8th International Conference on Mass Customization and Personalization – Community of Europe (MCP-CE 2018)
Digital Customer Experience
September 19-21, 2018, Novi Sad, Serbia

MERGING COMMERCIAL AND TECHNICAL CONFIGURATORS

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Abstract: *Companies are increasingly investing in product configurators in order to automate sales and production processes. The investment in product configurators can also be quite high mainly because of the need for an expert team and software. Companies develop configurators to support the specification of both commercial (sales) and technical parts of their products. The previous research address both approaches, including the pros and cons of each solution. However, there are also advantages in developing merged technical and sales configurator for a specific product instead of just developing one of them. The merged approach is tested in three case projects in an ETO company to investigate the pros and cons of the suggested approach. The cost of the project and Return On Investment (ROI) and complexity analysis demonstrates the benefits gained from the proposed approach.*

Key Words: ***Product Configurator, Commercial, Technical, Case Company, Return On Investment (ROI), Complexity***

1. INTRODUCTION

Configurators can be applied to support the decision-making processes in the sales and engineering phases of product development, where the most important decisions regarding product features and product costs are made [1]. The configurator receives the individual customer requirements, configures the product based on the defined solution space, performs the calculations and finally generates all the necessary outputs including: proposals, bills of material, price calculation sheets or even CAD drawings [1]. Widely used in various industries, product configurators can bring substantial benefits, such as shorter lead times for generating quotations, fewer errors, and increased ability to meet customers' requirements regarding product functionality [2]–[7]. Furthermore, the results demonstrate the reported challenges during the planning, development and maintenance; which leads in reducing the performance and efficiency or even make the project to be a failure [8]–[11].

Configurators are normally divided into two main categories in the previous researches [12]: 1) The first class deals with the commercial part and is conducted by the sales teams of companies; 2) The second class is close to a product design activity and is mainly achieved by the research and development teams of companies. Haag [13] distinguishes between high- and low-level configuration because they require different technologies. Commercial or high-level configuration in which an external problem solver, usually a salesperson or customer, interacts with the configurator to make the creative decisions. Low-level configuration, in contrast, is manufacturing-oriented, a non-interactive, procedural process that selects the necessary parts, checks their availability, and determines the necessary routings at a level of detail that is no longer interesting to the customer [13].

The integration of all configuration activities, from sales specification up to production and outbound logistics, is one key in achieving product customization [14], [15]. This highlights the need for a new approach, in order to simplify the management process of configuration projects. The main challenge when developing a configurator for one specific product is the business request to keep technical and commercial part separated, which call for two different projects efforts and budget. Keeping technical and commercial configurators separated, which is very common, make the two team working separately as well.

As the commercial configurators include simpler version of product models as compared to technical configurators, there are advantages from building the commercial configurators at the same time with technical one when modeling one product type. First, resources and time will be saved while two configurators will be delivered instead of one with the same principles, core model, planning, and project management procedures. Secondly, the sales and technical department are getting integrated in an automatic way while receiving an order. Hence, the technical and sales experts work together in a more efficient procedure. Finally, after the implementation phase, the maintenance task will be agile [16] because if there is an update in the product life cycle, it is inserted in one model and effecting both the technical and commercial configurators [17].

As the commercial configurators include simpler version of product models (higher abstraction level) as compared to technical configurators, there are advantages from building the commercial configurators at the same time with technical one when modeling one product type. First, resources and time will be saved while two configurators will be delivered instead of one with the same principles, core model, planning, and project management procedures. Secondly, the sales and technical department are getting integrated in an automatic way while receiving an order. Hence, the technical and sales experts work together in a more efficient procedure. Moreover, there will be no need for the technical personnel assistance during the sales process and the assistance of sales personnel when calculating the technical details. Finally, after the implementation phase, the maintenance task will be agile [16] because if there is an update in the product life cycle, it is inserted in one model and effecting both the technical and commercial configurators [17].

2. LITERATURE REVIEW

2.1. Technical and commercial configurators

Sales configurators are the knowledge-based software applications that support a potential customer, or a sales-person interacting with the customer, in completely and correctly specifying a product solution within a company's product offer [18]. A commercial model is a formal representation of the product space and of the procedures according to which a commercial configuration can be defined within such space [6]. Commercial configurator represents the description of the product the customer is willing to buy and the company agrees to supply. Product configurators support not only the creation of sales specifications, but also the creation of technical specifications, such as bills of materials, production sequences or technical drawings, which are the pre-requirements to satisfy the customers [19]. The technical configurator consists of all the technical details of the product and relevant calculation [1], [19]. A technical model is a formal representation of the links between commercial characteristics and the documents that describe each product variant [19].

Even though the technical and commercial configurators are different in terms of product knowledge and the output documents, they are depending on each other by sharing core knowledge of the product. Based on literature, in the commercial description of the product some characteristics are not strictly associated with the product itself as in technical configurator from the material point of view, can be included, such as price, delivery terms, packaging, etc. [6].

The technical configuration process can be defined as all the technical activities that generate the documentation of the product variant based on the commercial description of such variant [6]. So, in order to satisfy the customer's requirements as far as possible, each variant must be functionally complete, technically feasible [13]. Technical configurator introduces the links between commercial characteristics and the details of product variants [19]. Of course, product documentation in technical configurator is based on the data from commercial configurator [20]. On the other hand, the commercial configurator is built on the feasible solution defined by technical requirements with less details [21].

2.2. Cost benefits analysis

Discussions concerning the unpredicted costs of configuration projects indicate that the rough estimations involved in cost analysis are considered a challenge that need more attention from academia [22]. The financial benefits of configurator projects should be clear from the beginning, and cost evaluation is important from the initiation phase. Cost-benefit analysis is used to compare the expected costs and benefits for different scenarios and the results from a variety of actions [23]. Return On Investment (ROI), which is commonly used as a cost-benefit ratio, is a performance measure used to evaluate the efficiency of a number of different investments [24], and it has been used to determine the profitability of configurator projects [25].

The results from the literature review shows that by utilizing configurator reduced man-hours and lead-time for generating the specifications is acknowledged in numerous of research [26]. The reduction can be traced to automation of routine tasks and elimination of the iterative loops between domain experts, as configurator makes all product knowledge available [7]. However, in this research, we focus on the saved man-hours which is simple and quantified.

2.3. Complexity Measurement

To measure the complexity of configurators, Brown et al. [27] categorize them into three major components; 1) execution complexity, 2) parameter complexity, and 3) memory complexity. Execution complexity covers the complexity involved in performing the configuration actions that make up the configuration procedure and the memory complexity refers to the number of parameters that system manager must remember. In this paper, the parameter complexity is the most important, as it measures the complexity involved in providing configuration data to the computer system during a configuration procedure [27]. Therefore, we assessed the parameter complexity in terms of two major parameters inside the configurator: attributes and constraints (Table 1).

Table 1. *Complexity assessment in terms of parameters in configurators [17]*

	No. attributes	No. constraints
Small complexity	500 - 1300	200-800
Medium complexity	1300-2000	800-1200
Large complexity	>2000	>1200

3. RESEARCH METHOD

The proposed approach was tested using a single case company [28]. Case study research provides the opportunity of comparing different theories and observations from empirical data [29], [30]. Moreover, case study methods have considerable comparative advantages relative to statistical methods or formal models [31]. Qualitative and quantitative information in was obtained by means of (1) archival documents, (2) participant-observations and (3) interviews [32].

4. PROPOSED APPROACH

The literature review discusses the differences between commercial and technical configurators while keeping them separated as two different projects. The challenges clarify the bottlenecks in different phases of configuring projects. The literature review clarifies the possibilities of combining commercial and technical configurators of one specific project in order to minimize most of the challenges.

Based on the relevant information in the literature, the team then identified the key challenges they encountered during the commercial and technical configurators projects process. There is a call that the two previous configurators have not been used by business because of the lack of alignment. Even though, stakeholders still asked for the new version for both projects separately, the research team managed to analyze the challenge by proposing a new approach for merging the two projects. Iterative design method, which blends the activities of designer and user, creator and player, is based on a cyclical process of prototyping, testing, analyzing and refining an approach [33]; thus, we developed the approach through an ongoing dialogue between the research and configuration teams.

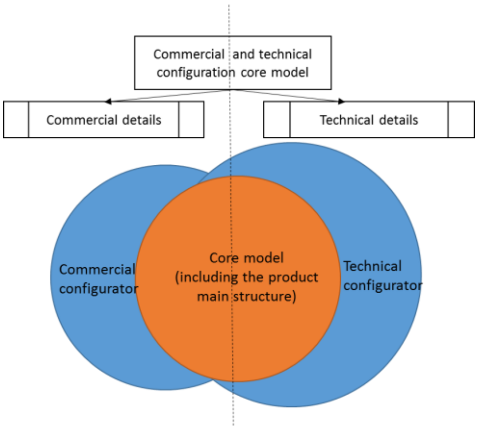

Fig. 1. *The logical structure of commercial and technical configurators combined as one system*

There are three fundamental alternatives for building configuration systems, as well as the conditions that determine the appropriateness of each alternative as: weak automation of commercial and technical configurator, full automation of commercial or technical configurator, and the full automation of both technical and commercial configurator [6]. Combining the commercial and technical configuration systems is another way for having two automated configuration process on technical and commercial level while decreasing the investment on both parts (Figure 1).

5. CASE STUDY

Based on the proposed approach to merge the commercial and technical projects, we study three projects to test the approach. The previous separated commercial and technical configurators' comparison with the new combined configurator facilitate the process of validation. Therefore, the units of analysis were the individual configuration projects. Having different units of analysis and multiple data sources improved the validity of our findings.

The case company, which operates globally, specializes in catalyst production and process-plant technology. This project focus on one of the popular most seller catalyst at the company consisting of both commercial and technical departments. Three project have been developed in the case company that can covered the two scenarios below:

1. Two separated technical and commercial configurators (two different projects, two different configurator).
2. The combined version of the technical and commercial as one project including both commercial and technical data (one project, one configurator).

There are two different scenarios for future way of working. The scenario number one is to have two separated configurators for the two departments as shown in Figure 2. This solution requires the investment in two separated projects while the process illustrates an inefficient final process. There is still manual process and meeting that should take place, even though both departments have access to configuration systems.

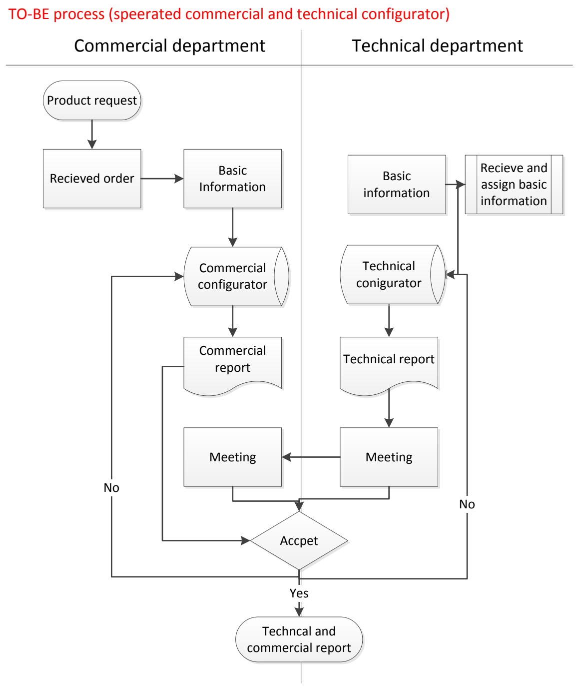

Fig. 2. *Future scenario (two separated configurators for sales and technical departments)*

The last scenario which is the recommended one to align the two projects. As Figure 3 shows the process will be so short and efficient and fully automated. The different phases of the project will consume more time and resources compared to only one configurator as it has to cover core model and the specific knowledge for each configurator.

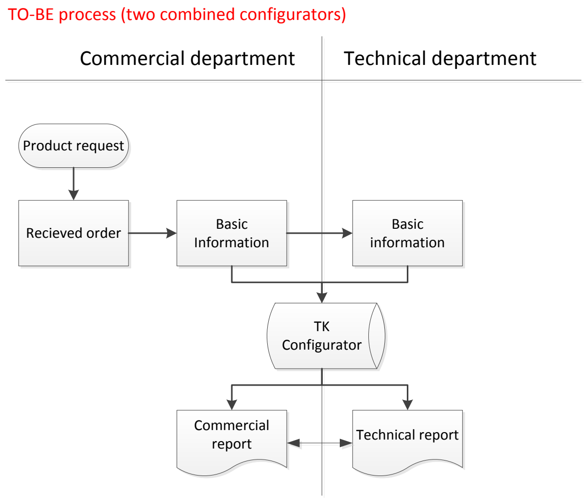

Fig. 3. *Future scenario for the proposed approach (one combined configurator for both departments- sales and technical)*

6. RESULTS

In this section, the complexity of the projects is compared and discussed. Finally, the cost analysis for different projects illustrates the assessments of the investment and gained costs during the three projects: commercial; technical; and merged version of technical and commercial.

The complexity of the three projects is very close and in the range of small to medium. Obviously, the combined configurator is more complex but with minor differences and still in the same range. Meanwhile, if the two technical and commercial projects are separated the sum of the two projects is in the range of very large projects. Here we cannot call it one project and consider it as one project, but the sum of the attributes for two projects will be 2415 and constraints 1374.

Table 2. *Complexity assessment of different configurators at the case company*

Different configurators	No. attributes	No. constraints	Size of the project
Commercial configurator	1299	720	Small/ Medium
Technical configurator	1116	655	Small/ Medium
Technical and commercial configurator (combined)	1500	790	Small/ Medium
Technical and commercial configurator (separated)	2415	1374	NA

If we want to assess the ROI for two commercial and technical configurators separated, we should sum everything in two projects and the ROI will be around 130% which is equal to having one configurator on board. However, there are other benefits from automating the whole process even if the configurators are separated, the ROI shows that it is an additional investment for the company.

Table 3. *Cost elements associated with different case projects*

Case Projects	ROI in 1st year (based on saved man-hours)
Technical configurator	137%
Commercial configurator	130%
Merged technical and commercial configurator	200 %

7. DISCUSSIONS AND CONCLUSIONS

This paper proposed an approach for merging commercial and technical product configurators. The concept of this approach is to develop a core product model that is shared between the commercial and technical parts of the configurator. This implies that the same product information only has to be implemented once and only needs to be maintained in one system, as compared to the scenario with two separate configurators. Besides the core product model, information related to only commercial and technical configuration is added to the core product information model of the system.

As the cost analysis showed, in the case of a merged commercial and technical configurator, the one-year ROI was higher as compared to separate configurators, namely 200%, as compared to 130% for the technical configurator and 137% for the commercial configurator. The setup at the case company provided the flexibility of identifying the practical challenges of applying the approach and in long-term allows us to assess the commercial, technical and merged version of the two projects in detail and in-depth. Besides, one case company and the same group of involved resources in all three projects allow us to eliminate the unnecessary factors in evaluating the approach such as cross-organizational cultures.

Obviously, there are some generalization limitations associated with only having tested the proposed approach in one case. However, to demonstrate the feasibility of the approach, one case can do that. In other words, the paper has demonstrated that at least in some cases it is possible to merge commercial and technical configurators, and that this can give rise to significant benefits. For companies to determine if they can harvest similar benefits from the suggested approach, they first need to determine if their products are suitable for both commercial and technical configuration; and if so, if there are and adequately large amount of shared product information between the two domains. If this is the case, there is a need to analyze the possibilities of adapting the organization to support this sharing of configurators. Future research needs to conduct further studies of the application of the suggested approach in order further detail the approach, as well as to provide more knowledge about its application potential.

8. REFERENCES

[1] L. Hvam, N. H. Mortensen, and J. Riis, *Product customization*. Berlin Heidelberg: Springer, 2008.

[2] L. Ardissono *et al.*, “A Framework for the Development of Personalized, Distributed Web-Based Configuration Systems,” *AI Magazine*, vol. 24, no. 3, p. 93, 2003.

[3] V. E. Barker, D. E. O’Connor, J. Bachant, and E. Soloway, “Expert systems for configuration at Digital: XCON and beyond,” *Communications of the ACM*, vol. 32, no. 3, pp. 298–318, Mar. 1989.

[4] L. Hvam, S. Pape, and M. K. Nielsen, “Improving the quotation process with product configuration,” *Computers in Industry*, vol. 57, no. 7, pp. 607–621, Sep. 2006.

[5] T. D. Petersen, “Product Configuration in ETO Companies,” in *Mass customization information systems in business*, Igi Global, 2007, pp. 59–76.

[6] C. Forza and F. Salvador, *Product information management for mass customization: connecting customer, front-office and back-office for fast and efficient customization*. New York: Palgrave Macmillan, 2007.

[7] S. Shafiee, K. Kristjansdottir, L. Hvam, and C. Forza, “How to scope configuration projects and manage the knowledge they require,” *Journal of Knowledge Management*, vol. 22, no. 5, pp. 982–1014, 2018.

[8] S. Shafiee, “Conceptual Modelling for Product Configuration Systems,” Technical University of Denmark, 2017.

[9] K. Kristjansdottir, S. Shafiee, H. Hvam, C. Forza, and N. H. Mortensen, “The main challenges for manufacturing companies in implementing and utilizing configurators,” *Computers in Industry*, vol. 100, no. May, pp. 196–211, 2018.

[10] P. Blazek and K. Pilsle, “Learnings From Setting Up Product Configurator Projects.,” *Annals of the Faculty of Engineering Hunedoara*, vol. 15, no. 1, pp. 25–28, 2017.

[11] D. Walcher and L. Werger, “Why MC Organizations Fail-The Classification of Failure Reasons,” in *2011 World Conference on Mass Customization, Personalization, and Co-Creation MCPC*, 2012.

[12] M. Aldanondo, K. Hadj-Hamou, G. . Moynard, and J. Lamothe, “Mass customization and configuration: Requirement analysis and constraint based modeling propositions,” *Integrated Computer-Aided Engineering*, vol. 10, no. 2, pp. 177–189, 2003.

[13] A. Haag, “Sales configuration in business process,” *IEEE Intelligent Systems and their Applications*, vol. 13, no. 4, pp. 78–85, 1998.

[14] L. L. Zhang, E. Vareilles, and M. Aldanondo, “Generic bill of functions, materials, and operations for SAP2 configuration,” *International Journal of Production Research*, vol. 51, no. 2, pp. 465–478, 2013.

[15] P. Pitiot, M. Aldanondo, and E. Vareilles, “Concurrent product configuration and process planning: Some optimization experimental results,” *Computers in Industry*, vol. 65, no. 4, pp. 610–621, May 2014.

[16] B. Selic, “Agile Documentation, Anyone?,” *IEEE software*, vol. 26, no. 6, 2009.

[17] S. Shafiee, L. Hvam, A. Haug, M. Dam, and K. Kristjansdottir, “The documentation of product configuration systems: A framework and an IT solution,” *Advanced Engineering Informatics*, vol. 32, pp. 163–175, 2017.

[18] A. Trentin, E. Perin, and C. Forza, “Increasing the consumer-perceived benefits of a mass-customization experience through sales-configurator capabilities,” *Computers in Industry*, vol. 65, no. 4, pp. 693–705, May 2014.

[19] M. . Heiskala, J. . Tiihonen, K. S. . Paloheimo, and T. Soininen, “Mass Customization with Configurable Products and Configurators,” *Mass Customization Information Systems in Business*, pp. 1–32, 2007.

[20] C. Forza, A. Trentin, and F. Salvador, “Supporting product configuration and form postponement by grouping components into kits: the case of MarelliMotori,” *International journal of mass customisation*, vol. 1, no. 4, pp. 427–444, 2006.

[21] L. Hvam, Z. N. L. Herbert-Hansen, A. Haug, A. Kudsk, and N. H. Mortensen, “A framework for determining product modularity levels,” *Advances in Mechanical Engineering*, vol. 9, no. 10, p. 168781401771942, 2017.

[22] S. Shafiee, L. Hvam, and M. Bonev, “Scoping a product configuration project for engineer-to-order companies,” *International Journal of Industrial Engineering and Management*, vol. 5, no. 4, pp. 207–220, 2014.

[23] A. C. Haddix, S. M. Teutsch, and P. S. Corso, *Prevention effectiveness: a guide to decision analysis and economic evaluation*. Oxford University Press, 2003.

[24] P. A. Lemoine, H. C. Woodard, and M. D. Richardson, “Return on Investment,” in *Handbook of Improving Performance in the Workplace, Volume Two: Selecting and Implementing Performance Interventions*, 2010, pp. 302–308.

[25] K. Kristjansdottir, S. Shafiee, L. Hvam, M. Bonev, and A. Myrodia, “Return on investment from the use of product configuration systems – A case study,” *Computers in Industry*, vol. 100, no. July 2017, pp. 57–69, 2018.

[26] M. Aldanondo, E. Vareilles, and M. Djefel, “Towards an association of product configuration with production planning,” *International Journal of Mass Customisation*, vol. 3, no. 4, p. 316, 2010.

[27] A. B. Brown, A. Keller, and J. L. Hellerstein, “A Model of Configuration Complexity and its Application to a Change Management System Aaron,” *IEEE Transactions on Network and Service Management*, vol. 4, no. 1, pp. 13–27, Jun. 2007.

[28] R. K. Yin, *Case Study Research: Design and Methods*. CA; Newbury Park: Sage publications, 2003.

[29] D. M. McCutcheon and J. R. Meredith, “Conducting case study research in operations

management," *Journal of Operations Management*, vol. 11, no. 3, pp. 239–256, 1993.
[30] A. H. Van de Ven, "Nothing is quite so practical as a good theory," *Academy of Management Review*, vol. 14, no. 4, pp. 486–489, 1989.
[31] A. W. Finifter, *Political Science: The state of the discipline II*. Amer Political Science Assn, 1993.
[32] C. Karlsson, *Research Methods for Operations Management*, no. January. Routledge, 2009.
[33] E. Zimmerman, *Design Research: Methods and Perspectives*. The MIT press, 2003.

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