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Newness and Outcomes in Commodity-Driven New-Product Development Projects: A Survey in the Norwegian Manufacturing Industry

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Abstract

Based on longtime experience in the global automotive industry, we have observed steadily higher expectations in the execution of product development projects regarding time, budget and quality. This is particularly challenging when different stakeholders, including customers, design, manufacturing and suppliers, impose changes to the agreed product content late in the project. This paper addresses commodity-driven automotive projects and the impact of externally and internally driven changes in the project content—which we denote 'newness'—on performance outcomes. Aiming to falsify our initial hypothesis that such newness in project content during new product development will have negative impact on project outcomes, we examine data from Norwegian companies obtained by surveying their experience with project outcomes relative to imposed changes in content. The participants were asked about the different level of innovation and project specific circumstances perceived forming the basis for successful and unsuccessful project outcomes. The data show a significant positive correlation between newness and unsuccessful project outcomes, whose underlying factors are examined and discussed further in the paper.

Keywords: Innovation; Projects; Commodity; Automotive; Norwegian Manufacturer; Survey;

1. Introduction

Over the past several years, there has been a trend in several industries that products and services lose their unique identification. Customers can choose between many options while making products and services increasingly interchangeable. This implies that parts of the business world are drifting more and more towards a commodity business [1]. Already in 1966, Raymond Vernon first argued that products experience different stages during their lifecycle [2]. Here, the late phase maturity is characterized through sales volume peaks, decreasing profit and market share due to increased competition, followed by cost reductions [3]. These characteristics show some similarities to those of a commodity business, which can be defined as: *In economics, a commodity is an economic good or service that has full or substantial fungibility; that is, the market treats instances of the good as equivalent or nearly so with no regard to who produced them* [4]. In this connection, the automotive industry is not an exception. Approximately 80% of the content of a vehicle is components from a pure commodity business [5].

The focus on cost, time and quality in projects is known as *the classical triangle* in program management, see Figure 1. This classical Iron Triangle has been used since the 1950s without knowing exactly who first developed this scheme [6]. Atkinson and Pinto [7] added later more perspectives to the Iron Triangle, but costs, quality and time remained the most important measures in project management [8]. These three basic dimensions play even more importance in commodity-driven projects than in other projects. There is a competitive environment for commodity products that can be compared with the environment of mature markets. This implies that if one supplier is not willing or capable to deliver a product

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according to the desired cost, time and quality, the contract can be sourced to another supplier.

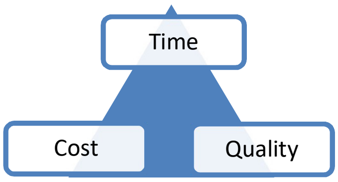

Figure 1: Iron Triangle

An increasing number of automotive projects are ‘commodity type’ projects. This trend is expected to continue in the future, as the business environment is getting more and more competitive, faster and globally connected. The superior position of OEMs and the increasing shift towards commodity in the automotive industry put competing Tiers under high pressure in order to accept and succeed with this type of projects. The risk of losing reputation, market share and may be the next ‘big project’ with the OEM is often too high to justify no-bid response to a request for quote for commodity-projects. As a result, often the quote is submitted and, if rewarded, the development time gets under pressure, the outcome heads in the direction of ‘copy cat’ and the resources get squeezed in terms of budget, manpower and time, without or with limited ability to react to different changes, or ‘newness’, during Product Development (PD).

In terms of context, process-driven projects are typically characterized with a high grade of reliability, robustness, repeatability and a fixed value potential. This type of projects are described in the research from Shenhar as ‘A-Low tech, 1-assembly engineering project’ [9]. In the other end of the spectrum, we find exploration-driven projects. Delivering value from this type of projects is usually characterized by ambiguity, uniqueness, newness and unlimited value potential since the outcome is open. Yalcinkaya described the difference as ‘Exploration and Exploitation Capabilities’ in firms [10]. Therefore, it seems to be logical that projects in a commodity business are typically more on the process-driven (or exploitation) side, see Figure 2.

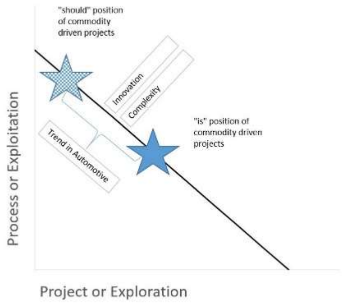

Figure 2: Trend in Automotive

Our initial assumption is that newness, in the meaning of explicitly changing the content of projects, leads to reduced performance in the development process itself. Our understanding of such newness in the context of commodity-driven development projects is that these include changes in the project, product or process environment. Here, the term newness can be extended to include innovation in a broader context, including changes or improvements, not necessarily major, disruptive or radical product innovations. Change in the content could, for example, imply that the customer demands tighter dimensional tolerances or ask for new services associated with the use of the product. Improvements could be that the company chooses new ways to structure the PD-team or sources a new supplier that the company has never been working with before. During the course of a project, different stakeholders tend to push the boundaries more and more toward the exploration-driven projects, but without adapting the targets for costs, time and quality. This again leads into challenges and contradictions that need to be better understood in terms of their impact on overall project performance.

As a basis for this work, we formulated the following hypothesis:

‘In a process-driven automotive world, where costs, time and quality dictate the success of a project, newness (or innovation) during PD has a negative impact on project performance itself’

The overall target is to falsify this hypothesis, which was developed from real-world experience in international development programs. The underlying research questions related to the above are as follows:

Which are the most crucial success factors in commodity projects?

What is the influence of complexity in this context?

In order to address these research questions, the remainder of the paper continues with theoretical background with a primary focus on innovation and complexity as a basis for a deeper understanding of the research topic. In Section 3, the research method is presented, including a survey conducted to answer relevant questions regarding this research field. Section 4 presents the results, and discussion and the conclusion is given in Section 5.

2. Theoretical background

2.1. Impact of Innovation

As discussed above, commodity type projects are usually confronted with different types of innovation during the execution phase. As a result, program teams are faced with changes and newness in the PD process. According to the definition by Fagerberg [11] *‘Innovation is the attempt to try out new or improved products, processes or ways to do things*.’ Hence, the topic of this paper partly falls under the category of innovation, when considered at operational level.

The similarities between innovation and newness are not new, see e.g. the paper by Johannessen et al. [12]. Here the important questions are: what is new, how new and new to whom. Based mainly on Schumpeter’s [13] research, they divided innovation into six dimensions, including new products, new services, new methods of production, opening new markets, new sources of supply, and new ways of organizing. Said in popular terms, thus, innovation is related to newness in terms of doing things differently or doing different things. Or as stated in [12], *‘Innovation itself is an unidimensional construct which is distinguished only by the degree of radicalness.’*

The request for changes or newness in process-based projects are driven from different stakeholders and starts usually with a simple change. These changes do not need to be new-to-the-world. Nevertheless, when the company or the team faces them the first time, this forces them to deal with new things—and according to the above definition, to deal with innovations. Industries, companies and teams need to learn dealing with ambiguity caused by newness. In commodity-projects where limited resources are usually allocated to explore and learn, this can potentially overstress the project team and lead to poor results. In summary, the extended interpretation of innovation as a construct forcing the team to do things differently or doing different things in the everyday life of a commodity driven project is the focus of this research.

2.2. Impact of Complexity

The topic *complexity* is also highly related to performance of project management, especially in international programs with a global approach [14]. Our working assumption on this topic is: *"Innovation can lead to an increased level of complexity, which also has negative influence on the performance on the project."* Here we adopt the definition of complexity due to Vidal [15]: "*Project complexity is the property of a project which makes it difficult to understand, foresee and keep under control its overall behavior, even when given reasonably complete information about the project system.*"

The fact that complexity itself has a negative impact on projects is a frequently researched topic during the last few years [16]. There are many different definitions of 'Complexity Drivers' in the literature, see e.g. Vogel and Lasch, who identify thirty-six different literature sources, which contain different definitions of complexity drivers [17]. After studying the literature in the field, they proposed the following definition:

"*Complexity drivers are factors, which influence a system's complexity and company's target achievement. They are responsible for increasing system's complexity level and help to define the characteristics or the phenomenon of a system's complexity. Complexity drivers are influenced by one another, that is by internal or external drivers, and cannot be reduced completely to another one.*"

Vogel and Lasch distinguish between internal and external complexity factors.

Table 1: Project Complexity Framework after Marle and Vidal [16]

	Organizational Complexity	**Technological Complexity**
Project System Size	Duration of the project Capital investment No. of activities No. of investors No. of objectives No. of stakeholders No. of groups/teams …	Resources Scope …
Project System Variety	Diversity of staff Geographic location Hierarchical levels Variety methods and tools applied	Product Variety Component Variety Technological Variety
Interdependencies [In.] within project	In. of shared resources In. of schedules No. of Interfaces Team Cooperation Team Dynamic Networks …	In. in products In. in resources In. in specifications In. of processes …
Elements of context	Competition Culture Laws and regulations Degree of Innovation …	Competition Culture Laws and regulations Innovation …

Kohr separates between market, product and production complexity as a framework [18]. The separation from Marle and Vidal between different system levels in projects [16] seems to be most suitable to fit our research. In this connection, there are four different groups: project system size, variety, interdependencies within the project system and element of context. Each of these groups has an organizational and technological view. Marle and Vidal [15] give several examples of factors in this group as shown shortened in Table 1. They argued that around 70 % of the identified complexity factors belong to organizational aspects.

3. Methods

The test of our working hypothesis will be done by proving or disproving the significance of innovations to project success. A survey about successful and unsuccessful project had been developed to find answers to our research questions [19]. The strategy adopted herein is to survey (perceived) successful and (perceived) not successful projects in Norwegian manufacturing companies. The survey was done in workshops with Norwegian manufacturing companies during the summer of 2018. The survey included 24 questions in two questionnaires. The same questionnaires were used two times, first by considering successful and second by considering not successful projects. The questions Q1-Q3 quantify the level of innovation or newness in the product, process and market view. The other questions from Q4-Q24 are about project specific circumstances, which are related to how companies deal with innovation. Project specific success factors are getting more attention in the recent research [20],[8]. The project-specific success factors will be discussed more deeply in the following. A 7-point Likert scale was used where the employees could answer between 1 (no or very little compliance) to 7 (full or very much compliance). This was done for each individual question or statement. Overall, 28 participants answered 24 questions in two rounds (successful and not successful), providing 48 answers and 1,344 individual data points. The 28 participants worked for 12 Norwegian companies, mainly automotive and aluminium manufacturers with a highly competitive market background. At the end 1,222 single data points (individual answers) out of 1,344 possible data points were available, indicating a loss of 9% of the data. For the first three question, the average of missing data is around 18.5%.

	Questions
Q1	Rate the newness of the product
Q2	Rate the degree of change in the production process
Q3	Rate the newness of the product to the market
Q4	Was Information and knowledge from previous relevant projects accessible for this project?
Q5	Were Solutions tested physically before the final design was decided?
Q6	Did the team develop/ search for more alternative solutions before the final design was decided?
Q7	Was the product designed/developed for the existing production process?
Q8	Did the project and the customer worked together on developing the solution?
Q9	Did the project communicate sufficiently with the customer to sell the solution?
Q10	Did the project cooperate with an external R & D environment (designers, engineers, researchers) regarding the development of the solution?
Q11	Did the project cooperate with the supplier regarding the solution development?
Q12	Did the involved actors agree on the product innovation goal?
Q13	Were roles and responsibility in the project sufficiently defined throughout the product development process?
Q14	Did the management facilitate the opportunity to succeed with the product innovation?
Q15	Did the project have sufficient resources (time, money, expertise) ?
Q16	Were the right competences involved in the project?
Q17	Was there sufficient follow-up with regards to time, cost and participants in the project?
Q18	Was there sufficient number of meetings where solutions were discussed and further developed?
Q19	Was more achieved when working together as a team than was achieved trough individual efforts?
Q20	Was there trust between you and the external contributors to share information and ideas openly within the project?
Q21	Were the solutions developed by an interdisciplinary team (team members from different professional backgrounds proposed solutions and contributed to analysis and testing)?
Q22	Was the Information within the PD process fact oriented (sufficient, relevant and trustworthy)?
Q23	Was the communication within the product development process clear, rich and well reasoned?
Q24	Did the project reflect and document lessons learnt?

4. Results and Discussion

After the company representatives completed the surveys, the questionnaire was collected and the data evaluated in Excel. The average was calculated for both samples, one ‘successful’ ($\bar{x}_{ks}$) and one for ‘not successful’ projects ($\bar{x}_{ku}$) as shown in Figure 3; i.e.

$$Q(\bar{x}_{kx}) = \frac{1}{n}\sum_{k=1}^{n} a_k \qquad (1)$$

Here *n* is number of measurement points (24), *k* is an integer representing the individual question and *a* is the individual data point for response *k*.

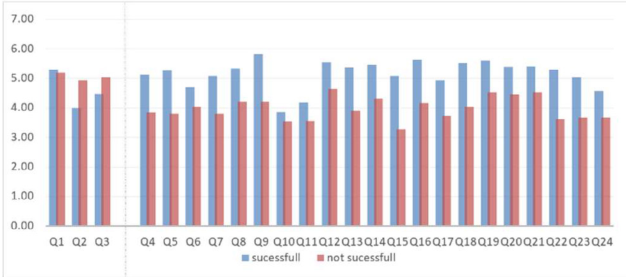

Figure 3: Survey Outcome

In the next step, we asked two questions related to the data. Which topics/questions have the bigger impact on projects related to success and are therefore more important? Does the ‘important’ questions provide statistical significant answers?

To answer the first questions we first calculated the crucial point as represented by the average difference ($\bar{x}_{kd}$) between the means of the two samples ‘successful’ and ‘not successful‘ projects, [21]:

$$\bar{x}_{kd} = \bar{x}_{ks} - \bar{x}_{ku} \qquad (2)$$

The statics show that $\bar{x}_{kd}$ is 0.97 for all 24 questions. The average difference $\bar{x}_{kd}$ for the first three questions is -0.46, whereas the other 21 questions together gives 1.17. To have a better overview of relevance to our research, we first sorted the

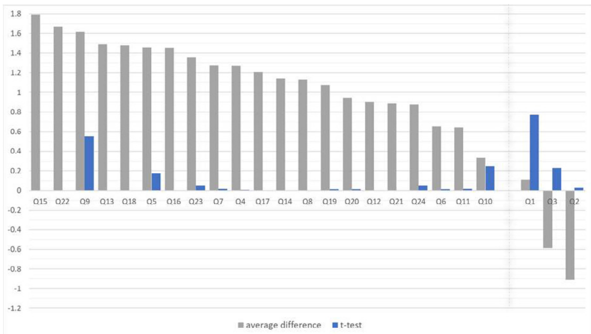

Figure 4: Average difference between successful and not successful projects sorted with related t-test value

average differences to identify the biggest positive correlation successful and not successful projects in Figure 4. To answer the second question, we tested the significance of the data with a *t*-test for independent data, 2-tailed, α=0.10. In other words, the difference between the two categories’ averages most likely (more than 90%) reflects a statistically significant difference in the population of successful and unsuccessful projects. We added these *t*-test values to the sorted average difference of each question in Figure 4 to have the full picture.

Table 2: importance and significance for Q4-24 and Q1-3

Que.	Imp.	Sig.
Q15	Yes	Yes
Q22	Yes	Yes
Q9	Yes	No
Q6	Less	Yes
Q11	Less	Yes
Q10	Less	No

Que.	Imp.	Sig.
Q1	Less	No
Q3	Yes	No
Q2	Yes	Yes

The summary in Table 2 shows the most and least important questions in combination with the significance for each question. In the following examination, it has been decided to concentrate most on the questions that are important and associated statistically significant responses in terms of difference. It is noteworthy that the less important questions could still be interesting to compare with the current research.

4.1. Project Specific Circumstances

Overall, successful projects had higher scores in all project specific circumstance questions (Q4 - Q24) than unsuccessful projects. The larger difference in mean between successful and not successful projects was identified for 'sufficient project resources' (Q15), 'fast internal communication' (Q22) and 'good communication to the customer' (Q9). Even when Q9 fails to provide statistically significance in our case (with a reduced sample), these factors are overall still crucial to the success of projects. This is in accordance with prior research in the project management research area [22], [20].

On the other hand, the overall impression is that 'working together with external R&D resources' (Q10), 'cooperation with suppliers during PD Phase (Q11)' and 'if the team developed or searched for more alternative solutions before the final design had been decided (Q6)' are less crucial for the successful outcome of projects.

Q10 has a deviation of 0.33 and shows no statistical significance in the data. Thus, this question has the smallest affect for the success of a project, according to the data. The *t*-test indicates that there is no sufficient difference between both groups. This result is interesting input to the discussions on open innovation strategies in companies. Laursen evaluated data from U.K. manufacturing firms finding that 'it appears that there are moments or tipping points after which openness—in terms of breadth and depth—can negatively affect innovative performance'. However, overall, he concluded that open innovation can be an enabler for success if the external sources are managed carefully [23]. Grimpe and Kaiser figured out in their paper that 'R&D outsourcing can become disadvantageous if firms rely heavily on external knowledge' [24]. The paper from Cassiman state that an external involvement of R&D activities lead only to better innovation performance when internal R&D are also involved in the PD process [25]. The literature implies that R&D outsourcing is not always an advantage that will lead to more success in a project. Our data, although somewhat weak statistically, are in line with the finding that R&D Outsourcing has no or limited effect on the success of a project.

Q11 'you cooperate with the supplier regarding the solution development?' shows an average difference of 0.64 and statistical significance in the data. McGinnis [26] found that the frequent, early supplier involvement is not important for the success of new PD projects. On the other hand, in the same paper he mentioned that supplier involvement overall can contribute to new product success. Based on our limited details of circumstances of supplier involvement, we can only conclude 'supplier involvement' as less relevant, but still significant statistically.

Q6 'did the team developed/ searched for more alternative solutions before the final design was decided' is linked with the question if a Point-Based Design (PBD) [27] or a Set-based Concurrent Engineering (SBCE) [28] approach has been used. The average difference is 0.65 regarding a set-based engineering setup with more open design solutions are more successful than a point-based engineering setup with choosing one design earlier in the process. The difference in populations are found to be of statistical significance. Even when the current research is quite active in this field, the data show us slightly lesser influences on project success as the factors 'learning' (Q24), 'working inter-disciplinary' (Q21) or 'agreed innovation goal' (Q12).

4.2. Level of Newness

The first three questions of the survey is highly relevant to our initial hypothesis. Q1 'rate the newness of the product' has a deviation of 0.11, although there is no statistical significant difference between the two populations. Robert G. Cooper suggested that there are a lot of problems and pitfalls with new products [20]. New products are not naturally more successful than other products. Major problems in new PD are poor marketing research, technical problems, insufficient marketing effort and bad timing. This could explain the neutral view of the participants on new product success. Our data indicates that 'newness of a product' has typically no effect on success. Q3 'rate the newness of the product to the market' had an average difference of -0.58. This indicates that the participants perceive that major changes for the market could be less successful. On the other hand, the data is not significantly different in statistical terms. However, the 'market view', is indeed an important factor in new PD. Most common new product failures were poorly done market studies with over 70% [21]. Penetrating or competing in a new market is not an easy task. According to Ansoff [29] there are two ways to get into a new market. First is going with an old product in a new market, which is called 'market development'. The second one is 'diversification', which implies entering new products in new markets. Diversification is the strategy with the higher risk. To develop a new product and enter a new market, demands new knowledge and additional resources [30], [31]. In 'market development', the company stay concentrated on its core competencies regarding PD but finds either new customer segments or new markets for example in other regions. Q2 indicates that the change in the production process in a successful project was smaller than in a not successful project, with an average difference of -0.91, and a statistical significant difference between successful and unsuccessful projects. This means that new technology or changing setup in the production causes difficulties that often lead to unsuccessful projects. In other words, this implies that projects with less change in the production set-up is typically more successful.

4.3. Limitations

The survey had been done with 28 participants from different manufacturing companies in Norway, and the individuals interpreted the definition of successful and unsuccessful subjectively. Therefore, the participants could have different individual definitions, which could affect the scores. The *t*-test should have n>30, while here n is slightly below and could lead to potential inaccuracies, especially in the border areas.

5. Conclusion and further work

Even when 'project success' itself is a much wider field than the traditional reduction on keeping time, budget and quality during PD under control, the factors are still very powerful performance indicators. In an increasing process-driven commodity world these are as important as ever. To progress commodity-driven development projects as efficient as possible, a robust, repeatable and constant development environment is necessary. On the other hand, newness and innovations are parts of the daily business in a more and more complex construct of projects. Our data shows that there is a significant negative correlation between successful project outcome and newness. As product novelty stays almost neutral to project success, new markets and especially changes in the production process are rated negatively against the success of a project. Our data, when evaluated on averages as well as statistical significance of the survey, underline that well-known factors in new PD such as 'sufficient project resources' (Q15), 'fast internal communication' (Q22) and 'good communication to the customer' (Q9) are indeed important for making a project successful. Commodity-driven projects are no exception. On the other hand 'working together with external R&D resources' (Q10), 'cooperation with suppliers during PD Phase (Q11)' and 'working on alternative solutions (Q6)' have less influence on the outcome of a project which is overall in alignment with other research on these topics.

This is a first attempt to test a research model for assessing success/no success in PD projects. Overall, newness is recognized as an important issue in projects, which needs to be investigated more deeply. Further work will include to improve the data basis and verify it with a larger sample. To examine the topic more qualitatively, we will use case studies and interviews in international companies to triangularize the data between different methods.

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