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THE ROLE OF PRODUCT COST DEPLOYMENT IN THE EARLY PRODUCT MANAGEMENT METHODOLOGY WITHIN THE WCM SYSTEM – A CASE STUDY

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Abstract
World Class Manufacturing system consists of ten technical and ten managerial pillars. These, impacting directly and indirectly on each other, generate the flow of internal processes. Two of the mentioned pillars, Early Product Management (EPM) and Cost Deployment (CD) play a special role in the system, because they create a future strategic management of a company influencing design engineering, manufacturing and economy [1, 2]. Referring to the author's previous publications on Early Product Management methodology [3, 4], the role of Cost Deployment pillar in the new product launch remains an important issue. Additionally, there is a noticeable lack of publications in this specific field of the WCM system. Therefore, a proper understanding of the relationship between these two technical pillars is the basis for effective project management for the implementation of new products. In this article, the correlation between EPM and CD will be highlighted whereas some critical remarks will be indicated. The main part of the article will describe: the current approach to project management according to the standards set by the WCM system and recommended improvements originated from EPM and CD pillars. The quality scientific methods used in this article are based on a case study of internal processes in an international plant specializing in agriculture machinery production and include elements of direct observation and theoretical analysis and synthesis. This paper refers to the presented issues in practical terms on the example of the methodology of managing of new launch product projects in terms of cost management. The purpose of this paper is to draw attention to the problem of the cost factor generated during the design phase and early implementation of the new product into production, which will enable effective cost management of new implementation projects.

Keywords
Early Product Management, World Class Manufacturing, Cost Deployment, Continuous Improvement.

The importance of the project cost management in new product implementations

The issue of budget estimation, analysis and cost tracking during the implementation of tasks resulting from the investment plan is one of the key factors influencing the success of subsequent implementation. Although the cost aspect is one of the vertices of the project triangle, the so-called iron triangle [5], the issue of tracking costs is very often treated as a subordinate issue in relation to the time and quality of the product (Fig. 1).

The issue of cost management in the project was addressed in Morrison's work [6]. As a result of the research, the author pointed out the importance of experience and the use of knowledge, taking into account cost calculations from previously implemented projects.

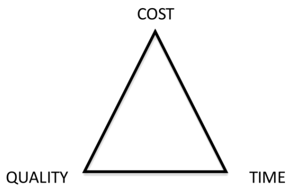

Fig. 1. The "iron triangle" of the project.

In the article [7] prepared by Babu and Suresh, a linear mathematical model was presented to assess the factors necessary for successful implementation of the project. The authors have analyzed individual implementation stages, comparing the costs of implementation of individual stages between planned budget expenses and unplanned so-called "crash activities". It was indicated that there is a possibility of extending the presented linear models to non-linear ones, which will determine more precisely the quality of the conducted project related to the time factor and cost factors.

The concept of the 'quality' of a project and the related costs of the managed project is also addressed in article [8]. The authors paid a lot of attention to the analysis of the essence of flow management and the way of providing information at different stages of the project implementation as well as methods for data exchange between individual project participants. The aim of their work was to create a universal tool to manage the flow of information and support managerial decisions.

Based on the research of two case studies – implementation projects in an Australian construction company, the authors developed the tool Project Management Information System (PROMQACS for short). The proposed solution was supposed to support project managers in tracking the costs of introduced changes in the project and their impact on the overall budget. The summary shows the versatility of this solution, which can also serve as a support for clients, contractors and customers in the issue of cost management in the project.

Doloi in her work [9] analyzed the reasons for the excessive costs of conducting projects in the construction industry. The author focused on the role of individual project participants, both internal (e.g. designer, financial analyst, project manager) and external (e.g. client, suppliers and subcontractors). Further on, the issue of cost management in the investment project was discussed, from the stage of tender and bidding for the client and preliminary budgeting to the stage of project launch. Based on the philosophy of cognitive mapping and the use of soft system methodology (SSM), all relevant factors in managing cost overruns in the project were examined.

The results of the work clearly indicated the importance of establishing a clear communication line between the project stakeholders and their knowledge and experience gained from previous implementations in the project cost estimation phase. In the longer term – at the stage of implementation and execution of the investment, the main factors generating excessive costs become contractors and suppliers, whose activities often depend on the legislation and requirements of environmental regulations. On the basis of the studies, a relational model has been defined, which can serve as a basis for further analyses and improvements in the methodology of early project management.

An important issue in terms of project management is to determine as precisely as possible the costs of project implementation at the earliest possible stage. Chou, in his work [10], attempted to estimate costs precisely. As the main computational model, the author used the Monte Carlo simulation method (MCS) together with Cholesky's decomposition in which he took into account additional mathematical algorithms and correlation relationships between individual factors. The summary presents the results of the conducted simulations in relation to data obtained from implemented projects in the construction industry. The range of theoretical values deviations from actual values, depending on the method adopted, was in the range of 0.3–2.0% which is a satisfactory value. The author proved the usefulness of the applied methods in project cost management practice and indicated the need for further evaluation of the applied mathematical models.

An important element in the cost management system for engineering projects is the position of cost specialist [11]. In his work, Smith has repeatedly emphasized the need to establish international standards both in the area of cost management methodologies in projects as well as the methods of certification of specialists responsible for their supervision. In his work [12], the author has paid particular attention to the problem of the lack of regulations or directives in cost management, as well as non-standard or even erroneous methods adopted by specialists in various countries around the world.

As one of the methods of improving the cost management process already at the stage of designing and estimating offers, Smith points to the application of the BIM (Building Information Modelling) approach [13]. Due to the dynamic development of information technologies, extensive and shared databases made available by means of ICT connections (creating the so-called Internet of things). Among many tools supporting the process of cost management, CostX was given as an example. This tool uses 3D models of building bodies together with installations and infrastructure, as well as cost data for the individual ones, which create the so-called Cost Model. On the basis of the available construction data, it is possible to estimate the costs of investment implementation and present proposals for improvements that lead to savings in the project.

A multicriterial analysis of project management method was performed in a paper [14]. The authors of the article have made an in-depth analysis of literature sources in order to determine the most important factors influencing the success of implementation projects in the area of IT systems designed for financial institutions, including banks. 11 hypotheses referring to the four main components of the implementation project, which are presented:

- portfolio level,
- type & scope of the project,
- project manager,
- project team.

After creating a conceptual hierarchical research model, the authors analyzed the impact of individual hypotheses/factors on the result of a dimensionless CTPMS (Cost and Time Project Management Success). The real database developed on the basis of nearly 900 projects implemented in a selected Brazilian financial institution was used as a reference. Surprising results of the analysis were presented:

- It is recommended to ensure that all required resources are available to start the project before it is launched in reality. If it is not possible to allocate sufficient resources to the activities, the project should be suspended.
- For the analyzed case, there is no confirmation of the thesis that outsourcing of activities to external resources (outsourcing) has a positive impact on the success of the project. At this point, the authors point out the exceptional character of the institution under study (extensive structure of the IT department) and indicate the need for further research in other environmental conditions.
- A high position in the organizational structures of a project manager's company does not affect the effectiveness of team management.
- It is not recommended that a project manager should only specialize in a particular field. It is advisable to have the most universal and versatile experience possible, which allows for better adaptation to dynamic changes and problems during the project.
- Better results are achieved by a small project team consisting of members of the same organization for whom the success of the implementation is an important business objective.

The presented literature review refers to the cost factor in the project management process. The common part of the presented works is an attempt to identify particular roles played by particular participants of the project as well as methods of determining and tracking costs during the implementation of the planned activities.

Certainly, it can be stated that this area still requires further scientific analyses and their verification on the basis of implemented investments, however, the presented conclusions can be a starting point for the assessment of the effectiveness of the project cost management in the WCM system, for which the Cost Deployment pillar plays a vital role.

The role of early product management and cost deployment pillars within WCM system

Empirical research in this article comes from the integrated management system WCM (World Class Manufacturing) and mainly concerns correlation between its two technical pillars – Early Product Management and Cost Deployment. Theoretically, the combination of these two pillars is extremely important for the effectiveness of the project implementation and cost management. In the long term, their proper use translates into the stabilization of internal plant processes and further development of the company [15], which determines the existence of a continuous improvement effect [16].

Early Product Management is one of the ten technical pillars in WCM temple. This methodology has been widely described in the publication [3].

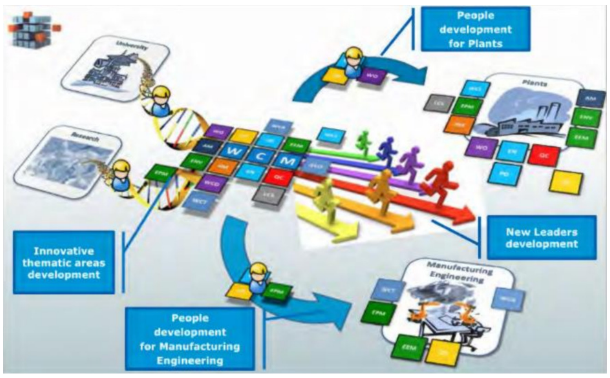

Fig. 2. Graphical illustration of WCM system [17].

The importance of EPM pillar, as a new product launch management methodology, has gained much attention recently. Based on extended Knowledge Management and Best Practices System, Fiat Chrysler Automobiles (FCA) company made a meaningful step forward by introducing not only well-known WCM system, but also World Class Engineering (WCE). The main assumption of this strategical move was to enhance product improvements and implement best practices in design engineering at the earliest project stage. This approach is in line with the New Product Implementation Cost Management and Product Life-Cycle Management aspect. Therefore, the overall and main goal of the EPM methodology is to make changes to the project at the earliest stage of introducing a new product to the market and improving it, while avoiding costly modifications before the product is manufactured and delivered to the consumer market.

The connecting element of WCM and WCE models is the EPM pillar, which can be found in both temples. In the WCM approach, Cost Deployment creates a separate technical pillar, whereas in WCE model, it is incorporated into EPM pillar. The concepts of WCM and WCE are shown in Fig. 3.

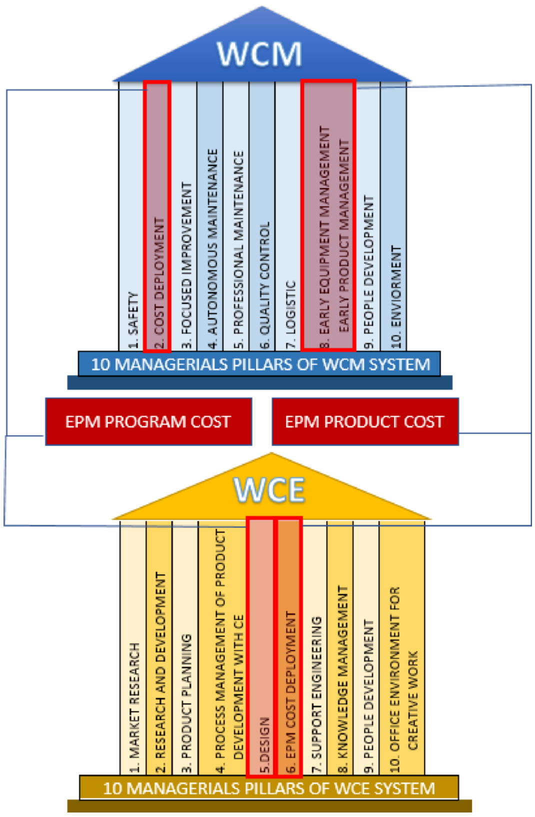

Fig. 3. Schematic of ten technical pillars of WCM and WCE systems.

The steering module that controls Early Product Management activities, in the common part of WCM and WCE, is the Cost Deployment method. This approach is based on the creation of a full cost history of implemented projects through detailed data collection during the investment.

Currently, an important role in the development of the WCM and WCE systems plays the Industry 4.0 concept. Therefore, many companies have developed a way to implement this approach to existing management processes, one of which is FPT Powertrain Technologies France S.A. In detail, this process has been described by the authors in a paper [18].

As a result of the actions taken in EPM activities, two areas are identified for Cost Deployment detailed analysis. These areas consist of:

- EPM Program Cost – which includes distribution of manufacturing launch costs, e.g. tooling investments, workstation rework, new manufacturing technology implementation.
- EPM Product Cost – which includes cost deployment of manufacturing standard product costs e.g. HPV (Hours per Vehicle), TMC (Total Manufacturing Cost).

A conceptual model for EPM and CD coexistence during new product launch project was presented in Fig. 4.

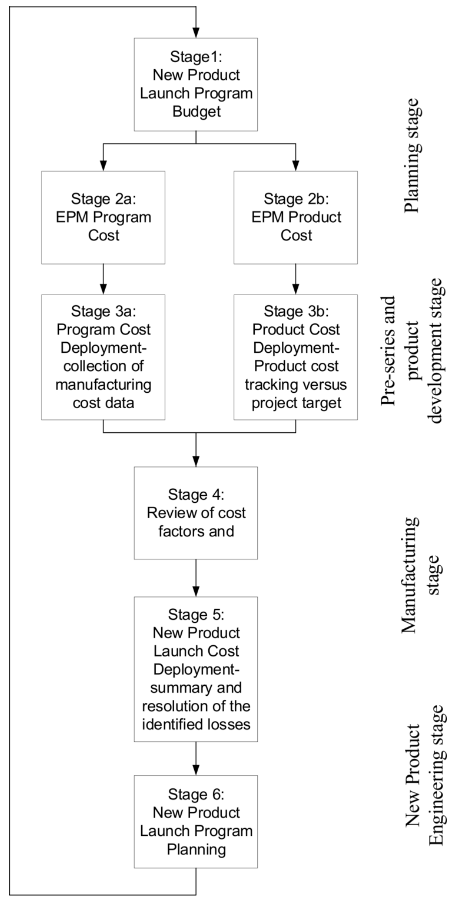

Fig. 4. A model of EPM and CD coexistence within new product launches.

New product launch project team building and project classification

In accordance with the main WCM concept, the extensive experience gained from the projects is used in a way known as Knowledge Management [19]. The effective use of this resource depends on the active cooperation of experienced and motivated project team members. By using best practices and their skills, concepts of improvement affecting the cost factor are created.

Project team consists of several positions and includes:

- Project Manager,
- Manufacturing Engineer,
- Production leader/foreman,
- Logistics engineer,
- Design engineer,
- Cost/value engineer.

As a support for the above mentioned team, in many highly developed companies in recent years an additional position of Advanced Manufacturing Engineer is being created and incorporated into the company structure. The main aim of this introduction is to develop EPM's activities on the borderline of Design and Production Engineering, taking into account the cost aspect. More details on the concept of AME can be read in the author's article [4].

The projects which are implemented in the analyzed company are grouped according to their type and estimated budget. The classification was presented in Table 1.

Table 1
Project type classification.

Project complexity		New product new process new line		New product (upgrade of existing process/line)	
ExperiencE		No	Yes	No	Yes
Project investment	>$20M	AA	AA	AA	A
	$10M–$20M	AA	A	A	B
	$5M–$10M	A	B	B	C
	$1M–$5M	A	B	C	C
	<$1M	B	C	C	C

The classification of a given type of project depends both on the level of estimated budget, adopted for a given investment, and on the organization's experience in the technology of manufacturing the selected product. However, the conclusions from the analyses are transposed regardless of the type of the realized project and define new directions of EPM activities in a new project.

Cost Deployment Pillar characteristics in WCM system

By definition introduced by Dr. Hajime Yamashina [20], Cost Deployment is a methodology to establish in a scientific and systematic way, a cost reduction program. This is done as a collaboration of production people and financial control.

Successful Cost Deployment implementation can be achieved by [21]:

- Investigating the relationship among the cost factors, process generating costs and various kinds of waste and losses.
- Finding connection among waste, loss reduction and cost reduction.
- Clarifying if the knowhow on waste and loss reduction is available and by obtaining the knowhow if needed.
- Ranking the items for waste and loss reduction according to priority based on cost and benefit analysis and then by establishing a cost reduction program for meaningful cost reduction.

Therefore, two phenomena are highly respected in Cost Deployment approach (Fig. 5):

- A *waste*, which stands for an over usage of input resources.
- A *loss*, which can be seen as input not effectively used.

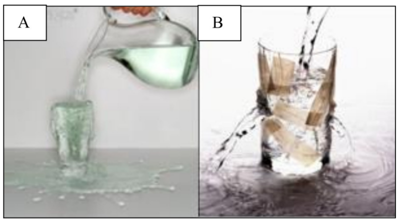

Fig. 5. Visual interpretation of a waste (A) and a loss (B).

As with the EPM pillar, WCM management under the Cost Deployment approach consists of seven stages, which include [22]:

STEP 1:

- Identify total factory costs by financial department.
- Establish targets for cost reduction.
- Separate total costs by different sources.

STEP 2:

- Identify wastes and losses qualitatively.
- Identify wastes and losses based on the past operating data (if available) or on the measurement of wastes and losses quantitatively.

STEP 3:

- Separate casual losses and resultant losses.

STEP 4:

- Translate identified wastes and losses into costs.

STEP 5:
- Identify methods to recover wastes and losses.

STEP 6:
- Estimate costs for improvement and the amount of possible cost reduction.

STEP 7:
- Establish improvement plan and its implementation.
- Transfer of best practices and experience to the next new product launch program.

As a result of the work carried out in the individual steps of the CD approach (Step 1–7), cost data is collected in the matrices, which are presented in the Table 2 [23].

Table 2
Cost Deployment matrixes.

Matrix type	Area of interest	Description
A	Process	Identification and quantification of the losses
B	Losses	Clarification of cause and effect relationship
C	Costs	Identification of connection between losses and manufacturing costs
D	Methodology	Connection of causal losses and improvement techniques
E	Projects	Identification of benefit to cost ratio and cost reduction program establishment
F	Evolution	Establishment and implementation of the improvement plan
G	Budget	Verification of the project scope & cost results to initial project budget

The practical significance of the correlation of the Cost Deployment and Early Product Management pillars

Effective cooperation between the pillars of CD and EPM plays a significant role in the development of business processes in the company, generally referred to as Continuous Improvement. Due to the fact that the Early Product Management methodology appeared much later than the Cost Deployment approach, the area of dependence of these two pillars is of interest to a narrow group of scientific circles and specialized practitioners. The outcome of the dissertations will be correlated with the increased experience in the accomplished projects. Using Cost Deployment tools, EPM utilizes best practices and drives improvements in the next new product launches (Fig. 6).

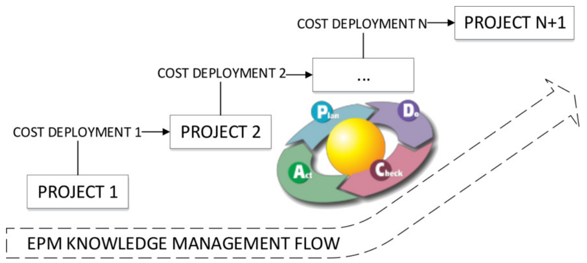

Fig. 6. Cost Deployment process and EPM Knowledge Management Flow.

Among the many issues related to the definition of the Cost Deployment approach in the area of Early Product Management, a number of extremely important factors should be identified. These should be met to ensure the effectiveness of the implemented actions. Based on proven experience and extensive literature review they should be highlighted [24, 25]:
- The data collected within the management process must be reliable and most up to date.
- High team motivation must be maintained throughout the whole project lifecycle.
- Plant top management must fully understand and support activities of the EPM team.
- Top management should avoid limiting the resources allocated to the EPM and CD activities.
- The activities must be focused on highest business need.

New product launch project stages in terms of EPM and CD methodology

One of the most important steps in managing the launch of new projects within WCM/WCE systems is visualization of changes in new products. These changes are marked in the Functional Block Diagram, which is presented in Fig. 7. On the basis of their grouping, which is carried out by an interdisciplinary project team, the main areas of activity and initial allocation of resources are defined.

Correct implementation of this stage has a decisive influence on effective and efficient project implementation. It is also the starting point where the pillars of Cost Implementation and Early Product Management meet and permeate until project closure.

The collaboration of project team members is concentrated on the main system at first, where numerous changes in the design of new product are identified. This step requires active participation of top product management board (in WCM known as Product Platform) and design engineering. In the next step the subsystems are analyzed in detail by manufacturing and production experts where Technical Features and Critical Parts are outlined. The schematic of this approach was presented in Fig. 8.

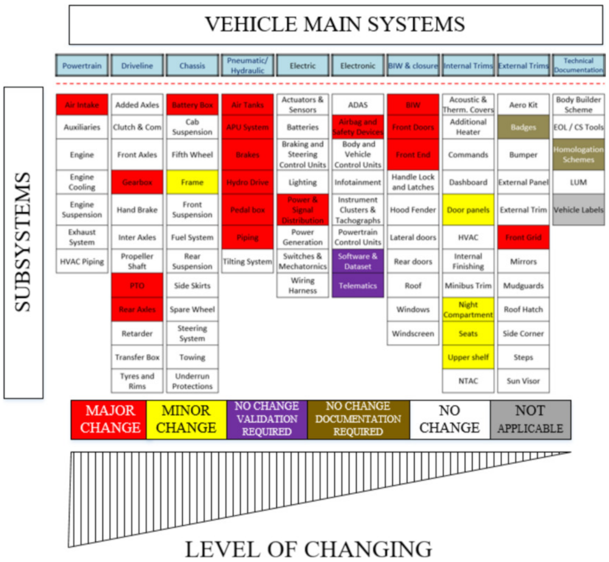

Fig. 7. Functional Block Diagram according to IVECO STANDARD 19-8230.

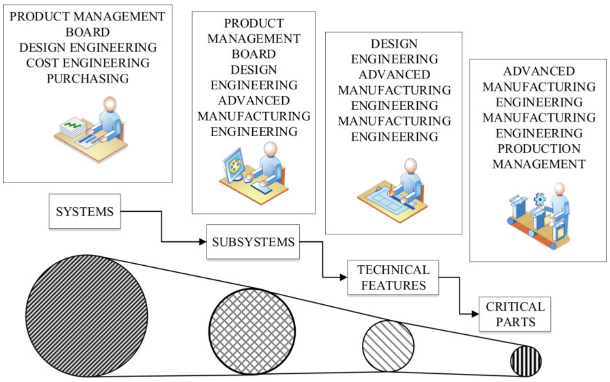

Fig. 8. Cost Deployment and Early Product Management team cooperation.

Based on the input and feedback described above, the product management board (i.e. product platform)is responsible for the scope of the program (final design), project's implementation strategy and investment plan. An example was presented in Fig. 9.

The effectiveness of a new product launch project management (by the platform and other members of the project team) is reflected by the correlation coefficient of the current product cost to the product cost target. Another factor which is tracked is the current project expenditure (launch cost) to the budget plan.

A common output of a Product CD and EPM computing starts with an A-Matrix correlating Resultant Losses with Operative Unit (where the loss was found). Through the B-Matrix the link between Resultant Losses and their Causal Loss is indicated which permits to depict the standard C-Matrix output showing the Pareto of Causal Losses.

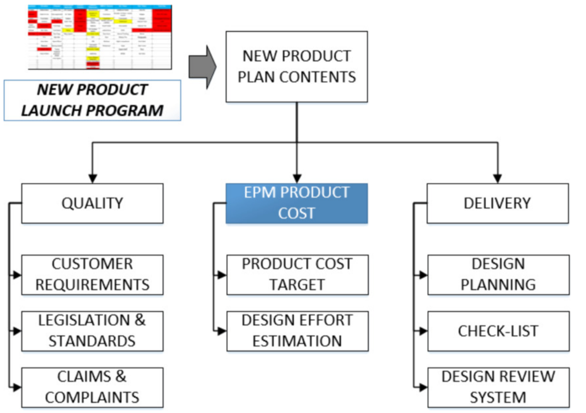

Fig. 9. EPM Product Cost – one of the two parts of Cost Deployment approach for a new product launch.

Case study example

The described case study describes the project management in the agriculture machinery plant. The level of implementation of the EPM methodology in practice has been assessed by independent audit teams (eight consecutive six-monthly audits in four-year history) at a very high level, set at three on a four-point scale.

In analyzed example, the EPM team had extensive experience in managing a type "A" project- an agriculture baller presented in Fig. 10 (New Product with no experience- upgrade of existing process, Investment \$10M–\$20M – Table 1 as a reference) implemented in 2014–2015.

Fig. 10. Completed former class "A" project type.

A type "C" project (New Product with experience – upgrade of existing process, Investment \$5M–\$10M – Table 1 as reference) was adopted as another example to improve the management process. The project covered an update of combine corn header unit, which was presented in Fig. 11.

According to the Continuous Improvement philosophy approach, the link between EPM and CD pillars was at the product development stage with a proactive approach. This was graphically shown in Fig. 12.

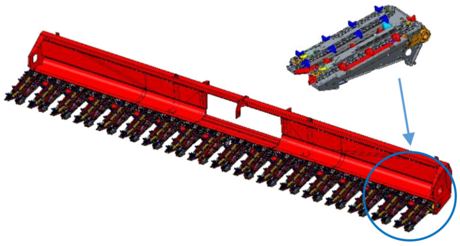

Fig. 11. New product launch Class “C” project type.

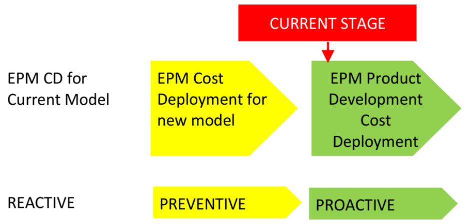

Fig. 12. Case study EPM and CD status.

Table 3

Identified causal losses in the implemented projects.

Phase	Macro category	Causal Loss	Definition
Developmental	Product	Design complexity	The design includes high number of new components, with many variations and high level of interconnection (you change one component in a system, you need to change many others). Complex design results in process/assembly errors and supply chain costs.
		Design not suitable for manufacturing	The design is found to be not suitable for manufacturing. The losses may be due to unmanageable interference or the material dimensions not suitable for the tools or equipment. This results in design changes, ME time, idle time, expedites etc
		Design change	Late design modification, any design modification, part design released more than once.
		Late design release milestone	Due to delay in engineering timelines not related or driven by manufacturing issues, losses were incurred to achieve the remaining milestones. The losses could be overtime in ME or expedites or obsolescence etc.
		Poor parts standardization	The presence of parts with different specifications for the same function, resulting in losses in terms of additional process, extra material etc.
		Unnecessary product part function	The presence of parts that deliver more in functionality than the specification or expectation.
Developmental	Process	Manufacturing process issue	Manufacturing process is not suitable for meeting the design specifications. For example, equipment cannot achieve the tolerance specified in the design.
		Late test/ validation failure	Failure of the part or product during the advanced stages of testing resulting in design and/or process changes.
		Sourcing delay	Delay in part sourcing process.
		Tooling issue	Tooling is not suitable for meeting the process specifications resulting in process or equipment changes.
		Complex equipment usage	AM/PM losses due to the complex design of the equipment.
Developmental	Material	Supplier quality issue	Defects in parts purchased from suppliers.
		Incomplete/ Incorrect specification	The drawing or design does not have all the specifications or information to carry out the manufacturing process. For example, “Torque specifications” not provided in the drawing or “incorrect Carbon content” for castings in the drawing. It is possible that the correct specifications were agreed with all the stakeholders but the drawings were not updated. This results in drawing modifications (design time), Manufacturing Engineering time (to revise process or work instructions), idle time in the line.
		Expensive parts usage	The use of expensive parts in the product when a lesser expensive part could perform the same function.
Production	Process	Lack of WO activities (Station Level)	To be used for Production losses.
		Incomplete visual aids, SOPs & error-proofing	
		Incomplete PFEP	
		Returnable racks not available	

Table 4
Identified resultant losses in the implemented projects.

Macro category	Causal loss	Definition
Process	Direct labor	Losses in operator and/or supervisor time during developmental phase.
Process	Indirect labor	Losses related to logistics during developmental phase.
Process	Plant Tooling change	Losses related to changes to working or manufacturing equipment or aids such as cutting tools, dies, fixtures, gauges, jigs, molds used to manufacture products on a product line within the plant.
Process	Expediting	Losses related to the coordination of the expedite freight (parts as well as tooling). In this category, only losses related to the administration and coordination are included. The actual freight costs are not included.
Process	Design engineering	Losses related to extra design hours necessary to redesign the parts due to design issues.
Process	Testing (extra)	Losses related to extra testing hours due to product design changes and scope changes (extra tests necessary, not foreseen in initial scope).
Process	Supplier tooling	Losses related to changes to working or manufacturing equipment or aids such as cutting tools, dies, fixtures, gauges, jigs, molds used to manufacture products on a product line.
Process	Manufacturing engineering	Losses related to extra process verification and process change caused by design changes.
Process	Inspection	Losses related to extra quality checks due to design changes.
Process	Rework	Actual or standard cost of correcting defective work. Rework means correcting of defective, failed, or non-conforming item, during or after inspection. Rework includes all follow-on efforts such as disassembly, repair, replacement, reassembly, etc..
Process	Freight costs	Additional costs related to securing the quality and timely delivery of goods and components in a shorter Leadtime.
Process	Over machining	Manufacturing process foresees excessive material machining which results in NVAA and raw material costs, since more material and time is needed than necessary to cut the material into a desired final shape.
Process	Excessive assembly time	Extra assembly time due to inefficiencies in design identified in DFA/DFM analysis.
Process	NVAA (Production)	NVAA identified during ramp-up or early warning phase of the new product that can be attributed to process breakdowns during new product development and launch.
Process	Unbalancing (Production)	Unbalancing losses identified during ramp-up or early warning phase of the new product that can be attributed to process breakdowns during new product development and launch.
Process	Rework (Production)	Rework losses pertaining to the rework of the new product or components belonging to the new product and this rework loss can be attributed to process breakdown during new product development or launch.
Process	Inspection (Production)	Inspection losses pertaining to the inspection of the new product or components belonging to the new product and this rework loss can be attributed to process breakdown during new product development or launch.
Process	Logistics (Production)	All logistics losses (inventory, material handling, transportation) during the ramp-up or early warning phase of the new product and these losses can be attributed to the process breakdowns during new product development.
Process	Warranty (Production)	All warranty costs of the new product during the ramp-up or early warning phase that can be attributed to process breakdowns during new product launch.
Process	BOM Update (Production)	All losses pertaining to update or adjustment of BOM of the new product during the ramp-up or early warning phase that can be attributed to process breakdowns during new product development.
Material	Scrap	Residue of raw material remaining after manufacturing process. Low quality raw material or abnormal size of raw material. Faulty or wrong product designing, sub-standard or unsuitable raw material, abnormal machine operation etc. are the main causes of scraps.
Material	Obsolescence	Losses related to material that is not usable anymore due to phase-out (implemented design change).
Material	Material premium	Extra material cost charged by supplier due to material specification or design changes.
Process	BOM Update	Errors in BOM and item master due to design changes.
Material	Pilot material	Material used for building prototypes: development and prebuild units.

The analyzed project was carried out in seven EPM and CD steps and passed all the stages specified for WCM-managed implementation projects [3]. The full product implementation took 3 years.

Based on reported problems, open issues collections, mandatory repair lists, CQA (Customer Quality Audits) and EPV (Engineering Product Validation) audit reports, a collection of all the issues identified during launch process in correlation with EPM Project steps is created. This database is described as *EPM Data Collection*.

The descriptive list of the encountered causal and resultant losses within the framework of implemented projects were categorized in Tables 3 and 4, respectively. The numerical values of particular losses have been omitted in the table as irrelevant for further consideration of the process.

Using the above resultant and causal losses supported by practical project data, *Matrix A, B and C* was created. The typical analysis flow was presented in Fig. 13.

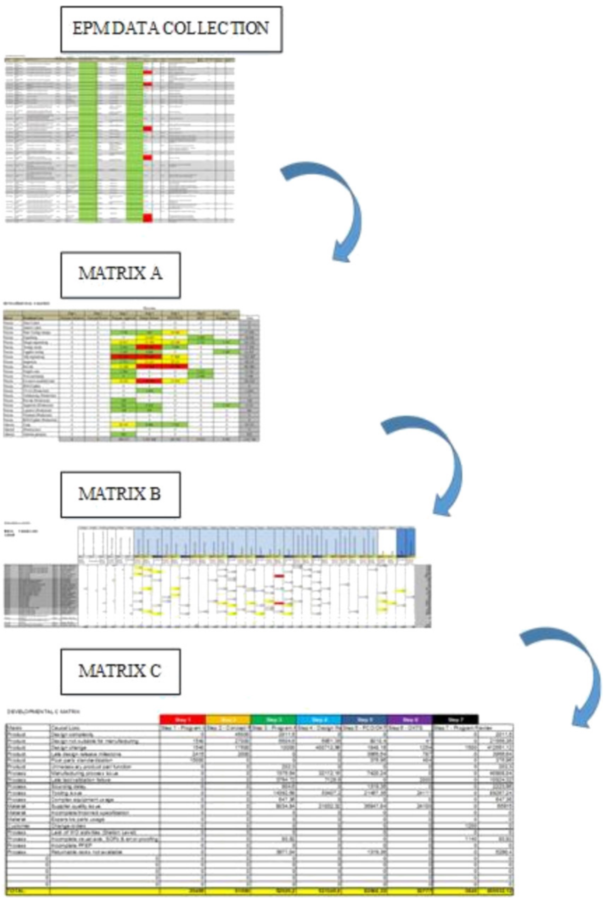

Fig. 13. EPM and CD analysis flow in project implementation.

Project "A" results summary

The most reflective outcome of the launch cost analysis and EPM integration were the graphs generated based on matrix C. These are presented in Figs 14 and 15.

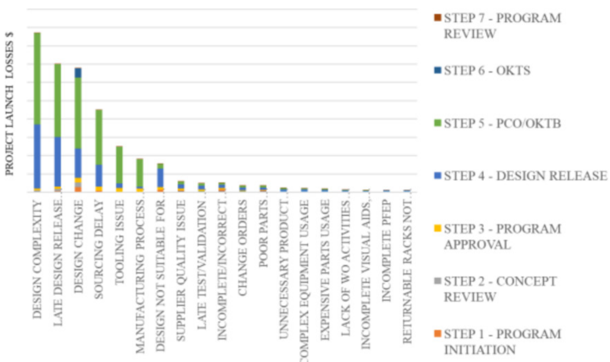

Fig. 14. New Product Launch Loss stratification by loss category – PROJECT "A".

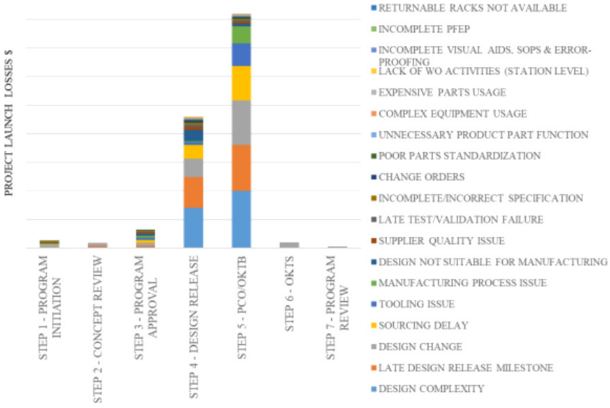

Fig. 15. New Product Launch Loss stratification by project phase – PROJECT "A".

Project "C" results summary

By using EPM tools, as indicated in the paper [3], and by indicating critical areas for change through the Cost Deployment approach, the effect of earlier identification of nonconformities was achieved (Step 5 $- >$ Step 4) and the level of losses in the main areas for project A was reduced. These results were graphically presented in Figs 16 and 17.

The new stratification has become another driving factor for the next product implementation project. This is a phenomenon of continuous improvement and EPM Knowledge Management in WCM system.

The cost results presented show that the main objectives of the EPM pillar have been achieved. They are described in detail in the paper [3], but can be summarized in two main assumptions:

- Identification of most problems should take place as early as possible in the project cycle. The results from the previously implemented project should be taken as a reference point.
- Based on the data from the original project, corrective actions should be taken, reducing losses in the areas generating the most losses (in this case for type A project: Design Complexity, Late Design Release, Design Change and Sourcing Delay)

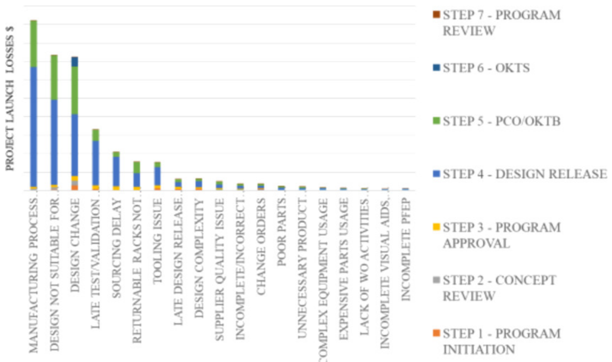

Fig. 16. New Product Launch Loss stratification by loss category – PROJECT "C".

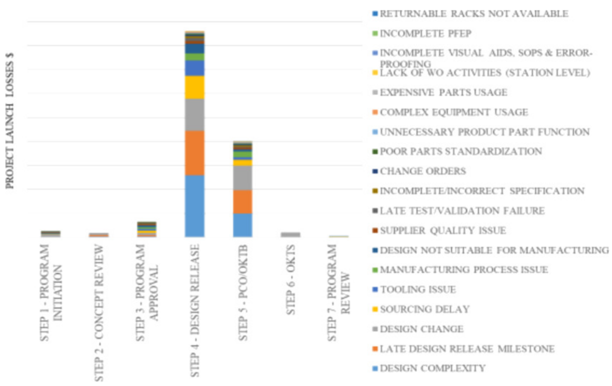

Fig. 17. New Product Launch Loss stratification by project phase – PROJECT "C".

Critical remarks

Despite the entirely positive results obtained in the implemented project, some shortcomings were observed, which are presented in the following comments:

- In the stratification of the project, mainly technical issues are taken into account – the managerial and organizational areas are not addressed, e.g. team motivation, employee competences, team workload distribution.
- The 'quality' of the analyzed data is, to some extent, based on value estimation due to the impossibility of precise determination of the level of losses, e.g. logistic costs, lack of availability of resources.
- During the project implementation, many of its participants worked on other implementations or were assigned to ongoing manufacturing activities (e.g. production management). This caused several time delays in their actions' completion.
- The boundary between the EPM (Early Product Management) and EEM (Early Equipment Management) pillars is very fluid and therefore there is a risk of misallocation of losses – e.g. the problem of allocating costs related to the rework of a welding tool or mold to the dimensional accuracy/quality of the produced workpiece.
- In the initial phase of project implementation and the way the project was financed (funds for project implementation came from the budget of the external product management board i.e. product platform and not from the plant budget), the involvement of top management in introducing improvements was limited. The savings generated were treated as secondary in terms of the plant's budget, defined as the so-called Cost avoidance-soft savings. These include the hypothetical cost that could be incurred to rectify the non-compliance at the time of product implementation with the defects.

Future recommendations

For more effective management in the area of EPM and CD cooperation, the author of this publication recommends that:

- The way in which data is identified and recorded should be as precise as possible and performed and verified on an ongoing basis.
- The team responsible for implementing new products should be permanent and composed of experienced specialists with comprehensive knowledge and understanding of the EPM approach.
- The possibility of exchanging experience between different teams in different production facilities, e.g. during an international conference, would be of great benefit.
- A cost comparison should be made for products of the same class, i.e. technologically and process similar – their manufacturing technology should be as similar as possible to each other.
- The way in which the generated savings (soft savings) are perceived should be just as respected as other savings realized for the currently manufactured products (hard savings)

Conclusions

This article, in descriptive way illustrates the issues related to the process of managing new product projects using the EPM and CD approach. The results of the work clearly indicate the effectiveness of the implemented activities. Nevertheless, further research based on practical examples in this area is advisable.

The combination of the EPM and CD approaches and their practical implementation allows organizations to improve their products, reduce the costs of new launches and build a knowledge bank. This is an extremely important aspect in the era of high competition and fighting for market advantage.

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