MANAGEMENT OF INNOVATION PROJECTS IN THE SUPPLY CHAINS OF AUTOMOTIVE CONCERNS

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Introduction/background: The automotive sector is one of the most important industries for many industrialized countries. More than 20,000 parts per vehicle are sourced from suppliers from all over the world. Innovation projects in the automotive sector are the most complex and increasingly implemented in an open innovation model, i.e. with the participation of designers from multiple companies (R&D organizations, OEM, component suppliers, raw material suppliers). R&D projects driven by technology developments such as autonomous driving, electrification, in-car connectivity and multimodality are leading to a transformation of the industry (the largest since the invention of the car in 1885). The application of ITC (including the use of Industry 4.0 solutions like blockchain) means a new level of management of R&D projects carried out in an open model and control of the value creation chain throughout the product life cycle.
Aim of the paper: The aim of the article was to introduce the concepts of inter-organizational innovation project management, project risk management, project management using ITC.
Materials and methods: The research method used was: a systematic literature review.
Results and conclusions: The article sought to confirm the thesis that automotive corporations are the forerunners of new solutions in the management of inter-organizational innovation projects.

Keywords: project management, R&D project, open innovation model.

1. Introduction

For many industrialized countries, the automotive sector is one of the most important industries. 2019, 92.6 m vehicles (passenger and commercial) were produced worldwide, while in 2020 it was 77.9 m - nearly 16 per cent less. China is the largest producing country with 29 m, followed by the US with 11.2 m, Japan with 9.7 m and Germany with 5.6 m vehicles. World passenger car production from 2009 to 2020 (in million units) is shown in Figure 1.

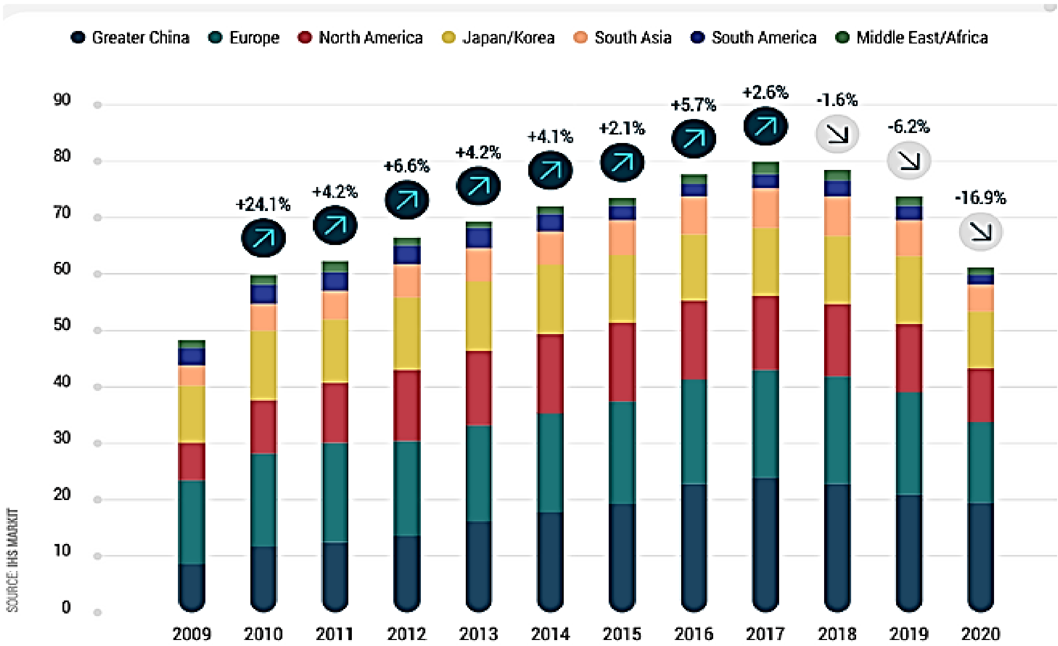

Figure 1. World passenger car production 2009-2020 (in million units).

Adapted from: AutoŚwiat, https://www.auto-swiat.pl/wiadomosci/aktualnosci/duze-spadki-produkcji-samochodow-rowniez-w-polsce/9bpln89.

The automotive industry's supply chains are among the most complex in the world, as each vehicle contains more than 20,000 parts, which typically come from thousands of suppliers around the world. Suppliers are a key driver of innovation and account for 60-70% of the value-added cost of producing a new car (Scannell, Vickery, Droge, 2000).

The automotive sector is in the midst of the greatest transformation since the invention of the automobile in 1885. The Fourth Industrial Revolution/Industry 4.0, signifies a new level of organization and control of the entire value creation chain in the product life cycle. This cycle is oriented towards increasingly individualized customer requirements and extends from product conception, through ordering, development and production, delivery of the product to the end user, accompanying services during the use of the car and recycling activities. (Bitkom, VDMA, ZVEI, 2015; Sendler, 2017).

The most important characteristic of the transformation of the sector is the network collaboration of all actors involved in value creation. This collaboration is increasingly taking place in an open model in which stakeholders have access to processes, innovation, production, logistics. Collaboration is enabled by the widespread digitization of innovation projects and processes. Within the inter-organizational environment, digitization is changing business and operating models and transforming supply chains. Collaboration and communication on digital platforms, results in improved effectiveness of R&D project management, reliability, agility and efficiency of innovation, production and logistics processes (Pfohl, Yahsi, Kuznaz, 2015).

As a recent study by Marion and Fixon (2021) has shown, there has been a significant increase in the uptake and use of project management tools, especially cloud-based ones, over the past ten years, and project teams and managers will benefit from their adoption. Marion and Fixon identified several trends in project communication.

The automotive industry is at the forefront of the fourth industrial revolution and coined the term 'Industry 4.0'. It set up a working group to clarify the requirements for a successful launch into the fourth industrial era and to develop industry recommendations for innovation design. The 'Platform Industry 4.0', an ideal thematic collaboration, was established. This platform was gradually expanded to include more actors from: companies, associations, unions, science and politics in order to align all stakeholders ("Platform Industry 4.0 - Platform Industry 4.0", 2018).

1. Management of inter-organizational innovation projects

Innovative projects are characterized by a high degree of uncertainty. An innovation project may be a failed project, or it may not be realized due to previously unforeseen technical reasons occurring at the time of its realization. With innovative projects, project activities are divided into stages to eliminate the risks.

Project management is a set of activities carried out in order to achieve the set main and intermediate objectives in a finite time. It includes, but is not limited to, the initiation, planning (including scheduling, budgeting), execution and control of the tasks needed to achieve the project objectives.

Innovation (or R&D) project management is defined as a set of logically structured activities that are not fully defined and sometimes only outlined. The refinement of the objective takes place during the course of the work in progress.

Researchers agree that an organization's innovation performance can be improved by implementing the Open Innovation (OI) concept in R&D projects and managing inter-organizational innovation projects.

Companies using the open innovation model have two very different growth objectives, i.e.: they are developing an existing business and/or a completely new business. Two types of product development challenges therefore arise, also referred to as two strategies for innovation projects, namely leveraging existing solutions and developing breakthrough solutions (Ericson, Kastensson, 2011). When developing an existing business, the company focuses on optimization and incremental development (makes incremental changes). When opening new projects, it then draws on its existing technology, experience from previous projects, including those in the IO model. Lack of design experience in a given topic means a greater need to open up to external competence and design experience, a more intensive search among potential collaborators. They require external technology and internal champions who can interact with external staff from many different functional departments (Wheelwright, Clark, 1992). An important function is that of a project manager, i.e. a person who not only enthusiastically supports the innovation project but is also personally committed to it (Cooper, 1979; Rothwell, 1992; Souitaris, 2002). Managers of innovation projects should be provided with management and funding support at the outset of the initiative, as well as support for the uptake of external solutions. Chesbrough's research has shown that R&D projects cannot be ad hoc. The course of the project must be clearly defined (described practices, systems, roles, responsibilities, risks, uncertainties). Design practices can be reduced to the four areas of recommendations shown in the table (Table 1).

Table 1.
Success factors for a project emerging from an open innovation model

1. Strategies and objectives - Communicate from top to bottom, encourage IO practices - Focus efforts and set growth targets alignment with business - Link R&D and Purchasing cell strategies and Purchasing (also create new channels of communication within and between organizations) - Communicate innovative project initiatives to suppliers (project description, concept drawing, status, assess supplier commitment, plan activities)	**2 Integration and management** - Describe company ownership and those responsible for success - Do not create separate management systems - modify existing systems (unless a new business model is needed)
3. Sources of innovation - Create deep networks in relevant areas - Innovate where R&D can add value and deliver wins - Obtain market exclusivity or purchase core technology directly	**4. Structure and organization of work** - Tailor structures and incentives to work in an open environment - Communicate link to Ol, make successes public - Present project ideas to engineers, presenting them to high level managers reduces their chance of success (operational leverage)

Source: own compilation based on: Chesbrough H., Crowther A.K. (2006), Beyond high tech: early adopters of open innovation in other industries, R&D Management 36, 3, Center for Open Innovation, Haas School of Business, UC Berkeley, CA, USA, Analysis Group, Menlo Park, CA, USA, p. 233.

Karbownik (2017) outlines how to proceed if a company decides to outsource R&D activities and indicates how to control the implementation of large projects. He indicates how to assess project maturity in the areas of methods and tools and project knowledge management.

Researchers suggest a structured approach to the 'make development or buy' decision, taken jointly by R&D engineers and purchasing staff (Le Dain et al., 2010). The decision to outsource design activities is multidimensional. The basic criteria for the 'make development or buy' analysis are cost and quality aspects (time, quality of solution, life cycle length, added values for incremental projects). Quinn (1992) advocated outsourcing for increased flexibility and shorter product development cycles, especially where new technologies are developing rapidly or are very complex. The more modular the final product, the easier the decision to purchase parts is, as there is less coordination of supplier work during the design development stage (Balwin, Clark, 1998). In addition, Veloso and Fixson (2001) argued that modularization is a key factor in increasing the responsibility of suppliers at different stages of a project in the automotive sector. Indeed, in a modular design strategy, component decomposability and interface compatibility greatly facilitate concurrent engineering with suppliers. However, analyzing product design activities requires special attention at the design preparation stage. According to Elfring and Baven (1994), automotive corporations should outsource component design to their suppliers preceding this decision with a "make development or buy" analysis.

Scholars argue that 'early allocation of roles and responsibilities with suppliers before they are contracted' contributes to improved project performance i.e.: reduced development time and costs and improved product quality (Birou, Fawcett, 1994; Primo, Amundson, 2002). Others have pointed out that 'make development or buy' analysis has long-term benefits for future projects, achieved by reducing supplier risks (Petersen et al., 2005). In subsequent joint projects, co-operators form privileged relationships and make full use of their technologies (Wynstra et al., 2001; Emden et al., 2006; Koufteros et al., 2007). Van Echtelti et al. (2008) analyzed supplier relationship management and formulated the concept of the so-called double loop of integration with suppliers at two levels of project management: strategic and operational. The study concluded that the success of collaborative projects depends on the ability to seamlessly capture short- and long-term benefits. When preparing for a 'make development or buy' analysis, it is important to rethink which organization and to what extent will be responsible for the project and its subsequent stages.

The different categories of suppliers involved in an R&D project have been defined by (Wynstra, Pierick, 2000; Lakemond et al., 2006). Asanuma (1989) was the first to divide suppliers by looking at R&D projects carried out in the Japanese automotive industry. He found that not all suppliers had the same responsibility for a project. So he distinguished categories of suppliers. His division was based on an assessment of responsibility in the project. Many authors have continued this division (Handfield et al., 1999) by calling suppliers: "no involvement"; "white box" (informal supplier), "grey box" (joint working/formalized integration), "black box" (the project is run by the supplier according to the buyer's specifications). Another breakdown of suppliers prepared by Calvi and Le Dain (2004) was based on the so-called 'Supplier Involvement Matrix'. This supplier portfolio model identifies five configurations of supplier involvement in project collaboration. The division was made along two dimensions: the level of supplier autonomy and the risk of developing the outsourced object.

The supplier's level of autonomy takes five levels: from zero (no autonomy) to four (the supplier has ownership rights to the object, and is responsible for any changes made to the object made during the project). The autonomy granted to the supplier in the development of the outsourcing object was determined according to the five-level scale suggested by Monczek et al. (2000). At the fourth level are suppliers with the highest autonomy, who, on the basis of the contract specifications, are responsible for global design (concept, feasibility studies, supply chain design, organization), detailed design, testing and creation of manufacturing and assembly processes, subsystem complex, continuous engineering. The supplier owns the intellectual property rights. At the third level of autonomy, the supplier, guided by the specification, takes full responsibility for the production concept and is then responsible for continuous engineering. It owns the intellectual property rights to part of the designed object. The second level of autonomy means that the supplier has full or partial responsibility for the detailed design, testing and configuration of production and assembly processes. The customer retains the intellectual property rights to the component and pays commissions on the supplier's design. The first level of autonomy is where the supplier is responsible for developing the manufacturing processes based on drawings provided by the customer. The supplier provides feedback on the customer's design, including suggesting improvements for cost reduction or quality improvement. At level zero, the supplier is responsible for the preparation of the production process, providing input into the customer's product design by sharing information about its equipment and production process capabilities.

Subsequent studies have turned their attention to risk. Wynstra and Pierick (2000) noted that the measurement of risk in design outsourcing requires further subdivisions of risk: internal risk, external risk, commercial risk and technical risk. To identify development risks, Calvi and Le Dain (2004) suggested six types of risk (one more was added later) that express the possible impact on the product under development. The risks extracted are: system connectivity, novelty, internal complexity, product differentiation, timeline, cost burden. Each risk is calculated based on the answers obtained from the survey question. The resulting risk score takes on a value (from 1 - very weak to 5 - very strong). The risks are defined as follows:

- System Link/System Link - refers to the interdependence between the outsourced object and other objects. The stronger the interdependence, the stronger the impact of the object on the technical performance of the final product.
- Novelty - novelty risk refers to the use of a new technology (from the customer's point of view) or the use of a known technology in a new application.
- Intrinsic complexity - refers to the number of distinct technologies or components used in the outsourced object/to the difficulty of determining the performance required by the product/to the difficulty of measuring performance, feasibility, execution of the production process.
- Product differentiation - refers to the contribution of the outsourced item to the functionality of the new product compared to previous solutions.
- Timeline - refers to the position of the outsourced item on the critical path of the development project.

- Cost burden - refers to the impact of the outsourced item on the cost of the final product.
- Project chain complexity - refers to the number of levels in the supply chain that need to be involved to complete the project order.

For each risk identified and assessed, a set of actions is prepared to mitigate the occurrence of the risk and a set of actions to respond to the occurrence of cost or quality problems associated with the project.

To divide suppliers according to autonomy and risk criteria, Calvi and Le Dain (2004) introduced five configurations of supplier involvement in a joint R&D project. Figure 2 shows this division of suppliers.

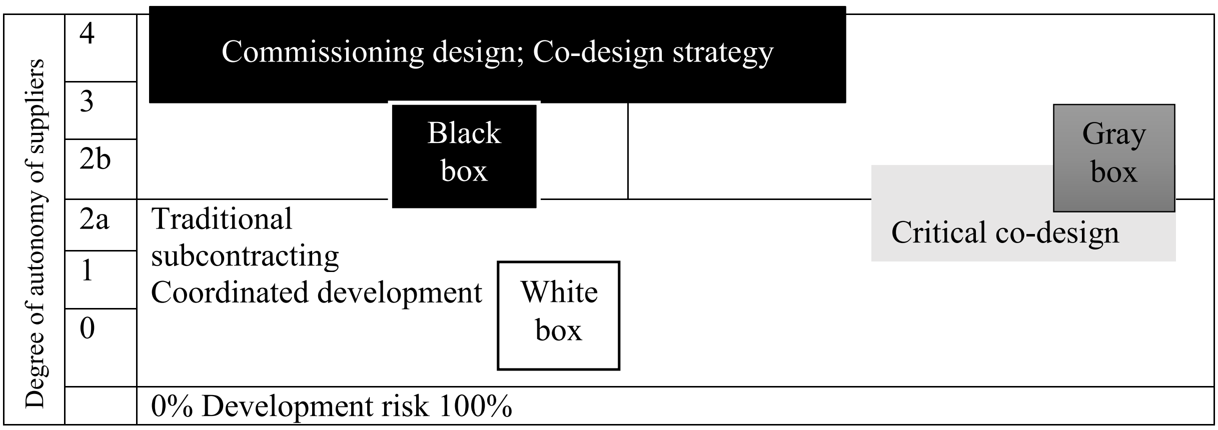

Figure 2. Matrix of supplier involvement in an R&D project.

Adapted from: Calvi R., Le Dain M.A. (2004), Le partage de l'activite´ de conception entre un client et ses fournisseurs: quels modes de coordination adopter? Collaborative development between client and supplier: How to choose the suitable coordination process? Sous la direction de Thomas Froehlicher et Bj ¨orn Walliser In La me´tamorphose des organisations—Design organisationnel: cre´ er, innover, relier, L'Harmattan, pp. 79-93; Calvi R., le Dain M.A., Fendt T., Herrmann C.J. (2010), Supplier selection for strategic supplier development, CERAG, Cahier de recherche no 2010-11 E4. https://halshs.archives-ouvertes.fr/halshs-00534830/document.

When the level of supplier autonomy is low, one speaks of a 'white box' model. The level of risk here can be either low or high but outsourced items are mainly simple parts that can still be designed internally. However, with higher risk, customer-led coordination is necessary. The aim of such coordination is to effectively integrate activities: product design and process design. When the supplier's autonomy is a high 'black box', low and high design risk are also identified. Low risk and high autonomy means that the customer 'delegates development'. High autonomy and high risk means 'strategic co-design'. In both cases, the supplier takes full responsibility for the design and development of the outsourced item. However, in strategic co-design, a high level of risk requires frequent communication to explain changes throughout the project. Grey box means high risk but limited autonomy for both parties, as in this case neither the customer nor the supplier initially has the knowledge or ability to completely design the product in-house. The higher the risk, the more the customer cares about managing the collaboration between its own project team and the supplier, but the decision to buy the project is a foregone conclusion. The matrix approach to 'make development or buy' analysis described above, also allows prioritization of supplier involvement in development projects. This approach is applied in four steps (Clark, Fujimoto, 1991):

1. Identify the degree of responsibility. This involves determining both the responsibility for the project that the project team expects the supplier to take, as well as assessing the various suppliers in terms of the responsibility they can take on.
2. Determining the level of risk. This requires answering questions on seven risks on a five-point scale. The risk assessment can also be done in percentages.
3. Assigning the supplier a position on the 'Supplier Involvement' matrix. Determining the position facilitates a 'make development or buy' decision and an appropriate relationship with the supplier. If 'buy' is selected, the order of own and supplier activities is determined.
4. The position of all suppliers (considered) is analyzed and may still change as a result of the project chain complexity analysis.

If the project chain is complex, the management of all the links becomes crucial to the success of the project. Aggeri and Segrestin (2000) introduce two criteria for assessing the complexity of a project chain:

- the number of entities/cells considered critical by the client and suggested by the first-tier supplier,
- the time required by the first-tier supplier to solve a problem occurring in its design chain; this time determines the framework of the design chain (the number of next-tier suppliers).

The complexity of the chain affects the cost of coordinating the design in that chain (Novak, Eppinger, 2001). The supplier involvement matrix should be completed with all first-tier organizations involved in the project. For each organization, the autonomy is defined and the risk of running the project is assessed.

A risk analysis in a systemic way by the client is necessary before signing contracts with suppliers (it can also prompt a 'make development' decision). A decomposition of this analysis must be made available to future suppliers, in order to encourage them to make efforts to mitigate risks before starting the project. The client should define the possible responses of the supplier to the risks involved. Acceptance of the expected responses facilitates the supplier selection process. If the project team uses stage gates in the innovation development process, the assessment of the supplier's competencies and resources and the responses on project risk levelling close the supplier sourcing stage and allow to move to the final selection of suppliers.

The signing of the contract starts the project work. In the first instance, work is programmed for first-tier suppliers. When defining the design chain, decisions are made on the roles and responsibilities that will be handled by the suppliers in the project and the timing of entry into the project. The timing of supplier involvement is important. Researchers believe that it is useful to involve suppliers early in the project (even those whose tasks come later), then they will be more strongly involved. A dedicated project platform and communication channel is launched for each project. The project manager always defines milestones and an external purchasing account at the first stage, in which he provides a first estimate of the purchasing costs. Until the end of the project, he or she is responsible for the results and cost monitoring. The researchers proposed a number of plans to respond to the occurrence of risks also during design.

At each stage of project development, 'relational' problems arise. The project manager attempts to solve them. In order to solve these problems quickly, it is useful to prepare employees for the roles of 'good cop and bad cop'. A purchasing employee can be a bad policeman (Brattström, Richtnér, 2013), and an R&D employee a good one. Research findings indicate that the success of the first stages of innovation projects depends on the earlier favourable attitude of the purchasing staff, who facilitated conversations, integrated, demonstrated the ability to manage alliances (Kale et al., 2001). Once a project is launched, their attitude towards the supplier may change. (Phillips et al, 2006) refer to this change in attitude as 'strategic gamesmanship'. It is a brief change of role for the purposes of one project, linked to the need to solve problems. The trade-off between the different objectives of designers is achieved differently from one company to another. There are cultural differences. Japanese suppliers focus more on quality and customer satisfaction, while Western companies tend to emphasise the productivity dimension first. Also, compared to Japan, in the West, improvements are more short-term oriented (Stainer, 1997).

For each project, a person is appointed to 'accompany the suppliers for administrative requests', a support task can be fulfilled by the IT system (stores and groups contracts, supports procedures for obtaining subsidies related to the innovation project, etc.).

The R&D and purchasing cells participate in each monthly Innovation Committee. They have validation and veto rights at each stage of the project involving external partners (supplier or research consortium).

Typically, project risks are managed as follows: possible causes of risk are identified, the probability of their occurrence is determined. The calculated risks are analyzed by the IO project team. A risk response plan is prepared. And the risks that occur are subject to monitoring and control.

The term uncertainty is prominent in the literature. Although the terms, risk and uncertainty appear mostly as synonyms, some researchers give them different meanings and use them in different contexts. The meaning of risk is closer to cause and consequence and has to do with the associated probability of occurrence and available information. Uncertainty, is discussed in the context of lack of knowledge in decision-making. Perminova et al. (2008) define uncertainty as the difference between the total knowledge required to perform a task and the existing knowledge. Many innovation projects are accompanied by uncertainty. In their research on uncertainty management in projects, Meyer, Loch and Pich, (2002) noted that risk management is oriented towards identifying and controlling change and predictable uncertainties. However, for innovative projects or in projects embedded in dynamic environments, there are large uncertainties and traditional risk management methods are insufficient. R&D projects need to focus on reliability, flexibility, and learning. Goffin and Mitchell (2005) confirm that dealing with risk and uncertainty is at the heart of managing innovations arising in IOs. In the most cited articles on risk management in R&D projects, the authors distinguish between uncertainty and risk management and focus on soft skills (Sharma, Gupta, 2012), which are supposed to help implement flexible management (Dingsoyr et al., 2012). Huchzermeier and Loch (2001) list the values of flexible management in research and development (R&D) projects. The authors focus on time uncertainty.

Regarding the flow of information in new product development projects, Eppinger speaks out. Eppinger (2001) believes that the processes of acquiring a new solution including joint R&D projects should be analyzed more in terms of information flow than the execution of activities by handover.

Wang and Lin (2009) dealt with project delays and reviewed the probability of risks associated with repetitive activities in a new product development project. Zwikael and Globerson (2006) described critical success factors considering successful and unsuccessful projects. The risk of technology incompatibility was addressed by Green et al. (1995), who presented a study of radical technological innovation that addressed the risk of incompatibility between project partners' technologies. Lewis et al (2002) found that there has been an increase in the diversity of management styles, and that this affects the performance of project teams. Uncertainty was described as a lack of knowledge and shared management style. Clegg et al. (2002) presented the concept of equal power in inter-organizational projects as a liberal form of governance. According to the authors, such governance can support quality management in projects, the concept of alliance, knowledge sharing and reducing transaction costs.

As suggested by Lechler et al (2012), even technical specifications and simple design activities are subject to unpredictable uncertainty, and the number of such uncertainties is steadily increasing (Hanisch, 2012). Losses of added value by co-operators have been analyzed. In creating project risk scenarios, it is worth considering the loss of value: ecological, economic market, social. The ecological risks of the project were dealt with by (Grabher, 2004), the social risks (dissolution of the cooperation network, weakening of stakeholder commitment, unfavourable organizational culture for the project) were dealt with by Crawford et al. (2006). The analysis of individual behavior (excessive expectations, involvement of intuition and emotions in judgements, biases and power conflicts, loss of trust and unwillingness to learn) was dealt with by Gladwell, (2006). The loss of market and economic values (associated with prolonged design time) was dealt with by Söderlund et al. (2009), considering these values as critical. Thamhain (2013) believed that there are key issues in all links of the project team and their environment that need to be looked at in order to analyses the risks to project management.

The researchers believe that the integration of unknown and identified risks requires a risk management strategy based on the soft skills of themselves and their suppliers. Soft skills for dealing with the uncertainties of R&D projects include: flexibility (Huchzermeier, Loch, 2001), knowledge management (Hall, Andriani, 2003), ability to form alliances (Clegg et al., 2002), ability to improvise (Leybourne, 2006) and resilience to stress (Thomas, Mengel, 2008).

2. The role of ICT in the management of collaborative innovation projects

The use of project risk management practices is still low in organizations (Zwikael, Sadeh, 2007). Fortunately, ITC tools are emerging that effectively deal with the described project risks.

ICT tasks for R&D projects were attempted by Aloni et al. (2017). They prepared a conceptual design of an integrated ICT platform to support the open innovation model. It includes a conceptualization of the main functions, a preliminary design, a proposal for an overall system architecture and a data model.

ITC creates access to information; creates direct access to suppliers, customers and other companies; creates a network between actors/organizations involved in innovation development. Interactive technologies are key to creating a collaborative design environment in industry. They enable designers, engineers, managers and customers to collaborate on the development of a new product or process, regardless of their geographical location. ICT supports collaboration in both virtual and physical spaces. A hybrid virtual-real environment is the optimal infrastructure for creative group work. Collaboration can be established in the early and late phases of the innovation process and subsequently the innovation project (Lindermann et al., 2009).

There are many tools available to support group work. The most important of these is a software package for creating a collaborative workplace via the web, developed by Fraunhofer. The package called Basic Support for Group Work (BSCW) enables: document attachment, event reporting and group management. Project stakeholders only need to have a standard web browser. Using the solutions developed by BSCW, many large organizations have developed their own co-design systems.

The systematic collection of knowledge in databases and its codification enables knowledge to be shared between employees/organizations in a structured way. Knowledge management using ICT is the process of capturing, disseminating and effectively using knowledge (Koenig, 2012). ICT is now central to all innovation processes and projects.

In innovation design in open models, the function of ICT boils down to integrating external and internal knowledge, in design development, virtual prototypes, templates of different design versions, automatic generation of technical documentation. The above are enabled by CAD/CAM systems and associated tooling. Modules related to knowledge storage and automation of the design process have, for example, CAD systems such as CATIA (Sycz, 2012). There are many ICT tools for creative problem solving e.g.: IWB (Innovation WorkBench). Such software packages use diagrammatic representation of problems and automatic analysis of generated diagrams, leading users to an abstract solution. The Innovation Assessment Program - invented by the United Inventors Association - helps inventors, entrepreneurs and marketing professionals to honestly and objectively analyses the risks and potential of ideas and inventions, and focuses on evaluating the invention (Sorli, Stokic, 2009).

The automotive industry faces the task of developing open-source innovations. The Automotive Grade Linux (AGL) community at the Linux Foundation is building an open source platform that can serve as a de facto industry standard. The common platform allows developers to create an application once and have it run everywhere. Car manufacturers can focus on developing new products and innovative new features that can be brought to market faster. The AGL Unified Code Base (UCB) infotainment platform is rapidly gaining popularity across the industry. Toyota adopted the AGL platform for its next-generation infotainment system in 2018. Dedicated ICT tools are available to project teams appointed by Volvo. They help project managers to analyses project risks, minimize those risks and document team management.

ICT tools still have much to offer in the area of initiating relationships between innovators. Initial research has focused on the phenomenon of open source free software (von Hippel, von Krogh, 2003), crowdsourcing platforms (Di Gangi, Wasko, 2009; Leimeister et al., 2009) , online innovation brokers (Whelan et al., 2013) . The contribution of ICT to knowledge absorption capacity has been analyzed (Chatterjee et al., 2002) , as well as new technologies for data mining, simulation, prototyping and visual representation to support collaborators in new product development (Dodgson et al., 2006). Currently, there is intensive development of design software in the IO model, based on Blockchain & Smart Contract technology. The Networking Innovation Room (NIR) model is a novel model for the protection of collaboratively created Intellectual Property IP (IP), embedded on the Blockchain platform. NIR proposes the use of a Non-Disclosure Agreement (NDA) as a smart contract, where the remuneration is a virtual currency of 'Wits' measured in 'Cleverness' (Carrillo, de la Rosa, 2007). Blockchain is a peer to peer platform using ICT to track ownership of generated and transferred assets in an IO model (Bogers et al., 2017). Smart inter-organizational contracts, are run and stored on Blockchain (Tapscott, Tapscott, 2016). NIR controls the value added by co-operators, thereby reducing companies' concerns about losing or undervaluing intellectual property contributions. In the NIR concept, special care is given to SME firms (Bikfalvi et al., 2016). Everything that companies report is disclosed in the NIR and is also time-stamped, indexed, preserved, searchable and traceable, and reported when requested by collaborating companies. The Enterprise Europe Network (EEN) using the NIR-VANA platform is considered the largest organization and platform in Europe. EEN coordinators believe that the integrated modules in the NIR already support the work of EEN advisors by enforcing workflows. The process of sourcing innovative solutions using the NIR model can be boiled down to the following activities:

1. an SME application/co-operation offer is registered and then prepared for use on www.imtdemo.eu, which is an online CRM tool for EEN consortia activities, and on www.easypp.eu, which is a tool for online co-creation of partnership profiles between SMEs and EEN advisors;
2. an Expression of Interest (EOI) is sent via NIRVANA to EEN advisors potentially interested in the proposal/offer;
3. the EEN advisor receives the EOI and finds interested partners often among SMEs.
4. parties are invited to attend the NIR to co-create the EOI project, once the NDA confidentiality agreement is signed, the collaboration begins. Interactions, data and IP protection are developed in the NIR.

It is recommended that NIR participants declare the intellectual property and knowledge contributed, and NIR will signpost the contribution of values over time and store them. Values are cited and disclosed at the same time. Companies apply for property protection. They will need protection to implement the consortium agreement, in future project proposals or to document their contribution to co-created solutions. Smart contract - the NDA confidentiality agreement is digitally accepted and can be signed when the user enters the NIR. The agreement clearly describes the IP regime within the NIR and how the co-created innovation will be protected. All those who want stronger IP protection in the NIR perform peer review of the IP in another NIR (Lusch, 2015). The function of the application under development is to sign legally binding smart contracts, which are produced using artificial intelligence that creates a trail of records on the block chain. This process is also called 'IP document notarization'. Inventions, designs, evidence can be quickly registered and a blockchain certificate will confirm the ownership, existence and permanence of the IP asset. All secured notarization, information will remain private through cryptography.

Table 2 compares the functionalities of different Blockchain platforms, with a possible composition of functionalities: (PoE timestamp, integrity and notarisation; IP registry; Content metadata; User authentication; Inventory; Access control; Licensing; Traceability; Citation monitoring; Reward mechanisms; Proprietary currency; NDA management; Industrial property registry; Proof of receipt).

Table 2.
Functionality of various interactive blockchain platforms

	PoE time stamp	IP register	Content metadata	User authentication	Evidence	Access control	Licensing	Traceability	Monitoring of citations	Reward mechanisms	Own currency	NDA management	Industrial property register	Proof of receipt
Blockai.com	+	+												
Originstamo.org	+	+												
Poex.io	+	+												
Bitcoin.com	+	+												
Blocknotart.com	+	+			+									
Copyrobo.com	+	+			+									
Sidnatura.co	+	+		+	?									
Po.et	+	+	+	+	+	+	+	+		+	+			
Creativechain.org	+	+	+	+	+	+	+	+	+	+	+			

Adapted from: Tapscott D., Tapscott A. (2016), Blockchain Revolution: How the Technology Behind Bitcoin is Changing Money, Business, and the World", Penguin Random House.

A smart contract is a solution that is used to create accounts, works between two or more participants. It allows the partners to establish a business relationship without any authority or intervention from the head office. The fairness of the transaction is secured and guaranteed not by the agents, but by the ICT system. Smart contracts are based on computer coding (using software that formally encodes terms and outcomes). The coding requires the agreement of the parties to the contract. Ethereum, which is a more advanced version, uses a virtual currency used to pay for the use of smart contracts. A smart contract can embed the contract entirely in its code or extend the natural language of the contract with encoded performance or with an encoded payment mechanism. There are already frameworks that help implement smart contracts, such as OpenZeppelin, Solidity, Enterprise Smart Contract Framework, Embark or Populus. The Smart Contracts Alliance (Smart Contracts, 2017) presents 12 smart contact use cases:

- Digital Identity.
- Records to store digital files, enable auto-renewal and release.
- Securities enable automation of dividend payments.
- Trade Finance: faster acceptance and payment initiation.
- Derivatives: enforce standard terms and conditions, eliminate duplicate records and check processes.
- Recorded financial data: uniform results, accurate recorded financial data.
- Mortgages: tool enables automatic payment processing and issuance of mortgages.
- Title recording: the tool prevents fraud and property transparency in transfers.
- Supply chain: provides reliable tracking of goods from factory to shop.

- Car insurance: recording of policies, driving records, accident processing reports.
- Clinical Trials: tool improves visibility during privacy.
- Cancer Research: improving data sharing between sectors.

Part of intensive innovation, requires fintech services, (Khan et al., 2017). Smart workflow linkages across the collaborative community are possible. Agreements are required on what each player has to do in the collaborative process, when and what corrective actions are to be applied, what rewards or penalties are applied for achieving/not achieving task milestones, etc. In this way, the open innovation pathway proposed by Chesbrough (who advocates smart contracting in his most recent publications) can be developed.

The established "Platform Industry 4.0" - an ideal thematic collaboration including automotive design is supported by international standardization bodies. While the degree of standardization in individual countries is at a relatively high level, standardization between automotive companies from different countries is often in its infancy. Free data conversion tools have therefore been developed. When data is encoded in a different way, it needs to be translated to make it accessible. Automotive decision-makers sponsor, develop and offer the resulting software for free or support the open-source community that works on such software. Data security is a fundamental requirement for the digital transformation of innovative automotive projects. This includes confidentiality (access only by authorized parties), integrity (modification only by authorized parties or by authorized means) and availability (legal access is not prevented). Automotive decision-makers support data security throughout the supply chain with the development of recommendations. With clear recommendations, all actors across the supply chain can publish more securely. Published data is classified as sensitive, classified and stored accordingly.

To increase the transparency and accountability of its supply chain for raw materials and the development of battery components, the BMW manufacturer has implemented block chain technology. Cobalt, the key mineral needed for electric car batteries, mainly comes from the Democratic Republic of Congo. Here, around 20 per cent is produced by artisanal miners, operators - often children - who mine by hand under threat of human rights violations and negative health impacts (Amnesty International, 2016). BMW has used block chain to reassure stakeholders (designers, manufacturers, customers) that it only uses cobalt mined in line with Corporate Social Responsibility in its batteries (Lewis, 2018).

3. Conclusion

This paper presents possible ICT solutions to support the management of inter-organizational innovation projects. Automotive companies are not only adapting innovation processes internally, but also experimenting with new patterns of collaboration with other actors. They are finding creative ways to collaborate with start-ups and supply chain partners.

A key challenge for innovation project management is digitalization. Digitization requiring inter-organizational and international standardization of data, data security and makes it easier for designers to acquire data security skills.

Solutions, standardization and security for innovation projects can be found in the automotive industry.

Based on a literature review, a conceptual framework for the management of inter-organizational innovation projects is introduced. Digital technologies for secure interaction were addressed. Platform capabilities are presented. Only selected platform capabilities supporting inter-organizational management of innovation projects are used by companies. Most often, the solutions mentioned are implemented by the automotive industry. Decision-makers in the automotive industry associated with Platform Industry 4.0 are aware of the possibilities, but also of the need to standardize solutions. A study by Marion and Fix on (2021) shows that the application of innovation design using digital platforms is a challenge for automotive companies, which are still very autonomous in R&D activities, traditional and hierarchical. And if component design is done in an open model, it is done in an asynchronous way. Platforms for cross-organizational innovation design are a key challenge for the future and for further research. To remain innovatively competitive, automotive companies must adopt them.

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