to the solutions and the larger the participation outreach, the most likely we will get a good result, as evidenced by the many initiatives in the field of collective intelligence. Contributions of Surowiecki (2005) and Bonabeau (2009) are particularly remarkable.

Discrete design practices and disciplines, that play a major role in innovation, may be reformulated from the perspective of collective intelligence, converting them into "hypercommunicative technosocial networks" (Hight & Perry, 2006). Collective intelligence pushes design, as well as research groups, to learn from the new models of distributed exchange and production based in sharing knowledge through technically enhanced networks.

Collective intelligence practices, based in participation, collaboration and learning, stand for transparency during the development of a project, therefore the involvement of designers and other professionals or even customers in decision making really takes into account the capillarity of knowledge and relevant data for innovation projects. Figure 1 is a conceptualisation of Innovation Consensus, understood as a continuous cycle that flows through participation, collaboration, learning and decision making.

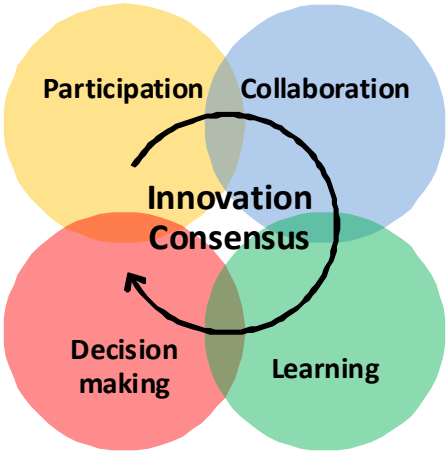

Figure 1. Collective intelligence conceptual framework

Objective and method of this research

The central objective of this research was the creation, development and test of a first prototype of a tool inspired in the concepts exposed above, applying action research methodology (Kock 2011). The exploratory-descriptive research done is intended at providing a new approach to collaborative innovation through the use internet technology. The central idea is that collaborative innovation will be enhanced gradually with the application of ICT tools.

The paper expose the Innovation Consensus model based in the principles of collective intelligence, and present a practical application of it, the "Cells of Innovation Development" (CID). So, once introduced the emerging trend of participation and the connection with online resources for sharing any kind of information, next sections will present a general model of Innovation Consensus and will describe CID, a particular Innovation Consensus tool consisting in an online system created to facilitate the participation of professionals and users in the decision making processes required in innovation projects. Figure 2 is a sketch of the structure of the paper.

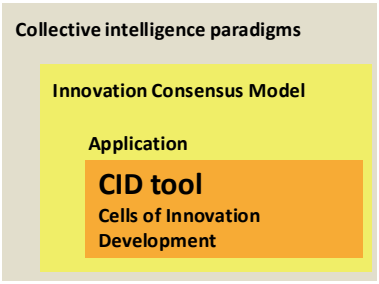

Figure 2. Structure of the paper

The Innovation Consensus Method

Real Time Delphi

Innovation Consensus is defined as a participative method inspired in a Delphi consultation that allow a group of participants to agree, validate or assess diverse aspects of an innovation project. Therefore it facilitates the transition from a model of a particular innovation construct proposed by a limited number of people to an agreed one, by a larger group of people. This process may be done real time or asynchronously as well as it can be organized in face to face meetings or virtually.

Based on Innovation Consensus, the CID model, which will be explained in the next section, is a Real Time Delphi system for the participation of designers, experts, managers and users, in the evaluation and discussion of all the relevant topics of an innovation project oriented towards the creation of a new product and/or service. As exposed by Monguet, Ferruzca, Gutiérrez et al. (2010) in "Vector Consensus: Decision Making for Collaborative Innovation Communities" provision of results to participants based on real-time calculation encourages the involvement of users in the consensus process. The innovation Consensus Model follows three main steps synthesised in figure 3:

- First a general innovation model is structured by a set of drivers[1], where each driver is defined by a question that represents a

[1] We use the term driver referring to the attribute, ítem, element or component that is used to define the model.

particular aspect related with a product/service or its process of design or development.

- Secondly, participants express quantitative preferences or opinions about those drivers. The questions are answered using scales with semantic differentials. The drivers are evaluated answering what are called participative questions, with the purpose of establishing its level of performance, difficulties or any other parameter. What does a participative question mean? The term participative refers to the fact that once answered, participants are allowed to see the aggregated votes of other participants and eventually change their votes.
- Finally in the third step an agreed model, defined through the evaluated drivers, is obtained and shared among all participants. The final model may be considered a quantitative-qualitative assessment of the different attributes of the innovation project.

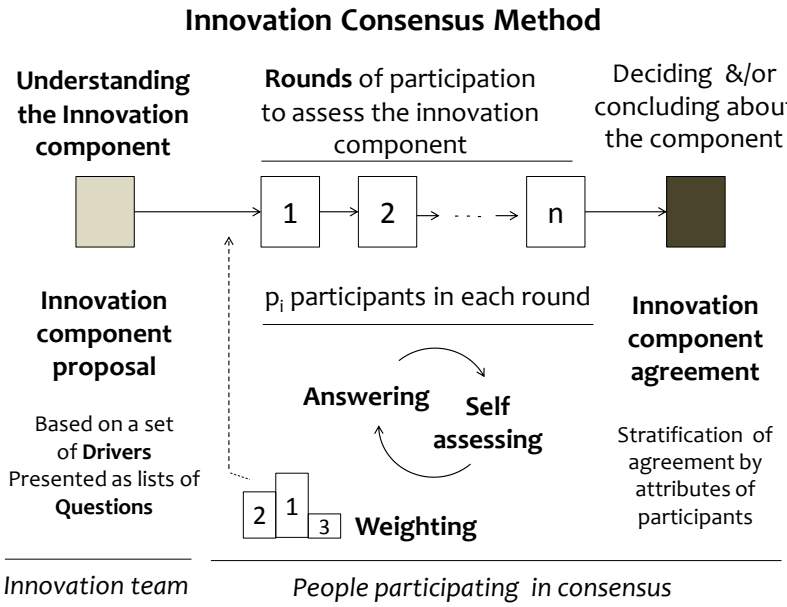

Figure 3. General view of the Innovation Consensus Method

Components and process

Once understood the model to be discussed and agreed, participants start the process of responding to the questions for each driver. As soon as a participant answer a question, an instant representation of all participants aggregated results is exhibited next to the answer. This way, the participant may ponder the answer against the crowd through centrality (mean or median) and dispersion scores (standard deviation or interquartil range) and decide whether or not to change opinion (Figure 4). As it is allowed to change answers to facilitate agreement, a degree of consensus should eventually be calculated, indicating which components of the model have gained a strong consensus and where weak agreement has been found. The model may be presented and displayed in a number of consecutive rounds, having each round a specific intention and an optional timing. Prior to the participation of the main group in each part of the consensus, it is necessary to get answers from a minor group, so the early participants may already compare with some previous respondents.

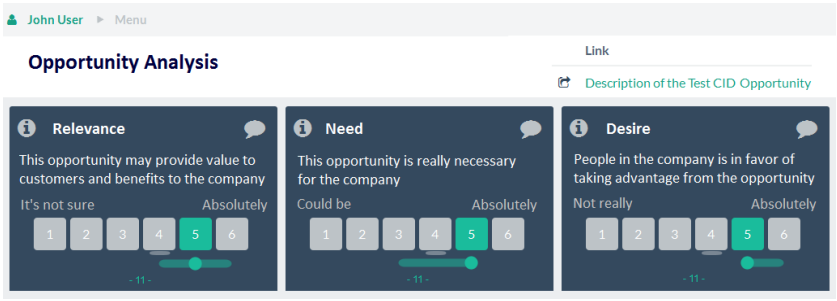

Figure 4. Three participative questions of the Opportunity analysis. Blue coloured square is the last answer and the grey line under the number is the first answer given blindly. The blue point is the median and the blue line is the interquartil rank

Participants as well as drivers are classified in specific categories. Then, participants according to their category may be associated to a specific expertise and their votes for each driver weighted correspondingly depending on the category in which the driver has been also classified.

In Table 1 the main components of the Innovation Consensus method are summarised.

Table 1. Components of Innovation Consensus

Innovation project	The object to be assessed looking for consensus or agreement.
Set of drivers	The items presenting the different aspects that define the innovation project.
Question	The question or questions that expresses a driver
Answer	Possible answers for the questions.
Scales	Structured answers based on semantic differential scales (1 to 6) where edges define the meaning range (e.g. completely disagree to completely agree).
Rounds	Groups of drivers, distribution of time and management of participants.
Feedback	For each driver, participants are allowed to give insights, comments and opinions.
Participants	All different professionals involved in all the rounds of consensus.
Research team	Team that have designed and built the model that represents the innovation project.
Weighting categories	Classification of drivers and participants in categories in order to weight votes.
Results generation	Presentation of consensus results to the participants.

Cells of Innovation Development

Drivers of the process of innovation

The CID system is a particular and first application of the Innovation Consensus Model and consists into a tool that provides a general checklist of the elements that may be considered from the detection of an opportunity till the assessment of a prototype of the resulting product and/or service.

The CID tool is based on 96 independent drivers and 24 dependent drivers that are obtained as a combination of the previous 96. The process to select the independent drivers has been based on a systematic review of the innovation processes in literature.

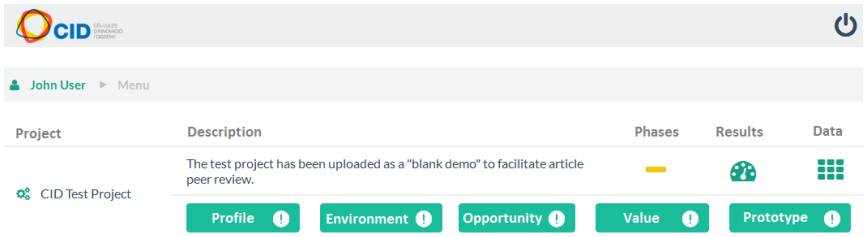

Figure 5. Steps of the innovation project as they appear in the management interface for each one of the projects loaded in CID

The CID tool divides the innovation process into four main steps as it's shown in figure 5:

- Environment: Any innovative project is carried out in a certain environment, which facilitates or hinders innovation.
- Opportunity: In the process of a project that aims to create a successful new product or service, it is necessary objectively evaluate the potential of the opportunity.
- Value: The expression of value of product or service may be divided in two steps, the concept and formal value proposition.
- Prototype: If the proposal is feasible from all points of view, then it can be created a prototype, which may be submitted to potential customers and users.

This cyclic process can be done n times, depending on the type of product or service to create.

Table 2 lists the 96 independent drivers separated in those 4 steps (rounds) considered in the process of innovation:

Table 2. Independent variables of the CID checklist tool

Environment	Opportunity	Value	Prototype
12 drivers of Culture of innovation	12 drivers of Importance of opportunity	12 drivers of Concept assessment	12 drivers of Prototyping assessment
- Initiative promotion - Risk management - Proactive	- Relevance - Need - Desire - Deepening - Specification	- Objectives clarity - Customers participation - Company	- Price - Quality - Distribution & sales - Novelty

attitude - Autonomy of people -Experimentation - Error tolerance -Inspiration - Model of innovation - Support to innovation - Innovation community - Teamwork - Values	- Diversity - Cost - Technical barriers - Cultural barriers - Risk of yes - Risk of not - Alignment	identification - Customer relationship - Customer communication - Prices policy - Balanced teamwork - Heterogeneous teamwork - Motivated teamwork - Commercial alliances - Technology alliances - Research alliances	- Utility - Warranties - Aesthetics - Usability - Brand - Deadlines - After-sales service - Sustainability
12 drivers of *Management of innovation*	12 drivers of *Capacity to manage the opportunity*	12 drivers of Proposal assessment	12 drivers of Prototyping improvement potential
- Idea generation - Idea selection - Application of ideas - Expertise - Company ecosystem - Time and money - Method of innovation - Strategy - Learning - Customer orientation - Selling agility - Benchmarking	- Sector - Trends - Model adequacy - Property compromise - Managers compromise - Staff compromise - Knowledge - Expertise - Technology adequacy - Segmentation - Specific customers - Competitors behaviour	- Integration - Requirements users - Co-creation - Project management - Sustainability - Legal Framework - Trials - Inclusion - User environment - Forecasts - Sellers - Resources	The same list used in the Prototyping assessment

The table 3 presents the 24 dependent drivers obtained as a combination of the previous 96 drivers. For each one of the 4 steps of the innovation process there are:

- 2 drivers that are obtained as a linear aggregation of two groups of the 12 drivers already listed in the table 3 for each step.
- 8^2 more drivers that are based in an algorithm using the 24 drivers of the corresponding round or step.

Table 3. The dependent drivers for each step of the innovation project

Environment	Opportunity	Value	Prototype
Culture of innovation	Importance of opportunity	Concept	Prototype evaluation
-Entrepreneurship - Creativity - Leadership - Collaboration	- Opportunity value - Identification - Viability - Risk	- Concept model - Business scenario - Team - Alliances	- Commercial - Product service - Design - Logistics
Management of innovation	Capacity to manage the opportunity	Proposal	Room for improvement
- Ideation - Resources - Process - Marketing	- Vision - Commitment - Know-how - Market access	- Design - Development - Tests - Sales	- Commercial - Product service - Design - Logistics

Process of participation

It may be defined in brief that the checklist of drivers presented above is used as a set of indicators to consensus the perception of performance level in the consecutive steps of an innovation project. The drivers, embedded in the online asynchronous opinion sharing system, allow the group of professionals to agree, validate or assess the innovation project, and as it has been explained, to do that, participants express their quantitative-qualitative opinions about the different attributes affecting the goodness of

[2] In the case of the prototype the 4 dependent drivers are repeated.

ideas, resources, limitations and/or results obtained. Therefore this is the way CID facilitates and carries out people involvement in the assessment of the innovation project. Following the checklist presented, participants begin with the evaluation of the environment and the opportunity of a product and/or service. First, a limited number of people share their opinions about the attributes affecting the goodness of ideas and concepts, but as the project advances, formalising the value and proposing some kind of prototype, it is expected to increase the number of people involved in the project assessment.

In Table 4, following the general Innovation Consensus presented in the previous sections, are summarized the main components of CID.

Table 4. CID components

Component	Definition	CID
Model	The construct, knowledge, decisions etc., which is object of consensus or agreement.	The innovation process, formed by four groups of indicators representing: • Environment of innovation • Opportunity for innovation • Value • Prototype
Set of drivers	The items displaying the model.	96 Independent drivers: - Encouragement of Initiative, - Management of risk, etc. 24 Dependent drivers: - Entrepreneurship - Creativity, etc.
Question	Driver related question.	One question per independent driver, referring to the level of the driver. For the driver "Encouragement of Initiative" the question is: "Organisation values imagination and encourages people to propose and lead new projects?"
Answer	Possible answers for the questions.	A scale from 1 to 6 with specific semantic differentials for each extreme of the question. For the driver "Encouragement of Initiative" the semantic scales are: - From time to time (minimal of 1) - Always (maximum of 6)

Rounds	Groups of drivers, distribution of time and management of participants.	Four rounds that are managed by an administrator according to the interest of each project.
Feedback	Communication facilities.	For each indicator (driver) participants are allowed to give insights, comments and written opinions.
Participants	All different professionals involved.	Groups of people invited to take part in the consensus process has not a limit except the logics of each particular innovation project.
Research staff	People that has designed and build the model.	A core group of 3 researchers and a group of 12 professionals have completed the first trial and validated the model with the online consensus system.
Weighting categories	Classification of drivers and participants in categories in order to review votes.	The indicators (drivers) and the participants are classified in three categories: Design, Management and Technology. The option selected the first weights 5, the second one weights 4 and the last one weights 3.
Results generation	Presentation of results to the participants.	The results of the participative process have two levels: - A final list with 24 indicators that aggregates the 96 independent drivers. - The stratification of answers for each group of users with the consensus for each one of the 96 independent drivers.

There are different ways and tools that are possible under the general model of Innovation Consensus, and during the design of the CID tool some decisions were taken to define it. Table 5, summarizes the criteria applied in the design of the CID solution, and it allows to imagine other possible applications based in the Innovation Consensus Model.

Table 5. Criteria and decisions taken during the design of CID

Drivers	The number of drivers and how to order and present them is the most significant aspect of the tool design. The accuracy of the model increases with the number of drivers,

	but it does so the complexity and the intensity of the participative process. The aggregation and classification of the drivers is a critical aspect in order to help participants to understand the innovation model.
Questions	The question for each driver is different and adjusted to express with fidelity the meaning of the driver. Using the same questions for all the drivers would have made easier for the participants to answer, but changing the questions for each driver produces a much more precise opinion.
Participants	The selection and stratification of participants is directly related with their gradual involvement in the innovation process. If the number of participants is very high the value of the consensus increases but participation becomes more depersonalized, and the impact of each participant vote is diluted.
Rounds	The model of innovation is divided into 4 consecutive rounds, and the number of participants may be increased en each round. A major number of rounds would have allowed to define the process with more precision, but also would have made more complex the definition of the innovation product o service.

The web-based tool

Nowadays internet capabilities allow creating, in a relatively feasible way, tools that are able to address the model exposed above. The following images in figures, 6, 7 and 8, together with figures 4 and 5 already presented, are a summary of the general functionalities of CID.

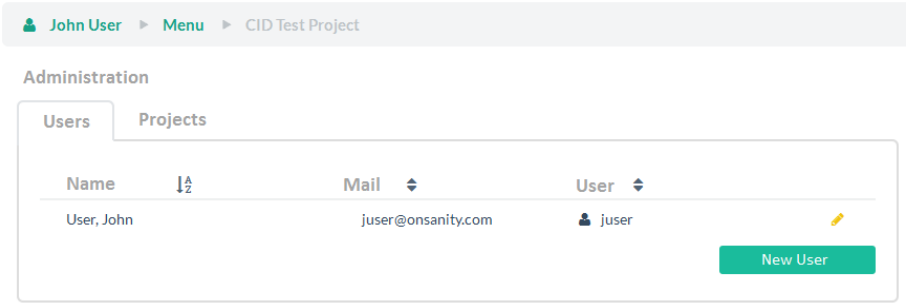

Figure 6. Main page of a user that has the privileges to open new projects and load new user.

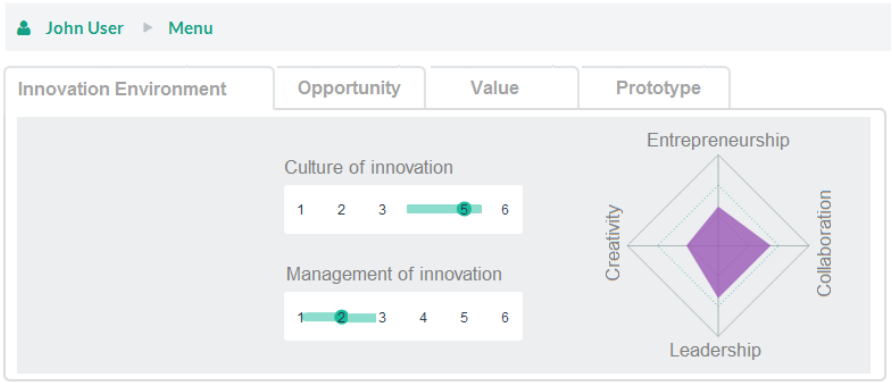

Figure 7. Visualitsation of results of a project, showing the level of the 24 dependent variables. In this case, the culture of inovation has a high level of 5, but the management of innovation may be improved considerably. The team promoting this project has also a certain lack of entrepreneurship and of creativity.

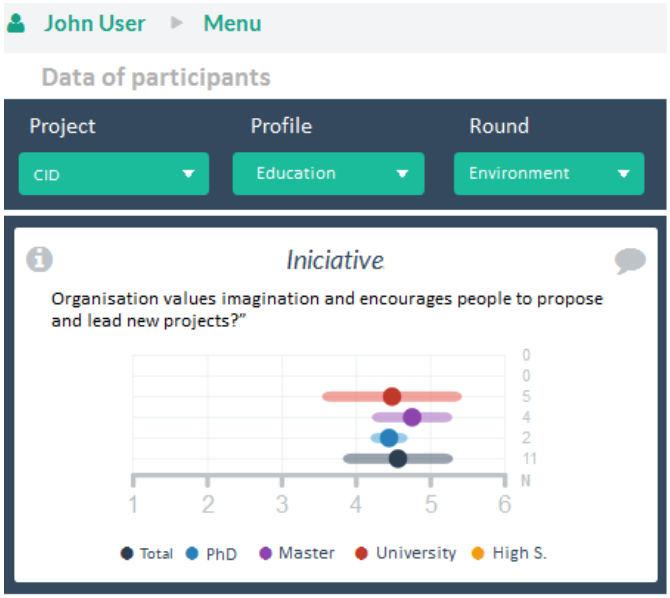

Figure 8. Presentation of data stratified by categories of users.

Results

To test and assess the validity and adequacy of the CID tool for the purpose defined, the research has been done in two phases; the first one was conducted without any kind of digital tool, working with the participating companies involved in the development of innovation projects that extend over a year. The second phase was based in the use of a digital tool that facilitated to users the CID application.

The first phase allowed, thanks to different tests and experimentation done with the companies, the design of the tool that was used in the second phase. The test and assessment process described in this paper represents a first step in the research, and is devoted to see the usability of the tool and the self identification of participants with the outputs.

The research technique applied in the first phase of the test has been based on a focus group inspired method, with 15 participants, all of them CEO's and/or leading people from the companies. At the end of the debates with each one of the participating teams, three main questions were asked regarding:

- The level of identification with the drivers of the model according to products and/or services of the company.
- The perception of utility of the innovation consensus model in order to facilitate the assessment of the innovation projects.
- The usability and viability of the application based on the presentation of the first prototype of CID.

In all cases, the final consensus about CID was more or less the same and may be summarized as follows

- In general terms everybody felt quite comfortable with the list of drivers, both, dependent and independent. As a result of the focus group a new functionality was added to the system allowing personalizing the list of drivers to a sector, particularly relevant for the health sector where the terminology used in hospitals is different from the more commercial one used in companies.
- Few people found difficulties in the use of the application, and if so it was due to the fact that they were using not updated computers or smart phones.

- Everybody agreed about the intuition of utility of the profile of the innovation project although because of the novelty nobody knew exactly how and when to use those outcomes.
- There were no relevant differences between the opinions of different kind of users.

The CID system, in the second step of the research, has been applied with 6 different cases, and the results are synthesized in table 6. The users were proposed to go to the application http://cid.healtconsensus.net and do the whole job by themselves without any kind of instruction or advice. The group of applications has allowed testing and assessing the validity and adequacy of the prototype of the tool. Not all the participants completed all the rounds before the presentation of this paper due to the differences in rhythm in the respective innovation projects.

Table 6. Companies participating in the validation of the prototype

N	Sector	Rounds	Participants
1	Health	3	3, 14, 14, -
2	Car Ind.	2	6, 7, -, -
3	Alimentation Ind.	3	2, 5, 15, -
4	Audiovisual Ind.	4	2, 6, 12, 23
5	Distribution	3	3, 7, 12, -
6	R&d Pharma Ind.	4	3, 5, 12, 16

In the figure 9 it can be seen a nice example of the utility of the tool as significant differences between customers and professionals where clearly depicted.

Figure 9. Presentation of data stratified by categories of users.

Conclusions

The objective of the work presented here is to share the advances in a research programme which intention is to provide tools and resources to help in the development of innovation projects. The main conclusions are:

- Experts, particularly design professionals, respond positively to the proposed model of participation based in the model of Innovation Consensus.
- The participation process is efficient and obtains high levels of satisfaction.
- Participants perceive they contribute with value as a result of their involvement in the participative process.

From this point, with a consistent model, it will be possible to continue with the development of new functionalities oriented to make recommendations to the companies according with their results.

The future research has two main directions. On one hand, the research may contribute to the development of the wide area of collective intelligence and the application of technological tools. Mobility, big data or social learning are some of the areas where the research will be extended.

The general goal of the research was to share the advances in a work which its explicit intention is to provide IT tools and resources to help in the development of a more participative innovation management.

There have been also discovered some weakness in the action-research design and development that provides very interesting elements to consider in the future versions of this prototype:

- There is a leak of culture in managing online asynchronous process that decreases the rate of response.
- There are difficulties managing the richness of multi-disciplinary and limitations when mixing very different profiles.

Knowledgments

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