ANALYSIS OF THE CORRELATION BETWEEN AGILE TEAM MATURITY AND STANDARDISED KEY PERFORMANCE INDICATORS IN AUTOMOTIVE DEVELOPMENT

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ABSTRACT

The application of agile development methods in response to increasing market dynamics and product complexity is a key lever in the automotive industry. Agile methods originally come from the software industry and enable fast, flexible and customer-oriented product development. These methods are also increasingly being used in hardware development. However, the evaluation of the benefits of agile methods in the context of automotive development has been primarily subjective. The publication aims to present a first data-based approach to objectify the benefits of agile methods in automotive development by highlighting the effects in the quality of collaboration within teams. A standardised procedure is therefore designed and presented. On the one hand, a model for measuring the agile maturity of teams is described. On the other hand, the quality of collaboration within a team is examined in different aspects using standardised key performance indicators. Based on the proposed procedure, a strong positive correlation was found between the considered key performance indicators of the quality of collaboration and the agile maturity of the development teams within the investigated organisation.

Keywords: Agile in Automotive, Design methodology, Research methodologies and methods, Teamwork, New product development

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1 INTRODUCTION

The shift towards a volatile, uncertain, complex and ambiguous (VUCA) competitive environment electrifies the automotive industry these days. Predictions and forecasts about future developments in the business world are thus becoming more challenging, which is why the ability to plan corresponding countermeasures is decreasing in this context. Instead of accurately predicting future risks and identifying measures to avoid them, agile development approaches accept and even welcome change. Agile development methods have become a standard in software development. It is proven that agile methods enable fast, flexible and customer-oriented product development (Digital. Ai, 2021). With the standardisation of this development methodology, the effort to determine a status quo about the implementation of agile approaches grew. This assessment is being achieved through agile maturity models (AMM) (Schmitt *et al.*, 2019). Some German automotive manufacturers consider agile product development to be an essential lever for reacting to increasing product complexity and market dynamics. However, applying agile methods such as Scrum to hardware or mechatronic systems development faces several challenges. According to Ovesen (2012), these challenges relate primarily to *constraints of physicality, paradigm perplexity, designer's dissent, team distribution dilemma, education and maturation*. Existing AMMs are therefore only suitable to a limited extent for the area of hardware development or mechatronic systems in the automotive industry as well. The assessment of the added value of agile development, in contrast to conventional development approaches, has so far been of a strongly subjective nature in the automotive sector and consequently represents a multifaced problem in this environment. The implementation of agile working methods is also correspondingly heterogeneous. Consequently, the measurable benefit of the agile development approach cannot be defined precisely. Subjective tendencies to evaluate the benefits are often present in a company-specific manner. An evaluation of processes based on Key Performance Indicators (KPIs), which is common in commercial enterprises, is missing in the agile context. **The research objective of this paper is to present a first data-based approach to objectify the benefits of agile methods in automotive development by highlighting the effects on the quality of collaboration within teams.** This requires a standardised procedure that can be used to establish the comparability of agile development activities. A procedure suitable for this purpose is not yet to be found in the literature. Operational development activities often take place based on team structures. Accordingly, this paper addresses readers who are interested in the beneficial aspects of agile automotive development at team level. A prerequisite for the assessment of benefits are comparable evaluation parameters in form of KPIs that allow reliable conclusions to be drawn about the added value of agile vehicle development. The research question of the paper at hand is therefore: **What is the relationship between specific KPIs and the agile maturity amongst development teams in the automotive industry?**

2 STATE OF THE ART

An extensive literature review by Albers *et al.* (2019) illustrates the variety of different descriptions of *agility*. Within this research, around 50 publications were examined and the following definition of the term was made: “Agility - based on the system triple theory - is the ability of an operation system to continuously check and question the validity of a project plan with regard to the planning stability of the elements in the system triple and, in the case of an unplanned information constellation, to implement a situation- and demand-oriented adaptation of the sequence of synthesis and analysis activities, whereby the customer-, user- and provider-benefits are increased in a targeted manner.” (Albers *et al.*, 2019) To meet the circumstances of the software industry at that time, 17 software engineers agreed on a common consensus of a working philosophy in 2001. The design of this agreement resulted in the Manifesto for Agile Software Development, which forms the basis of agile development today. This led to a multitude of techniques and methods in which agile development can take place. However, some of these methods differ considerably in their characteristics. Nevertheless, the common basis of these techniques is adherence to the "Agile Manifesto". Scrum, along with eXtreme Programming (XP) or Crystal, is one of the most popular methods in software industry. (Schmidt *et al.*, 2018) The specific terms of Scrum such as Sprint, Daily, Product Owner or Scrum Master (Schwaber and Sutherland, 2020) have entered the everyday vocabulary of many companies. In general, the use of agile methods is considered as an alternative to traditional and plan-driven development projects. In the

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context of the Cynefin framework, agile approaches are intended for projects that are considered complex or chaotic. (Snowden and Boone, 2007) Although agile methods are already used in hardware and mechatronic system development (e. g. automotive industry), traditional development approaches still dominate this environment. The stage-gate- (Cooper, 1990) or waterfall-model (VDI, 2021) are emblematic of the traditional approach. Once companies have successfully introduced agile methods, the question arises concerning the quality of the implementation of these methods. Based on this status quo, it is also possible to identify potential for improvement. From a process perspective, retrospectives as an agile practice in Scrum (Schwaber and Sutherland, 2020) are an established procedure for continuous process improvement. In this approach, teams examine their working methods regularly following the Scrum principle of inspection and adaptation to identify potential for improvement. This enables a gradual improvement. However, this does not result in an objective description of the status quo of a team's agility. (Schmitt *et al.*, 2019) Maturity models, such as Capability Maturity Model Integration (CMMI), are used to define different levels of maturity. These levels describe the maturity of established processes (CMMI Product Team, 2010). Similarly, different agile maturity models (AMMs) have been developed to provide an objective assessment regarding the establishment of agility in the enterprise. AMMs usually describe requirements to reach a higher maturity level and serve as a kind of roadmap towards improvements. (Schmitt *et al.*, 2019) As shown at the beginning, there are different understandings of the term agility. This is analogous to AMMs. There is no final definition here either of which components must be included and what purpose a maturity model must fulfil. (Schmitt *et al.*, 2019; Schweigert *et al.*, 2013) There are a variety of AMMs from academia and consulting, around 40 have been published in the academic field (Schweigert *et al.*, 2013). Authors such as Schmitt *et al.* (2019), Leppänen (2013) and Ozcan-Top and Demirörs (2013) conducted systematic literature research and case studies for comparison of AMMs. Yet none of the AMMs discussed in the publications is suitable for assessing the agile maturity of development teams in automotive industry, as the focus of the AMMs is either exclusively on agile software development or an assessment takes place at overall company level. While there are many maturity models for assessing the agility of development teams. Yet, apart from the model cited by Schmidt and Paetzold (2017), none takes into account the requirements of physicality or physical product development. In this model, maturity levels were determined through exploratory interviews rather than derived from literature. While no standardised methods for assessing agility at different company levels have been established in the hardware environment, mechanisms for project control are used in development projects. It allows development teams to detect discrepancies at an early stage to take countermeasures and ensure the success of a development project. (Rozenes *et al.*, 2006) Project measurement criteria in this context are often referred to as Key Performance Indicators (KPIs). Typically, these KPIs result from the "magic triangle" with the target dimensions of cost, time and scope/product quality. Before a project starts, a predefined target value is allocated to each KPI. The smaller the deviations from these target values during the course of the project, the higher the project's success rating. (Kuster *et al.*, 2022) In agile projects, a high degree of change is expected. This makes deviations from the initial project goal common. Consequently, setting predefined measurement criteria based on classic KPIs contradicts the agile concept. (Anderson, 2010) Since agile methods pay special attention to teamwork, an approach must be found to derive conclusions from the performance of the individual to the performance of teams. Ultimately, conclusions can thus be drawn about the beneficial effects of agile methods in physical product development.

3 RESEARCH METHODOLOGY

In this paper, two different research methods are combined using the mixed-methods approach. The approach describes the combination of quantitative and qualitative methods in one research design (Kelle, 2014). Within the scope of this study, the triangulation design is used, which represents one of the four research designs in the mixed-methods approach (Mayring, 2001). Figure 1 provides an illustration of the underlying research design. The qualitative (AMM at team level) and quantitative (KPI determination through a poll) research is conducted in parallel and the same sample of development teams at an automobile manufacturer is examined. The resulting findings are intended to complement each other through this procedure. Finally, the consolidated result is derived and interpreted from the joint research results. For some aspects of designing the model, the following subsections make occasional reference to existing literature. The sample size of this study consists of eight teams.

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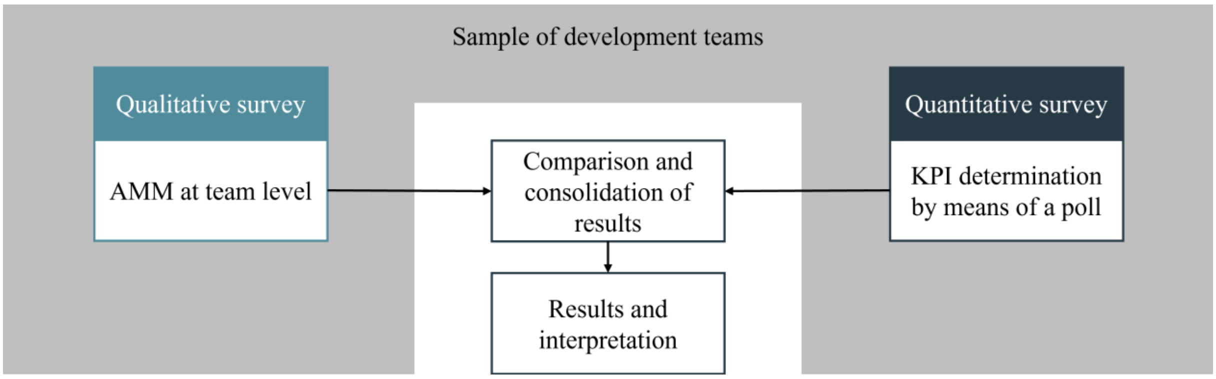

Figure 1. Underlying research design according to the triangulation model

Development teams were identified that are differentiated from each other by their activities in different areas of expertise but worked within the same project. The selection of a diversified set of teams is necessary to meet the objective of the study. Team experience in using agile methods ranged from six months to eight years. Two of these teams are involved in hardware development, while the remaining six teams develop software. The team sizes varied between seven and nine team members. The quantitative survey had 57 participants, while 65 persons took part in the qualitative survey. Qualitative data was collected through a series of pre-structured and standardised interviews. In addition, quantitative data was collected through a predefined questionnaire and aggregated into key performance indicators. The data collection period had a duration of two months.

3.1 AMM at team level

For assessing agile team maturity, a suitable procedure must be developed for both hardware development and software teams. The aim of the model is to assess the agile maturity of teams through self-assessment. The AMM and its contents should be easy to understand and comprehend for all team members, regardless of their hierarchical level. In addition, despite the self-assessment of the teams, it should be possible to assess the agility within the team as objectively as possible. To design the model, the necessary procedure must first be defined. For the design of the AMM at team level, the top-down approach is chosen, which is widely used according to Bruin *et al.* (2005). Accordingly, the agile levels or maturity levels are determined first. The basis for this are the agile levels of the "Agile Maturity Model" according to Patel and Ramachandran (2009). The maturity levels of this model are based on CMMI, and their evolutionary idea is familiar to those who work in software development. The individual agile maturity levels and their corresponding nomenclature are listed in Table 1. The table also shows the increasing degree of agility. The degree is low at the Initial level, while it continues to increase throughout the course and is highest at the Sustained level.

Table 1. Agile maturity levels of AMM at team level

Agile maturity level	Level 1	Level 2	Level 3	Level 4	Level 5
Level name	Initial	Explored	Defined	Improved	Sustained

After predefining the necessary maturity levels, the top-down approach provides for the determination of the characteristics within the dimensions. Consequently, all necessary *dimensions* must first be determined. In this paper, the dimensions of AMM are derived from the Scrum Guide's definition, theory, values, Scrum team as well as events and associated artifacts (Schwaber and Sutherland, 2020).
Therefore, the roles of *Product Owner*, *Agile Master* and the *Team* itself are relevant according to the Scrum Guide. As there are typically *Disciplinary Leads* in companies, this dimension is also relevant regarding an agility assessment. In terms of the culture in which a development team operates, attention needs to be paid to *Agile Values and Principles*, as well as *Feedback, Improvement and Adaptation*. *Accountability and Self-organization* are also relevant aspects of Scrum. If processes within the team are observed, the dimensions of *Product*, *Backlog-management*, *Customer Integration* as well as *Agile Rituals and Iterative Procedures* must be considered. (Schwaber and Sutherland, 2020) Each of the eleven dimensions is assessed against the five agile levels. This results in a matrix-like character of the AMM. In total, 55 fields within the AMM are used to assess the agility of teams. For comparison and

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consolidation of the results of the qualitative and quantitative research, a quantification of the collected data from the AMM must be done in the first stage. For this, each of the five fields per dimension must become assessable. This is achieved by using scoring levels. Depending on the degree of fulfilment by the criteria of the field contents, this field is either associated with the scoring levels 0, 0.5 or 1. To evaluate a single dimension numerically, the five field scores are summed up. To determine the agile maturity of a team, the arithmetic mean is calculated across all eleven dimensions. The agile maturity score of a team can therefore range from 0 to 5. The higher the score, the higher the agile maturity of the team.

3.2 Key performance indicators

The effects and advantages of agile development have been studied by (Leffingwell, 2008) and (Petersen, 2010), for example. However, the content of these publications relates to software development and is primarily qualitative in nature. To be able to assess the success or benefits of agile working methods, measurable indicators must be used to draw conclusions about the agile maturity of teams. For this reason, KPIs are introduced alongside the assessment of the agile team-maturity to enable measurability and thus create an initial approach regarding objectivity. Consequently, these indicators must also relate to the team. This is done through KPIs which focus on the quality of collaboration within a team, differentiated from their standard use. A standardised annual internal company-specific efficiency assessment is carried out in the organisation where the study was conducted. Elements of this survey are used in a modified version to form the qualitative basis. Table 2 shows the items of the questionnaire and the corresponding KPIs for measuring the quality of cooperation within the teams. The use of similar indicators (e.g. product quality) to assess the benefits of agile development of physical products can be found in the study by Nicklas *et al.* (2021). However, the assessment was not carried out at team level. Our survey had to be answered team-specifically by the respective members. For the participants, only the items were listed. The KPIs were not visible to prevent response bias. A Likert scale with the corresponding characteristic values enables the evaluation of the items and serves as a metric scale level. The given intervals have the same numerical interval. Characteristic values are used to assess the agreement or disagreement of the item in a five-point spectrum. In addition, a numerical value from 0 to 4 is assigned to each characteristic value to enable scoring similar to the AMM. Accordingly, an individual KPI can assume a score from 0 to 4. The higher the score, the better the KPI is rated. To determine the numerical value of an individual KPI, the arithmetic mean of all items per group is calculated. In addition, a total KPI score is formed from the 10 single indicators. This is done by determining the arithmetic mean of all 10 team-specific individual indicators from Table 2.

Table 2. Items and related KPIs

Item	KPI
The processes within my team are effective and non-bureaucratic.	Effectiveness
In my team, we make sure that we achieve the best quality in our company's products.	Product quality
Our teamwork focuses on the customer (internal & external) and their needs.	Customer orientation
Within my team there is an appreciative cooperation.	Appreciation
I am content with the cooperation within my team.	Contentment
Clear priorities are set within my team.	Prioritization
The processes and our teamwork are continuously improved.	Process improvement
In my team, the focus is on mutual success rather than on personal advantage.	Team spirit
In my team, knowledge of experts is used to ensure the best quality.	Cross-functionality
The collaboration within my team is motivating.	Motivation

3.3 Correlation analysis

In the final step, the scores from the assessment of team-specific agile maturity and the total score of the KPIs are examined for interconnections using correlation analysis. Correlation analysis enables the detection of relationships between two variables. The correlation coefficient expresses the extent of connection, i.e. strength and direction. The correlation coefficient r describes linear relationships, whereby it can take on values between -1 and +1. If $r>0$, it is referred to as a positive correlation. In this

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study, the correlation is measured according to Pearson's method, since this paper deals with interval-scaled data. The correlation coefficient r is calculated based on the formula below. (Schober *et al.*, 2018)

$$r = \frac{\sum_{i=1}^{n}(x_i - \bar{x})(y_i - \bar{y})}{\sqrt{\sum_{i=1}^{n}(x_i - \bar{x})^2}\sqrt{\sum_{i=1}^{n}(y_i - \bar{y})^2}} \tag{1}$$

For this $\bar{x} = \frac{1}{n}\sum_{i=1}^{n} x_i$ and $\bar{y} = \frac{1}{n}\sum_{i=1}^{n} y_i$ are the mean values of the variables x_i and y_i respectively and n is the sample size (Schober *et al.*, 2018). The classification of the correlation coefficients (absolute value) and their corresponding interpretation based on Cohen (2013) can be found in Table 3. Due to the sample size, a more restrictive classification was chosen. A significance calculation usually follows the calculation of correlations. Due to the limited size of the sample, this is omitted in this work.

Table 3. Interpretation of the correlation coefficient, in accordance with Cohen (2013)

Absolute value of correlation coefficient r	**Interpretation**
$\lvert r\rvert \leq 0{,}5$	Weak correlation
$0{,}5 < \lvert r\rvert \leq 0{,}8$	Moderate correlation
$0{,}8 > \lvert r\rvert$	Strong correlation

4 FINIDNGS

Following the methodology introduced, the results of the study were first clustered into the sections of agile maturity and KPIs. The specific results can be seen in Figure 2 and 3. Figure 2 shows the agile maturity scores of the eight surveyed development teams in descending order. The maximum score of five could not be achieved in the survey. The figure also shows that the development teams reached total agile maturity scores between 4.32 and 2.82 in a relatively even distribution. Only development team T1 is an outlier, with a comparatively low total score of 1.36. The team-specific total scores of the KPIs can be seen in Figure 3. The maximum score achievable by a development team was 4. This value and the minimum score of zero were not achieved by any of the teams. Overall, the distribution of the total scores of the KPIs is balanced, with no noticeable outliers, and ranges between the values 3.57 and 2.22. Individual team members' assessments of the indicators were partly heterogeneous. Nevertheless, as described in section 3, this paper deals with aggregation at the team level.

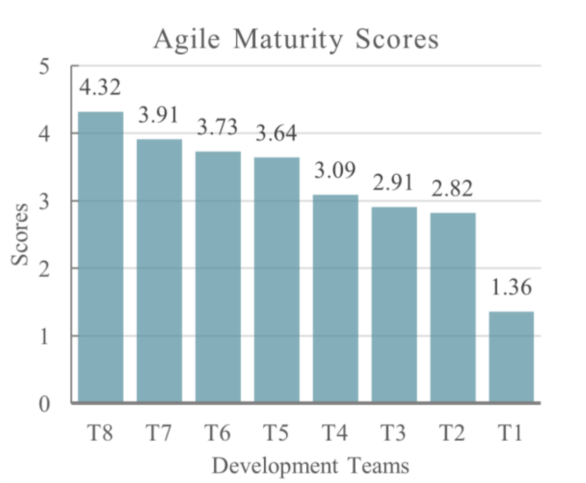

Figure 1. Ranked agile maturity scores

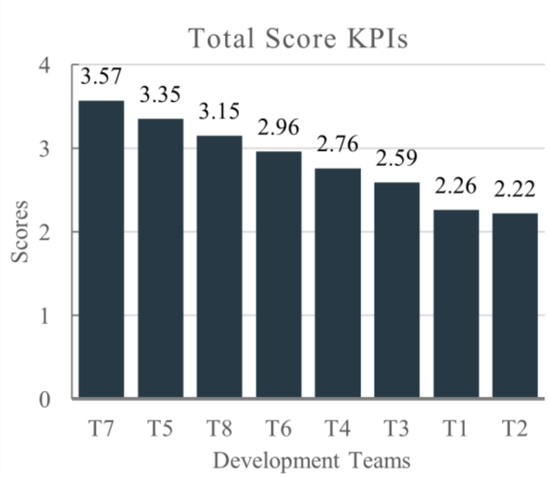

Figure 2. Ranked total score KPIs

Table 4 below shows further attributes of this study. For each of the eight development teams, the ten individual KPI scores are listed. The table also includes the operational background for the development activities of the teams. For the latter attribute, a distinction is made between development tasks in the software (SW) and hardware (HW) environment. Six of eight teams work in the field of SW development. Concerning the overall scores of agile maturity as well as the KPIs, the SW teams - except for T1 - achieved higher scores than both HW teams T2 and T3 (cf. Figure 2 and 3). The scores of the individual KPIs range from 1.33 to 4.0. The lowest score was achieved for Effectiveness by two teams each. The highest score, on the other hand, was achieved twice each for the indicators Product quality,

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Contentment and Motivation. In the overall assessment, the scores **Contentment**, **Appreciation** and **Motivation** were rated highest in descending order, while the indicators Process improvement, Customer orientation and Effectiveness had the lowest scores.

Table 4. Individual KPI scores and background of the development teams

Individual KPI score	**T1**	**T2**	**T3**	**T4**	**T5**	**T6**	**T7**	**T8**
Effectiveness	1.33	1.33	2.5	3.0	3.0	3.0	3.5	3.0
Product quality	2.67	2.0	2.0	3.0	4.0	3.0	4.0	3.0
Customer orientation	2.5	1.5	2.0	3.0	3.0	2.5	3.5	3.0
Appreciation	2.5	3.0	3.5	3.5	4.0	3.5	3.0	3.5
Contentment	2.5	3.0	3.5	2.67	3.5	4.0	4.0	3.5
Prioritization	1.5	1.67	2.0	2.0	3.5	2.0	3.5	3.0
Process improvement	2.0	1.5	3.0	2.0	3.0	3.0	3.0	3.5
Team spirit	3.0	2.5	2.0	3.0	3.5	3.0	4.0	3.5
Cross-functionality	2.5	3.0	3.0	2.67	3.5	3.5	4.0	3.0
Motivation	2.0	3.0	3.0	3.0	3.5	4.0	4.0	3.0
Background	SW	HW	HW	SW	SW	SW	SW	SW

For team **T1**, a wide spread of individual KPI scores from 3.00 to 1.33 can be observed. Here, the indicator Team spirit has achieved the highest score, while Effectiveness is attributed to the lowest score. The other KPIs are close to a score of 2.00. The evaluation spectrum for **T2** ranges from scores of 3.00 to 1.33. An even distribution can only be seen in the highest-rated indicators of Contentment, Appreciation, Cross-functionality and Motivation. Effectiveness, on the other hand, achieved the lowest score of 1.33 within the team. This development team achieved the lowest total KPI score in the overall assessment. The evaluation of the KPIs of **T3** showed a balanced structure with no noticeable outliers. Contentment and Appreciation were both rated the highest in this team with a score of 3.50. The lowest scores of 2.00 each were achieved by the indicators Product quality, Customer orientation, Prioritization and Team spirit. For team **T4**, the KPI spectrum ranged from 3.50 to 2.00. Appreciation stood out positively with the highest score in this team. The KPIs of Prioritization and Process improvement, on the other hand, received the lowest score. Nevertheless, the assessment of the KPIs in this team is quite balanced overall. There is also an even distribution of individual KPI scores at **T5**. The highest possible scores of 4.00 were achieved for Product quality and Appreciation. Process improvement, Customer orientation and Effectiveness received the lowest score of 3.00 within this team. In team **T6**, it is noticeable that the maximum score of 4.00 was obtained for Motivation and Contentment. All other KPIs are evenly distributed in the range from 3.50 to 3.00. Only Customer orientation and Prioritization are rated at 2.50 and 2.00 respectively. For the individual indicators Cross-functionality, Contentment, Team spirit, Product quality and Motivation, the highest possible KPI score of 4.00 was achieved in team **T7** in each case. The lowest scores of 3.00 were recorded for the indicators Appreciation and Process improvement. T7 achieved the highest individual KPI scores overall and consequently the highest total KPI score. The KPIs Team spirit, Appreciation, Contentment and Process improvement each received a score of 3.50 at **T8**. All other individual KPIs had a score of 3.00 each.

5 DISCUSSION

The research findings on agile maturity and total KPI scores will be evaluated in terms of a linear correlation using Pearson's correlation analysis (see Section 3.3). For this purpose, a team-specific chart of the agile maturity score and the total KPI score was first elaborated. The progression of these two aspects is shown in Figure 4 for all development teams from the surveyed automotive manufacturer. The graph below shows a positive tendency that with increasing agile maturity, the total score of the KPIs likewise increases. This trend applies to development teams T2, T3, T4, T5 and T7. The positive trend is noticeable for the development teams T6 and T8, yet it is less prominent than for the previously mentioned teams. For T1, the opposite trend can be seen, as agile maturity was rated lower compared to the KPIs. This observation can also be supported by a correlation calculation. Calculating the correlation coefficient with a value of r=0.806, in summary it is found that there is a strong positive correlation - and thus a strong linear increase - between the total KPI score and the agile maturity score of the development teams assessed. The results show that the aggregated KPIs improve as the agile maturity of

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the development teams increases. However, it should be noted that this finding only applies to the limited set of development teams in this paper.

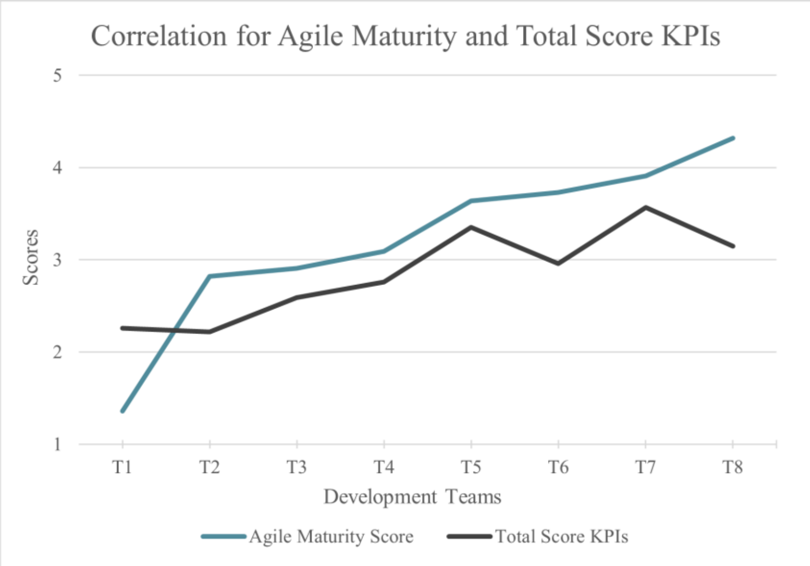

Figure 4. Correlation of agile maturity and total KPI score per team

To examine this linear relationship more closely, the individual indicators will be analysed further. Table 5 shows the rank of the specific KPIs depending on the value of the correlation coefficient and its interpretation. The algebraic sign of all correlation coefficients is positive. The interpretations are also based on the characteristics presented in section 3.3. The individual KPI of Effectiveness has a strong correlation with the total score of agile maturity. A moderate correlation can be seen, for example, in Motivation and Contentment. Product quality, Team spirit and Customer orientation, on the other hand, are characterised by a weak correlation.

Table 5. Individual KPIs ordered by descending magnitude of correlation coefficients and their interpretation in relation to agile maturity score

Ranking	**KPI**	**correlation coefficient *r***	**Interpretation**
1	Effectiveness	0.818	Strong
2	Motivation	0.783	Moderate
3	Contentment	0.769	
4	Prioritization	0.736	
5	Process improvement	0.708	
6	Cross-functionality	0.676	
7	Appreciation	0.658	
8	Product quality	0.497	Weak
9	Team spirit	0.491	
10	Customer orientation	0.472	

The Effectiveness of the teams therefore increases with growing agile maturity. On the one hand, the reason for this may be the duration of the collaboration and the associated routine within a team. On the other hand, it is due to the iterative approach of Scrum. The indicator of Motivation correlates moderately with increasing agile maturity, even though mechatronics development is characterized by instability. This observation also applies to the indicators of Contentment, Prioritization, Process improvement, Cross-functionality and Appreciation. Complementary to these results, the study by Michalides *et al.* (2022) also proved that the self-organization of agile teams correlates with the perception of project success. Although Customer orientation, Team spirit and the quality of the products are of central importance in agile methods, especially in Scrum (Schwaber and Sutherland, 2020), the weakest correlations were detected for these indicators. That might have been due to a misinterpretation of the survey item at one point. Another reason are the limitations in agile development of mechatronic systems that were introduced at the beginning. The HW teams scored lower in the maturity ratings than the SW teams, except for T1. T1 has

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been using agile methods for six months and has the lowest maturity score. T8, on the other hand, has the highest agile maturity score and has been working together in an agile way for the longest of all teams. Long-term agile collaboration seems to be an indication of high agile maturity, but this does not apply to all teams. A similar observation applies to the total KPI score relating to the HW and SW teams. Considering the individual indicators without taking into account the previously discussed correlations, the indicators of Contentment, Appreciation and Motivation are the best rated. The study by Nicklas *et al.* (2021) also shows similar results. In this study, individuals from different industries were interviewed who are involved in an agile development of mechatronic systems.

6 CONCLUSION, LIMITATIONS AND FUTURE WORK

The research objective of this paper was to present a first data-based approach to objectify the benefits of agile automotive development on team-perspective by using a standardised procedure. To meet this objective, the agile maturity of teams from the development department of an automotive manufacturer was compared with specially defined standardised KPIs. For this purpose, a maturity model for measuring team-specific agility was designed and ten KPIs were determined to measure the quality of collaboration. The evaluations of the two variables showed different characteristics between the HW and SW teams. Indications for the reasons exist but cannot yet be specified. The ten KPIs were aggregated into a total KPI score. This aggregated value and the agile maturity of the development teams were evaluated in terms of their relationship. The analysis revealed a strong positive correlation with a coefficient of r=0.806, indicating a linear relationship between the two aspects studied. Thus, the quality of collaboration increases simultaneously with the agile maturity of the teams. To gain further insights, ten individual KPIs were closely assessed. It was found that the indicator of Effectiveness has a strong positive correlation coefficient of r=0.818 with the agile maturity of the development teams, while six of the other indicators such as Contentment and Prioritization show a moderate and three indicators (Product quality, Team spirit and Customer orientation) a weak positive correlation. Regarding the limitations of this work, the first point to note is that the findings come from a limited sample size. It should also be considered that the agile maturity model has only been applied by one automotive manufacturer and therefore focuses on a single company in this industry. Despite the generally accepted formulations and the observed validity of the model within the sample, 75% of the teams work in the software environment. Furthermore, the correlation found between agile maturity and the KPIs relates to only eight teams. Therefore, it is not yet possible to draw general conclusions about the correlation found. From a methodological point of view, despite the combination of qualitative and quantitative research, a certain degree of subjectivity remains. Moreover, no falsification was conducted yet. Based on the limitations mentioned above, it must be stated that future research should primarily refer to a considerably larger sample to prove an interdisciplinary correlation as well as significance. A detailed analysis of the relationship between each KPI and the dimensions of the AMM presented should also be included. Furthermore, an application of the AMM in other automotive companies is recommended to further verify the validity of the model. In addition, improvements in the objectivity of the results are conceivable for both qualitative and quantitative survey. This could be addressed by an improved standardised data collection procedure. Moreover, the reasons for the divergent assessments of the HW and SW teams should be examined in detail.

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