



HOW DO MILLENNIALS FORESEE THE CAR OF THE FUTURE AND THE FUTURE OF THE CAR? EMPIRICAL EVIDENCE FROM AN OPEN INNOVATION PROCESS PROMOTED BY A MULTINATIONAL COMPANY

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ABSTRACT

This working paper aims to rebuild how one of the top ten global carmakers, Fiat Chrysler Automobiles (FCA), has defined all the aspects of crowdsourcing, i.e. all the tools needed to realize an Open Innovation Process - OIP. In particular, it describes how FCA has targeted its OIP on a "niche-crowd", represented by digital natives (who are also called young millennials). Moreover, it describes how FCA has decided to leverage on a dedicated on-line platform in order to conceive ideas and insights about "the car of the future and the future of the car". Percentages shown in the tables might be meaningless for academic scholars but – if read by top managers working for carmakers – these percentages seem to show the way toward the future of automotive industry. Thus, OI can be considered as a marketing activity and OIPs confirm their relevance as an effective tool for market researches.

Keywords: OpenInnovation;AutomotiveIndustry;Millennials

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Abstract

This working paper aims to rebuild how one of the top ten global carmakers, Fiat Chrysler Automobiles (FCA), has defined all the aspects of *crowdsourcing*, i.e. all the tools needed to realize an Open Innovation Process - OIP.

In particular, it describes how FCA has targeted its OIP on a “*niche-crowd*”, represented by digital natives (who are also called *young millennials*). Moreover, it describes how FCA has decided to leverage on a dedicated on-line platform in order to conceive ideas and insights about “*the car of the future and the future of the car*”.

Percentages shown in the tables might be meaningless for academic scholars but – if read by top managers working for carmakers – these percentages seem to show the way toward the future of automotive industry. Thus, OI can be considered as a marketing activity and OIPs confirm their relevance as an effective tool for market researches.

Keywords: open innovation; automotive industry; millennials.

1. Introduction

The passage from a closed to an open approach to innovation (Chesbrough, 2003) has driven management scholars to investigate open innovation (OI) according to two main research paths. The former considers the main aspects of OI while the latter considers the industries in which OI takes place. In reference to the former, management scholars investigated OI in reference to its origins (Enkel et al., 2009; Loren, 2011), its diffusion (Chesbrough and Crowther, 2006), its typologies (Phillips, 2011), its linkages with strategies (Chesbrough and Appleyard, 2007) and with business models (Frankenberger et al., 2014), its implementation (Chesbrough, 2004), or its further developments (Gassman et al., 2010; Chesbrough, 2012). Moreover, OI was investigated also in reference to the most common mistakes that should be avoided (Gaule, 2011).

Heterogeneity of results achieved in reference to the former research path has driven other management scholars to focus on industries in which open innovation processes (OIPs) have been implemented (the latter research path cited above). In this vein, Laursen and Salter (2006) examined OIPs in manufacturing firms and Chiaroni et al. (2010) investigated mature and asset-intensive industries. Enkel et al. (2009) investigated OIPs from a cross-industry perspective, while Chesbrough and Crowther (2006) and Di Minin et al. (2016) investigated OIPs in a wide range of industries, both high technology and traditional ones. This perspective seems to disclose more fitting insights about OI. In reference to food industry, it results that OI affects both innovations capabilities and market outcomes (Sarkar and Costa, 2008). In reference to the bio-pharmaceutical industry, it is demonstrated that firms do leverage on OIPs by looking for partners that are not in their core areas (Bianchi et al., 2011). In reference to the chemical industry, instead, it is clear that outside solvers collaborate with internal seeker scientists and R&D managers to select problems and formulate solutions that

can take to successful OIPs (Sieg et al., 2010). Eventually, in reference to the software industry, small players leverage on OIPs in order to face the incumbents' competition (West and Gallagher, 2006).

Industry-related results seem to facilitate top managers who aim to implement OIPs and, for this reason, there is an always-growing request of studies and researches about OI in specific industries. In particular, one of the industries in which there is an increasing number of OIPs is the automotive industry. However, even if a growing number of related contributions are proposed, generalized results and specific insights still need to be unfolded (Ili et al., 2010). This paper tries to fill in this gap and to answer to a related research question: can OIPs be an effective tool for market researches?

By rebuilding a pilot OIP recently realized by one of the top ten global carmakers, Fiat Chrysler Automobiles (FCA), this working paper aims to disclose new results and valuable insights on the design and implementation of OIPs involving digital natives in the automotive industry. The paper is structured as follows. Section two deals with the main issues that need to be defined when talking about OIPs and *crowdsourcing*. In particular, attention is focused on five main aspects of *crowdsourcing* activity: aim, target, questions, invitation, and incentives. Section three describes the pilot OIP promoted in 2015 by FCA that involved *young millennials* and aimed to conceive innovative ideas and insights about “*the car of the future and the future of the car*”. In section four, the data collection phase (involving 501 digital natives and carried out through a digital platform) is described. Then, the results of the content analysis, and the best four ideas and insights are presented. These results seem to show the way of the automotive industry.

According to the above, OI can be considered a marketing activity (Kelley, 2011) and OIPs confirm their relevance as an effective tool for market researches.

2. OIPs and crowdsourcing: a literature review

In order to enlighten some insights that might enhance the efficacy of OIPs in the automotive industry, it is necessary to start by recalling some contributions about the implementation of OIPs (Carpenter, 2011; Gaule, 2011; Rayna and Striukova, 2015) and, in particular, on *crowdsourcing*, i.e. all the tools through which OIPs can happen (Hopkins, 2011, pg. 15). In this paper, attention is paid on five main issues (aim, target, questions, invitation, motivation and incentives) that – in the FCA top managers' view – might be critical factors that can determine success, or failure, of OIPs.

2.1 Aim

In the present paper, a pragmatic approach rooted in the statement “*the end of a crowdsourcing initiative is its start*” (Carpenter, 2011, pg. 76) is adopted. For this reason, the first aspect to define when implementing OIPs is the aim to pursue. According to a well-known taxonomy (Hopkins, 2011), through OIPs it is possible to gather: 1) ideas from the crowd (*crowd-wisdom*); 2) ideas from the crowd and embody them in new products/services (*crowd-creation*); 3) judgements in order to classify information (*crowd-voting*); or 4) funds, through micro-lending (*crowd-funding*). Of course, the aim to pursue only depends on top managers who define and implement OIPs.

2.2 Target

After defining the aim, it is necessary to identify the target, especially in reference to its characteristics and size. As for the former, companies should be aware that if the target is copious and heterogeneous, then there is the risk of addressing wrong innovative paths. At the same time, if the target is homogeneous and narrow, then group-thinking prevails and no

robust results are achieved (Hopkins, 2011; Phillips, 2011). As for the latter, it is necessary to consider that approximately 1% of crowd joins OIPs (Hopkins, 2011). Therefore, the bigger is the size of the sample, the higher is the probability of getting a considerable amount of answers.

2.3 Questions

In reference to the questions, companies launching OIPs have two alternatives (Phillips, 2001). On the one hand, if companies know exactly what they are looking for, they can ask specific questions (directed). On the other hand, it can happen that companies do not even know what they are looking for. In this case, they ask for generic questions (suggestive) and all the answers are useful since they might open unexpected trajectories of research. Also in this case, there is no right choice. It depends on the pursued aim.

2.4 Invitation

At this stage, it is appropriate to define the type of invitation. According to Phillips (2011), it is possible to choose between directed vs. suggestive and between participative or invitational types of invitation. By matching the four types of invitation, it derives that invitation can be: 1) suggestive and participative if everyone interested in the OIP can propose generic ideas; 2) suggestive and invitational if specific subjects are invited to propose generic ideas; 3) directed and invitational if specific subjects are invited to propose specialist ideas; 4) directed and participative if everyone interested in the OIP can propose specific ideas. Also in this case, it is worth noticing that the right choice depends on the final aim.

2.5 Motivation and incentives

In order to steer the crowd to join OIPs, motivation (Carpenter, 2001) and incentives (Hopkins, 2011) are necessary. When dealing with motivation, i.e. the reason why the crowd should join OIPs, companies need to act in order to make the crowd aware of the relevance of its contribution (Carpenter, 2001). Of course, if companies can offer incentives then better results can be expected. As underlined by Hopkins (2011, p. 19), money can be not the right incentive. Incentives should fit with the crowd's expectations in order to be effective.

3. Implementing the OIP

Before the start of the OIP, the authors conducted four in-depth on-site interviews with FCA top managers (May-June 2015). In particular, they interviewed the Coo of EMEA (Europe, Middle East and Africa) Region and Head of FCA Business Development, the Head of Product Planning and Institutional Relations of EMEA Region, the Head of EMEA Region Vehicle Engineering and the CEO of Fiat Research Centre (CRF). Interviews were based on open questions aiming to understand the innovation strategy of FCA, its level of openness and its previous open innovation activities. Of course, the authors closely interacted with the company during the whole OIP (September 2015 – May 2016). An additional in-depth interview with the Head of Product Planning and Institutional Relations of EMEA Region was conducted after the completion of the OIP.

At this stage, it is possible to investigate how FCA top managers have implemented the pilot OIP in the automotive industry by defining the aspects mentioned in the subsections from 2.1 to 2.5. At first, FCA top managers had to define the aim to pursue. In reference to Hopkins' taxonomy (2011), FCA wanted to get ideas about "*the car of the future and the future of the*

car” (the contest’s claim defined by FCA) in order to use and convert them into new products/technologies. Thus it was decided to launch a call oriented towards *crowd-creation*. With regard to the target, FCA decided to involve *young millennials*, who are a “*niche-crowd*”. In particular, FCA wanted to explore creativity of *young millennials* attending management classes who are not expected to have technical or engineering competences. Only *young millennials* studying management in two Italian universities (the Second University of Naples – currently renamed University of Campania “Luigi Vanvitelli” – and University of Cassino and Lazio Meridionale) were invited to join. FCA chose these two universities since they are located in two Italian regions where the company recently raised two major manufacturing plants investing heavily.

In order to get the digital natives vision of their lives and cars, FCA defined four directed questions:

- 1) How do you foresee cars in 15 years?
- 2) What would you do with your car if you could?
- 3) What do you expect by carmakers to improve your life?
- 4) How can music, social nets and friends improve your relationship with your car?

As for invitation, FCA decided to invite *young millennials* studying management to propose ideas. Simply put, the OIP was invitational and questions were suggestive (in this way the risk of group-thinking was reduced). In order to make the invitation as efficient as possible, FCA decided to leverage on a *crowdsourcing* intermediary that, by definition, facilitates the match between *crowdsourcing* companies and the crowd (Enkel et al., 2009; Sieg et al., 2010; Frey et al., 2011; Zogaj et al., 2014). In particular, FCA decided to leverage on Start up Lab, an academic laboratory of the Department of Management of University of Campania “Luigi Vanvitelli” dedicated to entrepreneurship and open innovation. In particular, Start up Lab –

on the behalf of FCA – managed all the promotion activities and created the dedicated digital platform. In order to involve as many *young millennials* as possible, FCA decided to launch a digital-centred OIP. According to FCA, in fact, it was very relevant to involve web 2.0 users (Chesbrough, 2012; Rayna and Striukova, 2105) since it is well known that Internet technologies can reduce search costs and maximize information flows (Whelan et al., 2010). Eventually, as for motivation and incentives, FCA offered a 6-months internship in a FCA plant to each of the four winners. Out of 501 respondents, thirty respondents from the Second University of Naples and thirty from University of Cassino and Lazio Meridionale were selected. Out of them, twelve finalists were chosen (six per each university). The twelve finalists had the opportunity to defend their ideas to engineers and specialists working at Fiat Research Centre (CRF) during three individual meetings with them. Over these meetings, communication obstacles between finalists and engineers gradually decreased so that – at the end – the latter were able to deeply evaluate the ideas. After this, according to their degree of originality, feasibility and sustainability the Innovation Board (comprehending two FCA top managers and one academic of Second University of Naples) selected the four OIP winners and now they are conducting a 6-months internship in a FCA plant.

4. Data collection and results

4.1 Data collection

After defining the main aspects of the OIP, some junior projects managers organized dedicated events in order to invite the selected target, thus accomplishing the phase of posting. According to estimations, students joining these events were nearly 1,200. As regarding the subscribing phase, students were explained they had to respond to the four

above cited questions available on a dedicated web page linked to the website of the Start up Lab. After inserting their personal data, they had 1,000 characters available for each of the four questions.

The submitting phase started on October and ended by December 2015. During these three months, the junior projects managers organized some recall-events. After the submitting phase, the feedback phase started. Out of 1,200 *young millennials* involved, 501 of them provided valid answers – certainly a higher than expected percentage (Hopkins, 2011).

4.2 Content analysis of results

Two senior project managers were involved in the content analysis of results. Before showing the top five ideas and insights provided by *young millennials* in reference to each question, it is important to remark that millennials could give open answers. This means that they could propose more than one idea and that the total amount of ideas and insights exceeds the amount of participants (501 millennials).

In reference to the first question “How do you foresee cars in 15 years?” 501 digital natives provided 762 ideas. The top five ones are shown in table 1.

<i>In 15 years, I foresee that cars will be...</i>	
Green	46.0%
Smart	25.4%
Safe	7.7%
Comfortable	5.6%
Innovatively designed	5.0%
Number of respondents = 501; Number of proposed ideas = 762	

Table 1. Top five ideas/insights provided in response to question 1.

As noticeable, most of the *young millennials* expect that cars of the future will be green (i.e. water-fuelled cars, propelled by electric motors, with solar panels or internal accessories made up of renewable/recycled materials) and smart (i.e. with outside-in sensors concerning speed, proximity, temperature and with inside-out sensors related to health or emotions). Moreover, *young millennials* foresee safe and comfortable cars, able to recognize drivers when they get in, but then driverless (or equipped with a driver assistant) in order to let drivers enjoy their time while driving. Some of them expect cars completely new in terms of design.

In reference to the second question “What would you do with your cars if you could?” 501 digital natives provided 616 ideas/insights. The top five ones are shown in table 2.

<i>If I could, with my car I would like to...</i>	
Travel	43.1%
Drive smartly	21.9%
Improve personal leisure	9.7%
Drive comfortably	7.2%
Improve driving performance	5.9%
Number of respondents = 501; Number of proposed ideas = 616	

Table 2. Top five ideas/insights provided in response to question 2.

When digital natives answer that they would travel by their cars, they argue that they would like to have all their stuff available, whenever and wherever they need it. Instead, when *young millennials* answer that would like to drive smartly if they could, they allude to outside-in sensors (speed, proximity, temperature) and to inside-out sensors (health-related, emotional). In this way, they confirm answers provided to the first question. At the same time, *young*

millennials would like to improve their personal leisure and thus their cars are expected to remind the places they visit (through pictures made by cars themselves) and share them with all their friends (through social networks easily accessible by their cars). Eventually, *young millennials* would like to drive comfortably, thus they would like cars that are driverless or equipped with a driver assistant, and to get better performances (in terms of speed, safety and fuel consumption) when driving.

In reference to the third question “What do you expect by carmakers to improve your life?” 501 digital natives provided 626 ideas. The top five ones are provided by *young millennials* are shown in table 3.

<i>In order to improve my life, carmakers are expected to make cars...</i>	
Green	25.8%
Safe	22.5%
Smart	19.8%
Low-cost	6.4%
Comfortable	6.1%
Number of respondents = 501; Number of proposed ideas = 626	

Table 3. Top five ideas/insights provided in response to question 3.

This question, as emerged by several meetings with FCA top managers, is a sort of check question since it deals again with the car of the future but, in this case, *young millennials* are asked to consider the role that carmakers should play. Answers to this question confirm that *young millennials* do want carmakers to produce green, safe, smart and comfortable cars in the future. However, at the same time, *young millennials* ask for low-cost cars – this contrasting need seems to confirm that customers show a low willingness to pay premium

price for innovations (Rubenstein, 2014). Carmakers, then, should really spend their efforts in trying to find the right balance between the above insights that need to be mixed and embodied in cars that *young millennials* are going to buy.

In reference to the fourth question, namely “How can music, social nets & friends improve your relationship with your car?”, 501 digital natives provided 552 ideas. The top five ones proposed are included in table 4.

<i>Music, social nets and friends could improve my relationship with my car if they were able to...</i>	
Combine social nets and security	22.8%
Embody technological convergence	14.2%
Support info-sharing	14.2%
Be in a network created by carmakers	13.6%
Act as personal assistant	9.3%
Number of respondents = 501; Number of proposed ideas = 552	

Table 4. Top five ideas/insights provided in response to question 4.

From the above answers it emerges that social networks are part of *millennials'* life but they want to use them without risks. In this vein, many *young millennials* specify that voice-activated commands could be very useful. *Young millennials* also argue that cars of the future should be the result of technological convergence, by supporting all the millennials' devices (smart-phones, tablets, or laptops), or that they should be able to share position and get info about their friends' positions, share music, news and pictures in order to be always on. In particular, the idea of being part of a dedicated network created by their carmakers and the idea that cars could act as personal assistant are really tempting for millennials.

4.3 Best ideas and insights

Among the answers provided by *young millennials*, the Innovation Board selected the four answers that were best assessed in terms of originality, feasibility and sustainability.

One of the best four collected ideas concerns a car able to modify its settings according to the seasons (by improving car traction in line with the changing pavement conditions) or to characteristics of the driver (age, previous driving experience) in order to improve safety while driving. Another of the best ideas deals with an “emotional car” which uses recent advancements in emotion monitoring sensors. In particular, this car can recognize drivers’ emotional state in order to automatically play the playlist most fitting with their emotions. Still another best idea is about security intelligence of cars. In this vein, cars can memorize how drivers behave in their cars (i.e. if they exceed the speed limit, if they are distracted and so their cars swerve) and, once arrived at destination, on the car display it is summarized the correct/incorrect drivers’ behaviour so that they can improve their driving performance and risk less. Eventually, the last best idea is related to a learning car system based on inside out and outside in sensors sharing info. This could “drive cars on cloud” (the title used to present this idea), i.e. this could develop an advanced cloud system that can improve safety and performance while driving.

These four ideas are currently under deeper evaluation by both the FCA Product Planning team and CRF. As already said, the four award winners are currently involved in a 6 months internship at FCA.

5. Conclusions and discussion

According to FCA top managers, the decision to launch a pilot OIP as a marketing activity – in order to get some insights about young millennials’ view of the car of the future – has been successful.

The OIP implemented by FCA discloses that the risk of addressing wrong paths seems to be minimized in the automotive industry if a “*niche-crowd*” is selected. In general, ideas and insights proposed by a heterogeneous and copious crowd can be unfocused and this can cause distractions and inefficiencies, as emerged in reference to several OIPs in the ICT industry (Di Minin et al., 2016). According to the FCA experience, this risk seems to be manageable or even reducible if a “*niche-crowd*” is involved.

At the same time, FCA is aware that this pilot OIP is an explorative project (aiming to collect data from two Italian regions only) and thus achieved results need to be enriched. In this vein, it is worth noting that FCA has decided to invest in a second extended edition of the OIP. Started on September 2016, this OIP is directed to the same target of a broader geographical area (six Italian regions) and it is entitled “*I AM FCA*” – an acronym standing for “*Innovation Award Millennials FCA*”. Up to now, one of the best four ideas has already been incorporated in new cars.

In conclusion, the FCA experience discloses that OIPs can be a good practice on which companies can leverage in order to get info about the future of the car and the car of the future. Collected ideas and contributions, in fact, stand for what *young millennials* expect by all the car makers, not only by FCA. In this vein, FCA might be able to satisfy *young millennials*’ needs and expectations before its competitors and in a better way. Accordingly, OI can be considered as a marketing activity (Kelley, 2011) and – in reference to the research

question posed above – OIPs confirm their relevance as an effective tool for market researches.

References

Bianchi, M., Cavaliere, A., Chiaroni, D., Frattini, F. and Chiesa, V. (2011) Organisational modes for open innovation in the bio-pharmaceutical industry: an exploratory analysis. *Technovation*, 31, 22-33.

Carpenter, H. (2011) Motivating the Crowd to Participate in Your Innovation Initiative. In: Sloane, P. (ed.), *A Guide to Open Innovation and Crowd-sourcing. Expert Tips and Advice*. London: Kogan Page Publisher.

Chesbrough, H. (2003) *Open Innovation: The New Imperative for Creating and Profiting from Technology*. Boston (MA): Harvard Business School Press.

Chesbrough, H. (2004) Managing open innovation. *Research-Technology Management*, 47, 23-26.

Chesbrough, H. (2012) Open innovation: Where we've been and where we're going. *Research-Technology Management*, 55(4), 20-27.

Chesbrough, H. and Appleyard, M. (2007) Open innovation and strategy. *California Management Review*, 50, 57-76.

Chesbrough, H. and Crowther, A.K. (2006) Beyond high tech: early adopters of open innovation in other industries. *R&D Management*, 36, 229-236.

Chiaroni, D., Chiesa, V. and Frattini, F. (2010) Unravelling the process from Closed to Open Innovation: evidence from mature, asset-intensive industries. *R&D Management*, 40, 222-245.

Di Minin, A., De Marco, C.E., Marullo, C., Piccaluga, A., Casprini, E., Mahdad, M. and Paraboschi, A. (2016) *Case Studies on Open Innovation in ICT* (No. JRC100823). Institute for Prospective Technological Studies, Joint Research Centre.

Enkel, E., Gassmann, O., and Chesbrough, H. (2009) Open R&D and open innovation: exploring the phenomenon. *R&D Management*, 39, 311-316.

Frankenberger, K., Weiblen, T. and Gassman, O. (2014) The antecedents of open business models: an exploratory study of incumbent firms. *R&D Management*, 44, 173-188.

Frey, K., Lüthje, C. and Haag, S. (2011) Whom should firms attract to open innovation platforms? The role of knowledge diversity and motivation. *Long Range Planning*, 44, 397-420.

Gassman, O., Enkel, E. and Chesbrough, H. (2010) The future of open innovation. *R&D Management*, 40, 213-221.

Gaule, A. (2011) Common Mistakes and Stress Points. In: Sloane, P. (ed.), *A Guide to Open Innovation and Crowd-sourcing. Expert Tips and Advice*. London: Kogan Page Publisher.

Hopkins, R. (2011) What is crowd-sourcing?. In: Sloane, P. (ed.), *A Guide to Open Innovation and Crowd-sourcing. Expert Tips and Advice*. London: Kogan Page Publisher.

Ili, S., Albers, A. and Miller, S. (2010) Open innovation in the automotive industry. *R&D Management*, 40, 246-255.

Kelley, B. (2011) The importance of a strategic approach to open innovation. In: Sloane, P. (ed.), *A Guide to Open Innovation and Crowdsourcing. Expert Tips and Advice*. London: Kogan Page Publisher.

Laursen, K. and Salter, A. (2006) Open for innovation: The role of openness in explaining innovation performance among U.K. manufacturing firms. *Strategic Management Journal*, 27, 131-150.

Loren, J. K. (2011) What is Open Innovation?. In: Sloane, P. (ed.), *A Guide to Open Innovation and Crowd-sourcing. Expert Tips and Advice*. London: Kogan Page Publisher.

Phillips, J. (2011) Open innovation technology. In: Sloane, P. (ed.), *A Guide to Open Innovation and Crowd-sourcing. Expert Tips and Advice*. London: Kogan Page Publisher.

Rayna, T. and Striukova, L (2015) Open innovation 2.0: is co-creation the ultimate challenge?. *International Journal of Technology Management*, 69, 38-53.

Rubenstein, J. M. (2014) *A Profile of the Automobile and Motor Vehicle Industry*. New York: Business Expert Press.

Sarkar, S. and Costa, A. I. (2008) Dynamics of open innovation in the food industry. *Trends in Food Science & Technology*, 19, 574-580.

Sieg, J. H., Wallin, M. W. and Von Krogh, G. (2010) Managerial challenges in open innovation: a study of innovation intermediation in the chemical industry. *R&D Management*, 40, 281-291.

West, J. and Gallagher, S. (2006) Challenges of open innovation: the paradox of firm investment in open-source software. *R&D Management*, 36, 319-331.

Whelan, E., Teigland, R., Donnellan, B. and Golden, W. (2010) How internet technologies impact information flows in R&D: reconsidering the technological gatekeeper. *R&D Management*, 40, 400-413.

Zogaj, S., Bretschneider, U. and Leimeister, J. M. (2014) Managing crowdsourced software testing: a case study based insight on the challenges of a crowdsourcing intermediary. *Journal of Business Economics*, 84, 375-405.