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A New Maturity Model for Project Risk Management in the Automotive Industry

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ABSTRACT

The purpose of this article is to present a new maturity model for the assessment and ongoing management of project risk management capability in the automotive industry. The research design is based on a multi-project case study analysis in a major German automotive company. The approach is qualitative and inductive, using 12 in-depth interviews with major stakeholders in the project management function in the company to provide data for the construction of the initial maturity model. This model is then verified and refined via an on-line survey and three follow-up interviews. The findings provide material for the construction of a new maturity model that can be used for the assessment of project risk management capability and as a tool for on-going monitoring and improvement. The model is structured around four dimensions of risk management – identification, assessment, allocation and appetite – and has four maturity stages – rudimentary, intermediate, standardised and corporate. The model is based on a detailed analysis of in-depth interview material in a specific industry sector. It can be used as a basis for similar research in other industries. The model adds to existing risk management maturity models and is unique in being specific to the automotive industry. It can be used by risk and project managers, and can also be adapted to other industry sectors.

KEYWORDS

Centricity, Maturity Model, Project Risk Management, Risk Identification and Assessment, Risk Management, Risk Ownership and Appetite

1. INTRODUCTION

The management of risk is an integral part of the project management process and project failure remains an area of considerable concern in contemporary project management literature (McClure, 2007). Comprehensive risk management increases the probability of project success, and recent empirical studies show a significant positive relationship between project risk management and project outcomes (Jen, 2009). Risk management has become a significant element of some of the most widely deployed industry standard methodologies, yet there is no universally agreed method for managing risk; and, in part because of this, there have been some attempts to suggest more flexible and creative approaches to risk management (Bollinger, 2010).

Project risk management is a fundamental discipline in most industry sectors and can be defined as the process that dynamically minimizes risk levels by identifying and ranking potential risk events, developing a response plan, and actively monitoring risk during project execution (Zwikael & Ahn, 2011). It has implications for the effectiveness of the project management process itself, and for the management and communication of knowledge that is an inherent part of that process. Several organizations have developed industry specific formal policies and supportive analytical

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tools. Application of integrated risk management methods can support early risk identification and assessment, thereby improving project outcomes and avoiding delays and cost overruns (Zayed, Amer, & Pan, 2008).

Practitioners and researchers agree on the potential of risk management concepts and methods to improve the likelihood of project success in practice (Bannerman, 2008; Aloini, Dulmin, & Mininno, 2012; Martínez Lamas, Quintas Ferrín, & Pardo Froján, 2012). This research focuses on the development of a new maturity model for the assessment, monitoring and management of project risk capability in the automotive industry, specifically in a European context. The maturity concept first appeared in business and management literature in the 1980s and has become a mainstream concept for assessing organizational capability, and is thus appropriate for the study of risk management in a corporate setting. The following section explores relevant literature in this field, followed by a detailed explanation of the research methodology employed, and how the initial model was developed. It also then discusses how data from the in-depth interviews was analyzed, and how the initial maturity model was verified. Section 4 applies the model to one in-company project as an illustration of how the model can be used, in a manner that can be built upon by other researchers and practitioners. The final section draws together key themes covered in the article and assesses the contribution to research and practice.

2. LITERATURE REVIEW

2.1. The Key Dimensions of Risk

Risk identification is often viewed as the starting point for risk management in projects and is considered to be the most influential risk management activity for project outcomes (de Bakker, Boonstra, & Wortmann, 2012). It is recognized by many project managers as one of the key areas in need of improvement in complex projects (Harvett, 2013). The risk identification process was therefore seen as a key element of the maturity model. Holzmann (2012) views risk management as comprising five main activities, encompassing risk identification, risk assessment, risk allocation, and risk control. Other authors (Bannerman, 2008; Harwood, Ward, & Chapman, 2009) see risk appetite or treatment as an important dimension for overall risk management. This research combines elements drawn from these sources to focus on four main dimensions of risk management: risk identification, risk assessment, risk allocation and risk appetite; and it does not see risk in a purely negative context, but also recognises the potential of positive risks or opportunities.

Risk identification is the process by which the project team detects prospective events which might affect the project and documents their characteristics (Holzmann, 2012). Risk identification is considered to have the highest impact on the effectiveness of project risk management and involves the detection and classification of all known and - as far as is possible - unknown, risks, thus producing the foundation upon which the overall risk management process can be established (Chapman, 2001). Risk identification is also perceived as the most influential risk management activity (de Bakker, Boonstra, & Wortmann, 2011; de Bakker et al., 2012), and particularly in complex projects is seen as an area in need of improvement (Harvett, 2013).

There is a clear link in the extant literature between risk identification and the “risk as a subjective construct” concept. The identification of risk as a subjective phenomenon coincides with its creation – the risk exists only once the stakeholder has identified it. However, as Khan and Burnes (2007) put it, whether one views risk from a subjective or objective standpoint, the key question for organisations is: how can risk be managed? Risk identification can be performed in a number of ways, such as filling in questionnaires, consulting experts or available documentation from previous projects, doing brainstorming sessions, or conducting interviews.

The concept of centricity can also be applied to risk identification, and the other dimensions of risk discussed below. Centricity in a managerial context can be defined as the mind-set or attitude that characterises the manager's or organisation's outlook and motivation in relationship to others (Berntzen, 2013; Olsen & Roper, 1998). The identification of risk as a subjective phenomenon can be seen as person-centric, whereas objective risk identification is at the other end of the centricity spectrum. Visual aids like the Visual Ishikawa Risk Technique (VIRT) can overcome the person-centric identification issue and promote objective risk identification (Jen, 2009). Centricity has been extensively analysed and applied in relation to customer, user and citizen concepts, and also in process and network contexts (Berntzen, 2013; Blakemore, 2006; Lamberti, 2013; McDonald, 2006).

Project *risk assessment* is the stage in the risk management process at which each identified risk is assessed for its probability or likelihood of occurrence, and its impact - in terms of time, cost and quality - on either the project phase or the entire project, should it occur (Patterson, 2002). Risk assessment entails the study of the probability of occurrence and any associated consequences. Generally speaking, two broad categories of risk assessments have been used - qualitative risk assessment and quantitative risk assessments (Dawotola, Gelder, & Vrijling, 2012). Qualitative risk assessment makes use of descriptive scales for the assessment of probabilities, such as risk scores. These scores or rankings are subject to interpretation and therefore entail an inherent level of subjectivity (Dawotola et al., 2012). The application of qualitative risk assessment suffers some serious limitations, mainly the subjectivity of the values estimated. Qualitative risk analyses are flawed in the sense that they can produce wildly different results (Emblemsvåg & Kjølstad, 2006).

Organizations have developed checklists based on which type of risk assessment is performed. Research shows that perception of risk varies between stakeholder groups, over time, across project and life cycle stages, and between cultures. This leads to the conclusion that risk assessment based on published checklists may be biased and/or limited in scope (Bannerman, 2008). Risk matrices are one of the most popular risk assessment methodologies employed across many industries, providing the graphical output that enables the communication of risk assessment. The development of risk matrices (RMs) has taken place in isolation from academic research in decision making and risk management – risk matrices produce arbitrary decisions and risk-management actions. These problems cannot be overcome because they are inherent in the structure of RMs (Thomas, 2013). Their theoretical basis is superficial and the validity of the qualitative information they employ is highly suspect. Assessments of the likelihood of occurrence and their impacts suffer all the shortcomings associated with subjective assessment (Wall, 2011).

Risk allocation is a major task in the overall risk project management process (Harvett, 2013), and is based on the recognition that different parties have different objectives and perceptions of project risk, as well as varying capabilities for managing associated sources of uncertainty. Chapman and Ward (2007) consider risk allocation (or risk ownership as it is sometimes termed) a relevant phase within their formal process framework SHAMPU (Shape, Harness, And Manage Project Uncertainty). It involves allocating responsibility for managing project uncertainty to appropriate project parties. These allocations are fundamental because they can strongly influence the motivation of parties and the extent to which project uncertainty is assessed and managed by each party.

Risk allocation is related to the more general concept of business ownership which has seen a range of business functions take responsibility for various aspects of project delivery. In the past IT or engineering functions often owned exclusively the risk in their related projects. Now, it is often the case that the function in charge of the project helps business partners to take ownership of specific risks and assists them in making assessments and in following compliance mechanisms by themselves (Chobanova, 2014).

Project *risk appetite* (sometimes called risk treatment or risk propensity) reflects an organisation's attitude and strategy towards risk. It encompasses how risk is managed and whether exposure to risk should be reduced, or the impact of risk should be mitigated, transferred, externalized or accepted. These responses can be supported by a framework providing risk factor dependencies and priorities (Aloini et al., 2012). Harwood et al. (2009) see risk propensity as the organizational behavioural tendency towards taking reasonable risks, by recognising, assessing and managing risks. A riskaverse organisation is seen to have low risk appetite, and will take only those risks that are judged to be tolerable and justifiable.

A balanced treatment of risk would focus both on risk and reward. An overemphasized focus on risk versus reward may have considerable influence on strategic decisions such as entering new markets, developing new products or targeting new mergers and acquisitions (TowerGroup, 2014). Resultant executive inaction may lead to loss of potential revenue growth. Education and training in project risk management with subsequent additional experience in the organization can produce a better understanding of risk and reward. Risk management can then be understood as a protection shield, not an action stopper. Manager and employees learn through education and training to take and manage risks, not to avoid them. The organization will treat risk appropriately and not try to circumvent it.

2.2. Existing Maturity Models

The maturity concept has featured in a range of models used for assessing organizational capabilities encompassing the collective skills, abilities and expertise of an organization. Maturity can be understood as a measure of organizational performance in applying these capabilities. There are two major approaches to organizational maturity. The Organisational Project Management Maturity Model (OPM3) measures organisational maturity based on the level of best practices deployment, while the Capacity Maturity Model Integration (CMMI) assesses maturity based on organisational process effectiveness (Man, 2007). Further, organisational capabilities may refer to both processes and projects (Maier, Moultrie, & Clarkson, 2012). Assessing an organization's project risk management maturity level can help develop its project capability and performance. Risk management maturity reflects the organization's understanding of its risk portfolio and its attitude towards those risks. Organizations intending to implement or improve their project risk management need a framework against which they can benchmark their current practice (Zou et al., 2009), and maturity models can be used to identify the priority areas in need of improvement, and remedial actions can then be taken to increase performance (Hopkinson, 2012; Ciorciari & Blattner, 2008).

Hillson (1997) was an early proponent of risk maturity models. His approach consisted of four attributes (culture, process, experience and application) and four levels of maturity. His model (Table 1) is not industry specific and does not focus on risk in projects, but is a general organisational approach to risk. Yeo and Ren (2009) developed and tested a five-level maturity model (initial, repeatable, defined, managed, and optimizing) with three key capability areas: organization culture; risk management process; and risk management knowledge and technology, based on research of Asian offshore and marine projects. Similarly, Zou et al's. (2009) risk management maturity model was industry specific, in this case the construction industry in Asia and Australia. It had four maturity levels (initial, repeated, managed and optimized), and encompasses risk identification, risk assessment and risk appetite - but not risk allocation - in projects.

An extension of Hilson's maturity model is Hopkinson's (2012) Project Risk Maturity Model, which establishes a framework for assessing risk management capability against recognised standards. Hopkinson's model offers a working model to assess risk management capacity and applies it to an equipment procurement case study. Crawford (2006) identified some key issues for developing and applying project management related maturity models. One is the intrinsic subjectivity associated with the determination of an organisation's maturity. Crawford also concluded that, rather than necessarily striving to achieve the next level of maturity, organizations should instead determine their minimum level of maturity at which optimum value can be achieved (Crawford, 2006). Maier et al. (2012) established a roadmap to develop maturity grids for assessing organizational capabilities. They review existing maturity models and conclude that they offer a contemporary representation of different conceptualizations of organizational practices and capabilities that are viewed as important for success.

Table 1. Attributes of Hillson's Risk Maturity Model (Hillson, 1997)

	LEVEL 1 - NAIVE	LEVEL 2 - NOVICE	LEVEL 3 - NORMALISED	LEVEL 4 - NATURAL
DEFINITION	Unaware of the need for management of risk. No structured approach to dealing with uncertainty. Repetitive & reactive management processes. Little or no attempt to learn from past or to prepare for future.	Experimenting with risk management, through a small number of individuals. No generic structured approach in place. Aware of potential benefits of managing risk, but ineffective implementation, not gaining full benefits.	Management of risk built into routine business processes. Risk management implemented on most or all projects. Formalised generic risk processes. Benefits understood at all levels of the organisation, although not always consistently achieved.	Risk-aware culture, with proactive approach to risk management in all aspects of the business. Active use of risk information to improve business processes and gain competitive advantage. Emphasis on opportunity management ("positive risk").
CULTURE	No risk awareness. Resistant/reluctant t to change. Tendency to continue with existing processes.	Risk process may be viewed as an additional overhead with variable benefits. Risk management only used on selected projects	Accepted policy for risk management. Benefits recognised & expected. Prepared to commit resources in order to reap gains.	Top-down commitment to risk management, with leadership by example. Proactive risk management encouraged & rewarded.
PROCESS	No formal processes.	No generic format processes, although some specific formal methods may be in use. Process effectiveness depends heavily on the skills of the in-house risk team and availability of external support.	Generic processes applied to most projects. Formal processes, incorporated into quality system. Active allocation & management of risk budgets at all levels, Limited need for external support.	Risk-based business processes. "Total Risk Management" permeating entire business. Regular refreshing & updating of processes. Routine risk metrics with constant feedback for improvement
EXPERIENCE	No understanding of risk principles or language.	Limited to individuals who may have had little or no formal training.	ln-house core of expertise, formally trained in basic skills. Development of specific processes and tools.	All staff risk-aware & using basic skills. Learning from experience as part of the process. Regular external training to enhance skills.
APPLICATION	No structured application. No dedicated resources. No risk tools.	Inconsistent application. Variable availability of staff. Ad hoc collection of tools and methods.	Routine & consistent application to all projects. Committed resources. Integrated act of tools and methods.	Second-nature, applied to all activities. Risk-based reporting & decision-making. State-of-the-art tools and methods.

2.3. Provisional Conceptual Framework

Whilst some of these maturity models are of value in certain industry contexts, there is no maturity model specifically geared to project risk management in the automobile industry. This research addresses this gap by building and verifying a maturity model for the automotive industry in Europe. The initial conceptual framework for this model builds upon the four dimensions of risk discussed above – identification, assessment, allocation and appetite. These can be defined as:

- **Risk Identification:** The process by which the project team detects prospective events which might affect the project and documents their characteristics (Holzmann, 2012).
- **Risk Assessment:** The stage in risk management at which the identified risk is assessed for its probability (likelihood) of occurrence and its impact, in terms of time, cost and quality (Patterson & Neailey, 2002).
- **Risk Allocation:** The assignment of the responsibility for managing specific project risks or uncertainty to appropriate project individuals or parties (Harvett, 2013).
- **Risk Appetite:** The organizational (or individual) behavioural tendency regarding how to take reasonable risks (Aloini et al., 2012).

The research attempts to identify typical risk characteristics that can be associated with each of these four dimensions of risk at different stages of maturity in the risk management process. Like some of the models discussed above, the proposed model was assigned four stages with provisional stage labels of Rudimentary, Intermediate, Standardised and Corporate. Maturity models typically have either four or five stages, but in the five stage models, the difference between stages one and two is generally minimal, with stage one often describing a non-existent or minimal initial capability. Four stage models have the additional benefit of avoiding an assessor's tendency to select middle values (Zou et al., 2009). These stages can be defined as follows:

- **Rudimentary:** The organisation has no sense of need for risk management; teams do not follow any common approach in managing risks. Project risk activities are reactive and no lessons learned or improvement process is established. Typically no project risk plan exists.
- **Intermediate:** Some project management practitioners undertake certain project risk management activities. Neither these activities, nor the systems and applications used to support risk management, are standardised. The organisation does not gain the full benefit of implementing these risk management activities.
- **Standardised:** Risk management is seen as part of core business processes, and risk responses and their effectiveness are reviewed in most projects. Systems and applications supporting risk management are accessible and lessons learned are established to improve the overall risk management process.
- **Corporate:** The entire organisation recognises and values risk management, which is integrated into other processes. Executives actively audit and support risk owners. Multi-user risk databases are widely available and used as part of continuous improvement programs.

3. RESEARCH METHODOLOGY

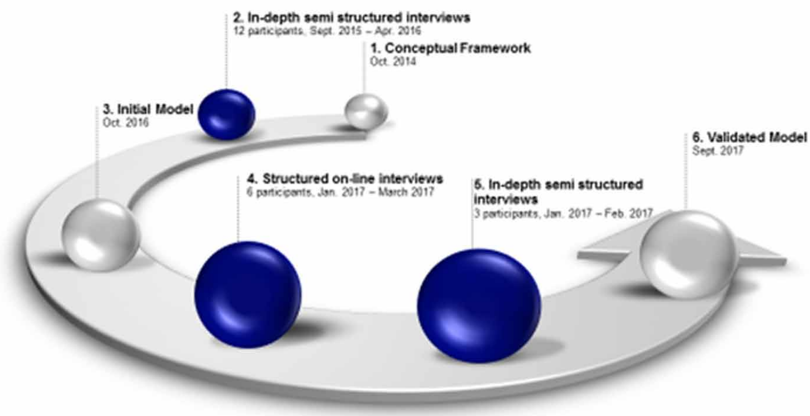
3.1. Overview of the Research Process

The overall research process (following the literature review) is depicted in Figure 1, and consists of six main steps. The process was largely sequential, although the interviews in steps four and five were conducted partly in parallel but independent from each other. The research centres on a single company case study, with two projects within that company analysed. The case study entails a "…detailed investigation of one or more organisations, or groups within organisations, with a view to providing an analysis of the context and processes involved in the phenomenon under study…" (Hartley, 2004, p. 323). This is exploratory research that adopts a qualitative approach. Project management success is complex, messy, and involves a range of stakeholders with different concerns and perceptions (Skinner, Tagg, & Holloway, 2000). A qualitative approach is particularly appropriate for research that seeks to explore real organizational goals, linkages and processes in organizations; to understand the failure of policies and practices (Marshall & Rossman, 2014).

The research is inductive, in that it builds explanations of risk management in practice from the ground up, based on interview evidence, observations, and analysis of available documentation. The interview is an important source for collecting data, and may take several forms (Yin, 2012). To achieve quality in data collection, interviews must be carefully planned. Data collection was undertaken through 12 semi-structured interviews, three follow-up in-depth interviews, an on-line survey, informal discussions, secondary material, and participant observation. The first batch of interviews, involving the 12 participants, were conducted in 2015/2016 (step 2 in Figure 1).

This research took place within the automotive industry, one of the leading manufacturing industries worldwide, where scientific method has an undeniable influence in manufacturing industry development. Operational research and systems engineering are two of the main academic disciplines that provide the basis for process improvements in this industry. The underlying theoretical perspective

Figure 1. Research design, model development and validation process



of these disciplines is positivism (Taylor, 1911), and the concept of separating planning from doing is reflected in the emphasis on planning and control in modern project management. Furthermore, rationality, universality, objectivity, value-free decision making, and the possibility of generating law-like predictions in knowledge are basic assumptions of modern project management (Gauthier & Ika, 2012). The traditional project management paradigm has been described as "rational, normative, positivist and reductionist" (Harvett, 2013, p. 51).

The study aligns with recent academic research from authors such as Harvett (2013), Niebecker (2009) and Olsson (2006) all of which explicitly characterize their work on project risk management in practice as post-positivist. These authors criticise the existing methodologies as putting forward a too mechanistic and simplistic view of the risk management process. In similar fashion, although addressing different questions, this study complements the bald prescriptions from guides and methodologies through a qualitative research approach that identifies descriptive labels specific to different risk management contexts. Some may suggest this is an interpretivist approach, but interpretivism, as an alternative to the positivist orthodoxy, assumes there is no absolute truth, but multiple realities and is based on subjectivity (Biedenbach & Müller, 2011). However, this research assumes there is an answer to the questions posed, even if the researcher must seek for the consensus views of the practitioners to validate what is known. For the interpretivist, all meaning is believed to be subjective, based on subjective perceptions and experiences with external environmental factors. This research adopts a post-positivist stance which looks for an objective, singular truth, thus differentiating it from the interpretivist paradigm (Phoenix et al., 2013).

De Bakker et al. (2011, 2012) argue that individual risk management activities generate communicative effects which contribute to the effectiveness of instrumental actions and thus to project success. This communicative effect, not considered by the positivist tradition, is a significant component of the post-positivist view, and creates the context which influences the setting, itself an integral component of activity that cannot be ignored. This study takes the post–positivist view of the world as open to interpretation in line with the observations of Krane, Olsson, and Rolstadås (2012) regarding different perspectives of risk held by project teams and project owners. The understanding of risk in the automotive project environment can be enhanced by the project stakeholders' subjective explanation of the phenomenon. This broader view of risk helps to better deal with threats and therefore to improve project outcomes.

The projects which serve as context for the case study are the implementation of SAP - a mainstream Enterprise Resource Planning (ERP) system - in several manufacturing facilities in Europe, and the launch preparation for serial production of new driver assistance systems for international car makers. The unit of analysis is the entire organisation. Following Yin's (2012) distinctions of designs for case studies, the one chosen in this research is holistic as opposed to embedded, in which more than one unit of the organisation are the units of analysis (Saunders, Lewis, & Thornhill, 2009). To obtain a general understanding of project risk management, project managers from the Research and Development (R&D) departments and also from the Information Technology departments were interviewed and their projects analysed.

In the selection of the organisation as the case study, several factors were considered - its regional presence, customer mix, and product catalogue. These characteristics make it a fair example of a global automotive supplier organisation. The company has over 135,000 employees, around 200 production facilities in some 40 countries, sales of €35.2 billion in 2016, and a yearly investment on R&D of about €2 billion. It is highly dependent on the success of its new projects and the smooth launch of serial production for global customers. Project risk management is a fundamental aspect of its project management process, and is applied globally. Project risks are documented, evaluated and risk controls are applied, and the risk management process is reviewed regularly to adapt it to the market challenges. A recent and dramatic example of the criticality of project risk management in the global supplier automotive industry has been the well-publicised failure to apply risk controls by one of Volkswagen AG's suppliers, resulting in the halting of production at six VW plants and a cut in hours for 28,000 workers.

3.2. Data Gathering and Interviewing Procedures

This research entails the collection of data on one single case from several groups in the organisation. The research phase was conducted over an eighteen month period with the results considered as having been obtained in a single point in time (Bryman & Bell, 2011), although do not focus on showing changes over time (Rübesam, 2015). Fourteen potential interviewees were initially invited, and 12 of them accepted the invitation. These business leads were chosen because collectively they represented project managers of major projects with high impact to the organization. An initial semi-structured interview took place with these 12 personnel (Table 2), in which their previous experience with regards to project risk management and their understanding of the risk management dimensions were explored. The Participant Consent form and the project information sheet were sent in advance to the participants, together with an interview agenda and questionnaire.

These interviews were conducted between April and November 2016 using responsive interviewing (Rubin & Rubin, 2011). This form of interviewing assumes that people interpret events and construct their own understanding of what happened, and that the researcher's job is to listen, balance, and analyse these constructions in order to understand how people see their world. Different from an ordinary conversation, responsive interviewing seeks detail, depth, vividness, nuance and richness. This technique encourages the researcher to adapt to new information and change directions if necessary to obtain greater depth on unanticipated insights.

The questions were grouped according to the four sequential project risk management dimensions. To support and balance these main questions, follow-up questions were developed to ensure breadth of discussion of each of the risk dimensions. The interview was introduced by a brief presentation using PowerPoint slides, to set the scene. Just four slides were discussed initially, and the remaining three slides were discussed in combination with questions. The interviews finished with a debriefing, requesting whether anything else could be relevant to the questions discussed, any other aspect that should be mentioned, or any question needing further elaboration. All 12 stakeholder interviews were

Table 2. Roles and experience of the 12 interviewees

*1. **Program Manager:** 8 years' experience as Project Manager – published articles on project risk management, PMP*
*2. **European ERP Manager:** 12 years' experience in IT and project management as project manager and Steering Committee member, PhD in IT, PMP*
*3. **VP Program Management Global:** 25 years' experience in Project Management, responsible for the Project and Project Risk Management methodology, training, templates and business process methods defined/deployed through the global organization, PMP*
*4. **Global ERP Manager:** 20 years' experience, responsible for ERP competency center, responsible of several ERP rollouts worldwide, PMP*
*5. **Director, Global Program Management of business unit:** 20 years' experience, responsible of the global business unit programs, manager of 15 program managers, experience with Project Risk management quantitative methods such as Monte Carlo, PMP*
*6. **Chief Engineer, PMO lead:** 15 years' experience, responsible of the PMO, engineering programs methodologies and systems, PMP*
*7. **PMO / Program Systems Coordinator:** 10 years' experience, responsible for standard program management training and Program management systems development, PMP*
*8. **Senior Program Manager:** 15 years' experience – responsible for major programs, PMP*
*9. **Senior Program Manager:** 15 years' experience – responsible for major programs, PMP*
*10. **Director, Global Program Management business unit:** 10 years' experience, responsible of the global Engineered Fasteners & Components programs, manager of 10 program managers, PMP*
*11. **Applications Engineer and Project Manager:** 5 years' experience, Project Risk management expert, co-author of the internal project risk management procedures.*
*12. **Senior Vice President, business unit:** 15 years' experience - ultimate responsibility for 12 sites in 9 countries, acting as Sponsor and/or senior Steering Committee member on major customer programs.*

transcribed verbatim, resulting in 135 pages of transcripts. These were then analysed and the initial version of the maturity model was constructed.

Having built the initial model from data collected through the 12 semi-structured interviews, this was then tested for validity and relevance (Maier et al., 2012). First, an online survey was undertaken involving six practitioners who were contacted by phone where the maturity model and the aim of the online survey was discussed. The responders were then requested to assign each of the 151 statements emanating from the interviews to one of the four maturity stages via an online form distributed via Google forms; a simple tool used to create and distribute questionnaires. The respondents answered the survey on their own with no influence from the researcher, and the responses were collected and stored in a repository.

Out of the six practitioners who participated in this on-line survey, four had already participated in the previous in-depth responsive interviews conducted to develop the initial risk management maturity model. The other two participants were project managers from the same company with relevant experience that could provide a broader perspective in answering the survey questions. These on-line surveys were conducted between January and March 2017. In a further step to verify and refine the model, additional in-depth structured interviews were carried out with another three of the 12 participants from the first interviews. The interviews were conducted in January and February 2017.

3.3. Model Development

The qualitative analysis to develop the initial model is depicted in Figure 2, and followed the ideas of Hopkinson (2012) and approach of Maier et al. (2012) on how to develop maturity grids based on organisational capability assessments. The responsive interviews included discussion of project related experiences of risk management, open-ended questions, and supplementary ratings to affirm and clarify meaning, particularly regarding the four dimensions of risk, and the maturity model stages. The data collected through interviews with practitioners and executives were analysed in line with the three step approach recommended by Creswell (2007): prepare and organise the data in transcripts, reduce the data into themes through coding and condensing the codes, and finally represent the data in figures, tables, or discussion. Continual synthesis of the data, thematic analysis, data reduction and coding were the basis for the data analysis. Building on the initial conceptual framework, the model was developed using initial categories for thematic analysis in searching through the transcript data. The transcripts were carefully read looking for keywords, trends, themes, or ideas in the data.

Certain data reduction techniques were applied without deemphasizing the importance of the context and richness of the data themselves (Namey, Guest, Thairu, & Johnson., 2008). The primary structural coding used was based on the four risk dimensions analysed. A secondary coding was done in the form of statements that were assigned to one of two extremes, either elementary (left) or advanced (right). This process then refined in a third stage that took the two extreme categories (elementary and advanced) and extended them to encompass the four categories or stages in the provisional model: rudimentary, intermediate, standardised and corporate. The data was assigned to the four stages by comparing the statements with the literature and quotes from the transcripts. The data was further processed into a set of "labels" or summary statements, and these were grouped into four types: people, organisation, process and systems. Finally, these labels were structured into a matrix form to build the maturity model. In order to simplify the number of label types, these were reduced to two: "process and systems" and "organisational and people" aspects. The initial maturity model was then subject to assessment and validation in two stages – via an on-line form circulated to six participants (the expert focus group in Figure 3), and then with three follow-up in depth interviews.

4. RESULTS AND MODEL APPLICATION

The resultant model comprises 156 labels allocated to one of the four dimensions of risk and to one of the four stages in the model. Following the verification process, the positioning of 51 of the labels was changed, 49 being changed by one stage in the model and 2 by two stages. For purposes of illustration, the model is now applied to one of the in-company projects, entailing the product development of a mechanical steering gear product for an international automotive Original Equipment Manufacturer (OEM). It encompasses formal customer confirmation of product technical and quality requirements, initial contractual forecast of volumes in a multi-years-period, and engineering product development

Figure 2. Data analysis procedures for development of the initial project risk maturity model

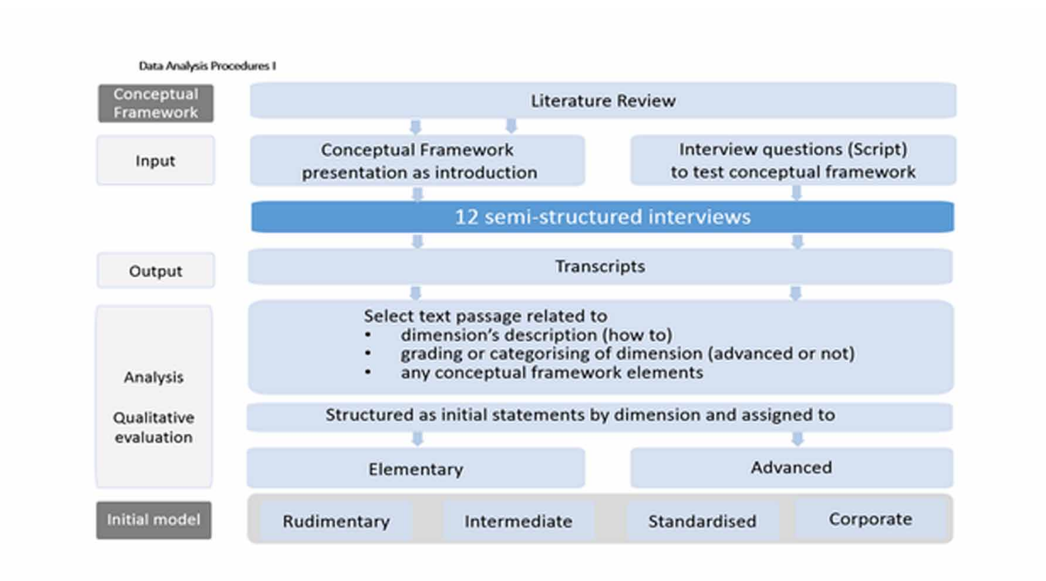
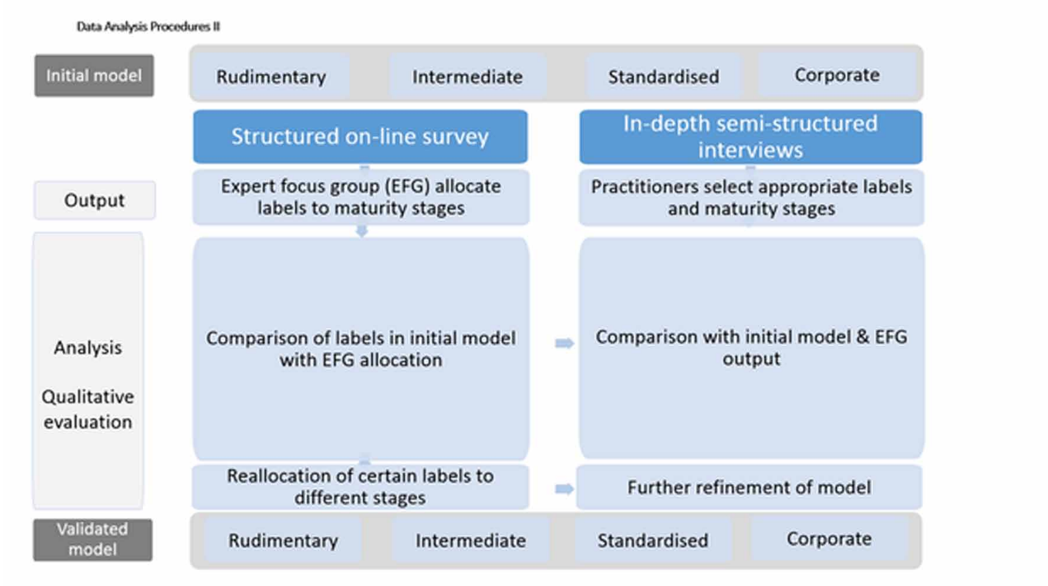


Figure 3. Data analysis procedures for validation and amendment of the initial model



through the start-of-production. As the steering system will finally be assembled in different countries with specific requirements and technical specifications, such as in the UK or Russia, several product variations needed to be validated.

The project team consisted of about 20 individuals with representatives of all functions involved in the project: Program Management; Sales; Engineering; Purchasing; Finance; Manufacturing and Logistics. The project followed a formal product development and introduction management process, which included risk management. The program manager reported directly to the Program Management Director, while the other team members reported into their departmental managers, with only a dotted line reporting to the project manager.

4.1. Risk Identification

The overall assessment regarding risk identification indicated the project was at the intermediate stage, with several characteristics of the standardised stage (Figure 4). Most project team members have several years' experience in project management, several of them are formally trained in project management, in which however only basic notions of risk management were discussed. The notions of risk management included providing instructions on how to use the risk register and fill in risk required information during the project phase exits. Mainly due to their professional experience, team members felt comfortable reviewing or discussing risks. When requested, they contributed openly with their input. Only the project manager had been specifically trained in project risk management. Management recognises the value of project risk management, but advanced training in risk management is not considered.

Risk descriptions are clear and address key issues in most cases. The documented risks in the risk register were generally well understood by the involved parts, e.g. regarding a risk associated with a new non-validated required technical solution the two involved functions - sourcing and sales support - coordinated the required risk response plan. This ensured the integration of all stakeholder views. End users, in this case the OEM, were informed about certain existing risks.

There is evidence in the risk register that a majority of risks have been identified and documented far in advance of their potential occurrence. Risk registers and phase exits required documentation

Figure 4. Risk identification capability assessment in the new product development project (blue labels match current project status; red labels are relevant but do not apply to current project status; black labels are not relevant to the particular project environment)

IDENTIFICATION					
RUDIMENTARY	Negative perception of risk	End users no involvement with risk identification process	Fear of raising risk concerns	Compliancy risks not identified even though may exist	Risk identification is ad-hoc, basic, hit and miss
INTERMEDIATE	People make full use of their freedom to act	Lack of integration of all stakeholder views	Disagreement among stakeholders if an event is a risk, subjectivity	Some compliancy aspects addressed but may have omitted significant ones	Potentially significant risk items may be omitted in reporting
	Lack of knowledge regarding what risk or uncertainty mean	Risk identification process characterised by subjectivity	No visibility of risk identification tasks / activities in project plan	Isolated non coordinated risk identification	Risk description is ambiguous, misleading
		New risks identified as they occur	Some remaining subjectivity (cultural differences)	Only focused on individual risks, managed at lower levels within team	Lessons learned not standardised. Unstructured documentation
STANDARDISED	End users have an active role in the identification process	Timely integration of previous phases	Clear risk classification (standard risks)	Set minimum frequency risk identification rules with senior members	Shared understanding of group approach to risk identification
	Recognises risk management but not ready to invest resources	Instructions with project categorization / risk sources identification	Routine planning reviews to aid risk identification	Bridge from the lessons learned into the risk identification process	Mechanism identifies gaps between planned tasks and resources available
	Use quantitative risk methods (Montecarlo) to avoid subjectivity	Established procedure for contradictory views (objectivise)	A risk identification process guide may be available Visibility on new sourcing, 'make-or-buy' decisions	Visibility of implications of risks associated with all relevant suppliers	Structured accessible lessons learned & risk registers database (DB)
CORPORATE	Earned Value (EV) monitoring highlights project performance shortfalls	Integrated process with involvement of all stakeholders	Formal communication regarding risk interrelations between projects	Top down approach related to project purpose and strategy	Real time reporting based on realistic data from all stakeholders

to classify risk. Risk items were updated regularly and discussed with senior management as part of the phase exits. Lessons learned were supported by standard processes. Risk management was rarely the subject of review in lessons learned exercises or continuous improvement initiatives. Lessons learned documentation was not easily analysed, and no specific risk management lessons learned were in place. Formal communication of potential risk interrelations between relevant personnel responsible for risk was missing.

Risk identification remains subjective in certain cases. One reason for this is the cultural differences which are accentuated by the virtual character or the team, with groups in dispersed geographical locations and infrequent face-to-face meetings. Analysis of the project's risk register shows five risk documented items which could be adjudged as subjective or subjectively identified. Four out of these five risks can be classified as "project schedule risks" (where timescale is a major uncertainty), and the fifth one can be classified as a "specification risk" (where completeness of specification is at risk). A lack of collective, objective assessment is indicated by the fact that, in the risk register, the risk type or risk category was not adequately maintained or updated by the project manager or any other team member during the project life cycle; and once the countermeasures agreed to mitigate the risk items were completed, these risks were then eliminated from the register without adequate consideration. From the risk register, examples of "project schedule risks" included "risk of delay in design verification due to component prototype timing" and "potential misalignment between supplier key product characteristics matrices". In the first example, once the manufacturing team had confirmed the prototype timing was not an issue for design verification, the risk item was closed. In a similar manner, for the second item, after the engineering representatives confirmed that there was no misalignment between the two lists with the responsible suppliers, the risk item was closed. The result of this confirmation was risk elimination. Project risk identification was not supported by use of any causal decision method, quantitative risk method, or earned value monitoring.

The computer applications supporting project management documentation were very limited in providing project risk management data. There were no intelligent systems which could enable querying and analysis of project risk management data in available project documentation. The involvement of certain stakeholders in risk identification was suboptimal, and the identification process did not reflect the overall project purpose and strategy, but the concerns isolated assessment of individual risks.

To fully reach the standardised stage, the model indicates a number of possible initiatives relevant to this project context and environment: first, increasing knowledge and usage of quantitative risk methods; second, improved usage and availability of lessons learned; and third, visibility of planned tasks against committed resources. Applying, for example, a first pass approach to estimate and evaluate uncertainties using the net present value (NPV) and Monte Carlo simulation is a simple and effective way to establish a simple risk model. Assessing and applying available lessons learned data and developing a reporting tool would also provide immediate benefit and require relatively little additional resource

4.2. Risk Assessment

As regards project risk assessment, the project exhibited most characteristics at the intermediate stage, but with some also at the standardised and rudimentary stages (Figure 5). The project risk management plan and risk register instructions exclusively consider risk items with negative impact, but not the potential of positive risks or opportunities. A higher focus on project issues than on risk is reflected in considerably higher time and resources dedicated to manage open item lists rather than on assessing and updating risks. The documented risk descriptions provide an indication of the source of risk and these are useful for qualitative risk analysis. Schedule analysis considers the documented risks using solely qualitative analysis. There is evidence of risk register maintenance, and consequently the identified risks are allocated to prescribed risk categories. Experts assess risk using mainly qualitative methods. Few quantitative methods are used in quality management in the product design phase. Probability estimation is weak, the lack of standard impact and estimation methodologies increases the risk estimation subjectivity. There are shortcomings in the methods used for risk prioritisation and quantification. The secondary effects of risks are not considered. Data on risk items which subsequently became project issues, or on the linkage and clustering of risks, is not available and existing computer applications do not support advanced data searches and queries. There is a clear procedure for risk assessment which establishes a minimum frequency for assessment activities, and evidence of the risk assessments is available. The project risk management plan is adapted to the project complexity, defined by the project categorisation.

To advance the risk management process and move to a consistent standardised stage for risk assessment, the model suggests several initiatives that could be pursued. First, improve risk analysis with the use of risk quantification and quantitative analysis. This analysis would allow improved integration risk management and cost planning. Second, the risk assessment would improve with a better understanding of the identified secondary risk effects, e.g. potential delays in new parts development may retain resources planned for next planned tasks and exacerbate other identified risks. Another opportunity would be to improve the risk management data structure and its reporting ability.

4.3. Risk Allocation

The model indicates that risk allocation resides between the intermediate and the standardized stages, and near to being fully aligned to the standardized stage (Figure 6). Risk allocation is equitably distributed among the business streams active in the project with participation of the purchasing, engineering, sales, and manufacturing functions. The risk allocation process is led by the project manager who is open to others' inputs. The project manager demonstrates the ability to identify groups not involved in risk allocation and has experience in assigning risks across several groups. Project management and engineering are the drivers of risk allocation.

Expertise within teams is recognized and harnessed, but some functional representatives with dotted line reporting to the project manager limit and negatively affect their level of involvement in risk management activities. All risks have a risk owner with authority who accepts responsibility.

Figure 5. Risk assessment capability assessment new product development project (blue labels match current project status; red labels are relevant but do not apply to current project status; black labels are not relevant to the particular project environment)

ASSESSMENT					
RUDIMENTARY	No relationship between risk information and cost forecast	Responses based on weak understanding or delayed thus ineffective	Isolated non coordinated risk assessment No evidence of opportunities being pursued	No fall back plans for risk mitigation or management	Only considered if project in difficulty or imposed by management
INTERMEDIATE	Higher focus on project issues than on risks is embedded in the culture	Description includes an indication about the source of risk	Lacks standard impact & probability estimate methodologies. This increases 'subjectivity'	Probability estimation accuracy is weak Formal risk register maintenance Prescribed risk categorisation	Risk description is impact oriented, lacks context and of uncertain origin
	Management does not prioritise project issues over project risks	Quantitative schedule analysis is not used	Struggle with Probability Impact (P*I) threshold concept		Use existing expertise and qualitative assessments
STANDARDISED	FMEA, 6s, poka yoke used for quality management (in product design)	Clear procedure, minimum frequency to assess risk event - Evidence based	Realistic estimates, use existing expertise and qualitative assessments	Sound understanding of risk combined with use of Monte Carlo, decision tree	Description is useful for qualitative risk analysis
	Planned costs consider risk management - Threshold based on $ or days	Visibility of high-impact risks, risks which became issues, risks clustering ability	Valid methods for risk prioritisation and risk quantification	Team members have good understanding of project's context and overall goal	Impact estimation includes secondary effects Certain use of Quantitative Methods
	Considers secondary effects which extend beyond immediate impact	Measure project team members' performance regarding risk issues (commitment)	Steering Committee may challenge the risk process – escalate when required	Systems analyse and summarise risk categories by project, customer or industry	Project categorization is standard Attempts to prevent event from happening in first
CORPORATE	Systemic risk assessment and continuous improvement	Ability to measure team members' performance	$ estimation of mitigated risk (Benefit of risk responses)	Risk management system integrated with other corporate systems	

Existing prescriptive risk classification of the documented items in the risk register does not enable allocation automation to existing job roles. There is evidence that risk item allocation is systematically reviewed according to the risk management plan. The project is characterized by fluid communication between customers and vendors. The contractual agreements specify financial liabilities for all parties, supplier with OEM, and sub-supplier with supplier. However, this is mainly about transferring risks from customer to vendors instead of developing risk sharing arrangements. The suppliers provide risk information, albeit sometimes late or incomplete.

To achieve a consistent standardized stage, the maturity model indicates a number of possible beneficial initiatives. First, improve the overall organisation attitude towards risk management. This is clearly reflected in the low recognition or support for appropriate risk management practice during steering committee meetings, and the very loose collaboration with suppliers to undertake complementary risk management. Further, within the project team, not all people working in the project actually use the risk management plan. With the exception of the engineering and project management team members, there is no evidence of autonomous risk allocation within other groups. There were no existing business guidelines regarding the risk taker.

4.4. Risk Appetite

As regards risk appetite, the project exhibited mainly characteristics of the intermediate stage, but also some from the standardized stages (Figure 7). Executives responsible for the project failed to challenge the risk process, and did not review risk details or their prioritization. The risk management knowledge in the team only allowed it to perform simple qualitative risk analysis. There were no standard quantitative methods available, and their use is dependent on the project manager's knowledge and decision making. Not all project team members were trained in risk management. The risk responses and risk mitigation activities were not properly monitored and controlled. As a consequence, the number or issues increased which required increased management attention, reducing further time and resources dedicated to project risk management. This situation has been depicted as a "self-fulfilling prophecy".

Figure 6. Risk allocation capability assessment new product development project (blue labels match current project status; red labels are relevant but do not apply to current project status; black labels are not relevant to the particular project environment)

ALLOCATION	RUDIMENTARY	Some stakeholders reluctant to divulge new information on risk	Unwillingness to assign risk ownership - perceived as telling to the other person 'you are doing it wrong'	Reluctance to own risk	Isolated non coordinated risk allocation	Some departments do not feel responsible 'project manager will be hold responsible'
		No active recognition or support for good risk management practice		Risk perceived as intrusive, lot of work and not keen to talk about its ownership	Lack of risk disclosure with contracting parties	
	INTERMEDIATE	Dependent on project managers' personality some of which are no open to others' input	Some program managers doing everything, but recognised as inefficient	Steering Committee meetings are pure status meetings	Only program management (and engineering) drive the risk allocation	In most cases assigned to project manager
			Only dotted line reporting to project manager 'my boss has not told me ...'	Suppliers provide risk information however not complete	Identify groups with potential but currently not involved	Constant communication with customer / vendors
	STANDARDISED	There is expertise to assign risks across several groups	Team members' actions are aligned with achieving overall project objectives	Expertise within teams is recognised and harnessed	Formal agreements with risk sharing arrangements	Clear business guidelines regarding who is the risk-taker
		All people working in the project actually use the risk management plan	Autonomous functional risk allocation System accessible, customised and team trained	All risks have a risk owner with authority and who accepts responsibility	Clear procedure with minimum frequency rules to update risk ownership	Suppliers undertake complementary risk management
		Steering Committee audits, processes and supports the risk owners	Contracts with formal risk agreement bearing clear financial liabilities	Every team member provides input on items with commercial impact	Prescriptive risk classification and job roles enable allocation automation	All stakeholders are open in their disclosure of all risk information
	CORPORATE	Good risk management practice, management audits the process and supports the risk owners		Escalation powers and procedures are in place	Consistently maintained multi-user concurrent access risk database is in place	

There were some characteristics of the standardized stage that were evident in the project. Identified risk items had adequate visibility during the formal project phase exits, and certain team members had shown their ability to commit resources prior to receiving customer order confirmation. On the other hand, there was no formal risk appetite statement at organizational level. Risk data was available on diverse non-integrated systems with limited access to limited team members.

Risk mitigation activities with impact on cost, schedule, quality or regulatory compliance were not considered as part of change management, and the integration of risk management and change management was weak. Lessons learned sessions were not formally documented and data was not easily available. Historical valuable information for risk analysis, such as original scope vs. outcomes in previous projects, was also not available. Decisions relating to risk management are sometimes not considered in a timely manner in the change management process. A comprehensive programme of risk management training for all the project team members was required as a first step to move risk appetite to a consistent standardized stage in the maturity model.

Overall, the model has limitations. It has been developed from a small sample of practitioners in the German automotive industry. However, the participants have over 200 years of relevant project management experience between them, providing a unique knowledge base that was explored in depth in the interviews. Although the focus was on two current projects in their current company environment, previous knowledge and experience also informed judgements on the significance of specific factors, processes, or capabilities. The model is also aligned to the automotive industry and the particular type of projects that operate in this environment. The qualitative model provides a set of characteristics (labels) typifying different stages of risk management maturity, relating to both processes and systems, and to organisational and people aspects.

Future research directions will focus on using the model in different business environments, and developing its pedagogic and operational potential. The application of the model to date has provided valuable insights into the subjective phenomena of success and failure, and the link to the maturity

Figure 7. Risk appetite capability assessment new product development project (blue labels match current project status, red labels are relevant but do not apply to current project status; black labels are not relevant to the particular project environment)

APPETITE					
RUDIMENTARY	Team members have little understanding of their responsibilities	Senior management makes little/no use of risk management	Lack of competency development plan for program managers	Executives fail to challenge the risk process, primary focus on issues	No project-specific risk management plan
	You raised the risk, you are in charge	No nominated risk manager		Fall back decision points are either not identified or ignored	Risk records cannot be retrieved reliably
INTERMEDIATE	Lack of standard quantitative methods, their use is a subjective decision	Review at fall back decision point but fails to result in decision	'Self-fulfilling prophecy', the less risk mitigation there is, the more issues are left open in the issue list	Mainly qualitative analysis	Steering committees are more akin to status boards
	Contribution to risk although not yet formally active in the program	Risk responses are rarely monitored		Trained teams	Diverse with limited access knowledge databases
STANDARDISED	Ability to commit resources without formal stakeholder confirmation	Highly integrated change management, readiness to take decisions	Clear, unambiguous and documented risk management process	Risk item details have adequate visibility in project phase gate exits	Top-down-approach to appropriate goals establishes the risk culture, strategic decisions first, aligned to project purpose
	The organisation's risk appetite statement is regularly updated	Promotes 'lessons learned' continuous improvement and standard practices	Responses to significant risks tackle risk at source	Resources and skills management address capacity risks	Risk responses consistently implemented Evidence available
	The value of risk management is recognized outside the project	Risk culture is encouraged – openness and respect of others' opinions	Risk awareness is reflected in certain level of compliance (SPICE, MAN5)	Audit trail is recorded	Risk management methodologies are more flexible and adaptable
	Stakeholders are aware of their role as risk takers with ability to cope with risk		Management requires risk response. Evidence available	Risk response effectiveness is reviewed	Systems can report original scope vs. outcomes (post mortem)
CORPORATE	Project risk management capability incorporated into process improvement	Risk management incorporated within other processes (planning, quality...)	Risk responses supported by 'Cost – Benefit' which also considers secondary risks	Lessons learned are effectively incorporated into a continuous improvement programme	

concept has added to this area of knowledge. The model will be applied by the authors in other contexts in the host company, but would also benefit from application in other automotive organizations in other countries, and then in different industries. It has the potential to be developed into a more generic model with wider applicability, with more industry specific variations at a secondary level.

5. CONCLUSION

This article sets out a new maturity model for assessing risk management capability in the automotive industry in Germany. The model is based on 12 responsive interviews that provided the base material for model construction. The model was then validated and refined through an on-line survey and follow-up interviews with three of the original interviewees. The model can be used to gauge the capability level of an organization as a whole, or can be used to assess a particular project. Once an initial assessment of maturity stages has been made, the model can be used as a guide or for the development of action plans and initiatives to improve different aspects of risk management.

The model can be used in practice in a variety of ways and contexts and for different purposes. Company project practitioners may select the appropriate labels from each dimension to assess their risk management capability. Senior management and project practitioners can identify a desired maturity stage; identify gaps in their capabilities with the help of the label descriptors; and develop a list of actions required to reach the chosen stage. In a training or workshop session, the model can also be "deconstructed", removing the allocation of labels to specific maturity stages, and project participants to select labels that appear most appropriate to the environment in which they work. Ensuing debate can then suggest the current maturity level for that particular project risk management environment.

Joustra (2010, p.3) refers to project risk management as a set of activities often perceived as a "bolt-on-extra" rather than being integrated with the project management process and organization. This maturity model can be seen as an integrating matrix that encompasses a range of elements relating to process and systems and to organizations and people. The matrix can also be viewed as a means of achieving improved communication within and across a project team, termed the "instrumental effect of risk management" by de Bakker et al. (2011, p.76). A communicative effect occurs when stakeholders deliberately use risk management to convey messages to others, with the aim of influencing their behaviour, synchronizing their perception, and making them aware of the context and their responsibilities. The matrix stimulates action and increases the effectiveness of the action, synchronizing stakeholders' actions and perceptions, making a situation more predictable which can lead to less uncertainty (de Bakker, Boonstra, & Wortmann, 2014).

This article provides new knowledge on how to integrate multiple rationalities of risk management coexisting in a project with the objective of supporting rational and consistent decisions in projects. As a contribution to theory, the maturity model complements existing models, and is specifically oriented to the automotive industry, one of the major sectors in the global economy which is currently experiencing dramatic disruptions. Supplier dependencies and legal and normative changes are some of the issues constituting serious risk to this industry. The aim of this research was to support automotive companies in the management of project risk.

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