Design for Supply Chains Based on Common Platforms

Mehdi Fatollah [1], Kia Parsa [2]

[1.] Department of Industrial Engineering, Islamic Azad University Karaj branch, Iran
[2.] Department of Industrial Engineering, Islamic Azad University North branch, Tehran, Iran
Kiaparsa55@yahoo.com

Abstract: This paper focuses on the essentiality of consistency between policies of supply chain management and common platform. Accordingly, a conceptual model and a decision framework for supply chains based on common platforms have been developed and proposed. The model is intended to work as a basis for product development through the chain and with a special focus on commonality approach. Based on the proposed framework, the possibility of choosing the best combination of common elements is provided, taking into account the supply chain and common platform policies. In order to reach the research objectives, following an extensive study of related works, field research and case study in automotive industry, related knowledge and experience has been extracted. Analyzing the results, modeling is performed and the model has been validated. Combining the two concepts of supply chain management and common platform strategy, and customizing and combining supply networks with platform based product architecture policies may lead to several advantages such as: reducing the variety of components and production elements, reducing the number of suppliers, reducing system complexities and increasing flexibility. Therefore, by faster reaction to market changes, chain members will be enabled to produce a large extent of products in shorter time and with less cost.
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1. Introduction

In the last two decades, improving cost and quality by close collaboration of manufacturers and suppliers was the focal point of attention in most industries. However, today, the focus has been shifted on three principles of innovation, flexibility and speed (Magretta 1998). In order to gain these qualities, most companies have considered using common platform strategy to meet their customers' requirements and expectations by producing a large extent of products and taking the advantages of economy of scope and scale (Meyer and Lehnerd 1997, Fixson 2005 and Simpson 2003). About the common platform, it can be said that it is a new manufacturing strategy according to which it is possible to provide a great variety of products and services by sharing resources and minimizing the production elements (Kim 2005). The matter attracts even more attention in network based markets whose members are always seeking for new ways to share gains and risks and produce more value. In this situation, a supply chain better be designed in a way that by utilizing the platform strategy, it can provide the success drivers in today's competing market such as technology, cost, quality and speed at the same time (Giunipero et al. 2006).

In this paper, following an analysis of relationships between supply chain management (SCM) and common platform (CP) concepts in manufacturing industry, it is tried to evaluate, analyze and model the affects of common platform strategy on supply chain. Little research has been previously done in this regard. However, we will try to propose the main idea of the paper in presenting the concept of platform based supply chains and consequently product architecture along the chain, in a conceptual framework of logical reasoning. The paper has been structured in the following manner: Firstly, having a brief review on the literature and concepts of common platform and supply chain, the main research questions will be identified and presented. Afterwards, applying the gained experience from a case study in automotive industry, it will be tried to introduce the success drivers and conceptualize the supply chains based on common platforms (SCBCP) as a conceptual model and a framework for decision making. The focus is mostly on the commonality approach. Finally, research conclusions and subjects for future research are presented.

2. Material and Methods

2.1. Concepts & Definitions

With markets getting more complex and customer expectations of new and diverse products getting higher, today's manufacturers are faced with a new challenge according to which they have to produce and offer a wide range of variable products in a short period of time. The challenge gets even more critical knowing the fact that variety and multiplicity

of production elements such as required raw materials or components and parts cause great complexities in managerial and operational levels (Ulrich et al. 2002). Accordingly, several methods have been proposed by different researchers trying to find a way to produce a wide range of products by the least possible variety of production elements that are mostly based on the idea of common platform (Meyer 1997, Muffatto 2002). Several advantages have been addressed in using the platform strategy such as: higher pace of innovation and new product development, cost savings, more effective management of supply and production elements, reduced operational complexities, reduced time to market and so on (Kim 2005, Nobelius 2002). It is important to note that besides several advantages, the platform strategy has also some disadvantages like difficulties and inadequacies in management of variable markets and products, and high setup investment costs for using common platforms (Suh 2005). According to Fathollah and Shafia (2006), the effectiveness of platforms in the field of manufacturing can be studied from different aspects. For example: organizational architecture, product architecture, manufacturing operations, management, production technology, and logistics and supply chain management. However the following paper only focuses on studying the interactions between CP and SCM.

Supply chain management refers to a situation in which, members of a chain including suppliers, manufacturers and distributors manage the flow of materials, products, information and money from the point of origin to the point of consumption with the aim of gaining additional value (Chopra & Meindl 2007). The modern form of supply chain management concept was introduced by Oliver & Webber (1982). Although since the development of SCM theory, many researches have been dedicated to this subject (Kim 2004), but changes in business and manufacturing factors have led to the emergence of new issues that call for the integration of supply chain and platform concepts and need to be studied. These issues include: management of product diversification, know how of applying resource sharing approach in supply chain, and evaluation of supply chain performance and effectiveness using CP strategy (Ulrich & Bradley 2002).

2.2. Research Methodology

This work is based on qualitative research methods and has been performed by case study in automotive industry, surveying scientific documents, and arranging semi structured interviews with executive experts. Figure 1, shows a demonstration of the research framework used in this paper (Kittipanaya 2007). Based on the explorative method and by designing know how questions, the interactions between SC and CP have been studied and the conceptual model and decision building framework have been developed using expert opinions. Subsequently, it is tried to develop a validation basis for the model by getting the approval of executive experts in this field.

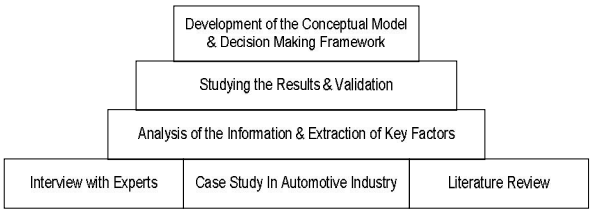

Figure 1. Research Methodology

2.3. Literature Review & Analysis

Analysis of interactions between SCM and CP has gained the attention of researchers in recent years; each of them studying and analyzing these two concepts from a different perspective. According to Fathollah & Shafia (2006), the related works can be classified in the following categories:

The first Category includes the articles in which subjects like product family design and development, process planning, and other subjects related to production and operations management are studied in concern with the concepts of supply chain and platform. It is important to note that these works have a stronger historic background and several researchers have dedicated their work to these subjects. These researches include Krishnan & Gupta (2001), Griffin (2002), Peterson et al. (2005), Lamoth (2006), Dogui et al. (2005), Mikkola (2006).

The second category includes works that have studied subjects like mass customization, product variety, new product development, and other related subjects with the aim of development and promotion of competitive advantages and performance in supply chain. These works have mostly referred to the concept of CP in an indirect manner. These researches include Andries (1995), Ulrich & Ellison (1999), Ulrich & Bradley (2002), Er & McCarthy (2006), Huang et al. (2005), Lamoth (2006).

The third category includes the researches that have worked on the subject of combining and integrating the concepts of SCM and CP. Gupta & Krishnan (1999), Muffatto (1999), Ulrich (1999), Park (2001), Krishnan (2001), Salvador et al. (2002), Doran (2003), Mikkola & Larsen (2004), Battaglia (2004), Ghosh et al. (2004), Huang et al. (2005), Lau & Yam (2005), Fixson (2005) are examples of these researches. In this category, some of the CP concepts such as: differentiation, modularity, commonality, product architecture, and product engineering are studied in different parts of a supply chain and their

effects in subjects like supply chain structure, purchase and procurement policies, promotion of collaboration between chain members, supply sources, and improvement of supply chain performance indicators are analyzed. Few performed works and numerous problems and issues that remain unanswered in strategic and operational levels regarding the integration of SCM and CP, make a great opportunity to perform further studies in this field. For example, decision making regarding design and development of new products, decision making regarding the supply chain form and structure, roles and responsibilities of suppliers, manufacturers and distributors based on platform strategy and many other similar topics are amongst the subjects that can be studied in this category (Krishnan & Ulrich 2001).

As a conclusion of the introduced works, one can say that despite numerous studies that have mostly been performed in the recent decade, the interrelations and interactions between CP and SCM still make an attractive field for performing qualitative and quantitative research in order to answer the critical operational and strategic issues and challenges that exist in this area.

2.4. Platform Case Study in Iran Khodro Co (IKCO)

During 2007, with the production of more than 600,000 cars in more than 70 different models based upon 4 platforms, IKCO has managed to diversify its products as a competitive advantage. In IKCO, platforms include automobile parts and components that are not in direct view of the end consumer. These parts form about 65% value of the whole car and include the propulsion system, dynamic and electrical parts, bottom part and framework of seats, and control and ventilation systems. Advantages gained by common platform strategy have convinced IKCO to create the basic designs for the parts of its brand new products upon existing platforms. Along with the implementation of new approaches in development of platforms and diversification of products, the roles of the IKCO supply chain members have changed. During the recent decade, major activities of IKCO were fabrication and manufacturing components and assembling cars. However in present time, based upon the platform approach, the company is mostly involved in sales, distribution, marketing and brand management and tries to outsource the possible design and engineering and also production and assembly steps to its selected suppliers. Main objectives of IKCO in utilizing the common platform strategy are as follows:

- Reducing the cycle times for design and product development in order to improve business performance.
- Using common parts in different cars in order to reduce the end price.
- Reducing costs by using economics of scale (in both manufacturer and supplier) .
- Rapid utilization of new technologies using the company's brand.
- Reducing the costs and time for design and new product development.
- Diversification of products together with the least possible variety in product parts.
- Improving quality levels and standardization in manufacturing and using common manufacturing method (same line).
- Improving productivity and throughput in production lines and manufacturing facilities.

The company seeks to reach its goals by making its platform strategies consistent with its other management and manufacturing disciplines such as SCM. Hence, the policies and operational schemes of the company towards integrating supply chain management and common platform approaches are described as follows:

- Defining and clarifying the common platforms in company and specifying the strategies for platform development and product diversification.
- Policy development regarding commonality, diversification, standardization and postponement along the chain.
- Reengineering and reorganizing the supply network upon the policies for development of products based platforms.
- Reducing the number of first tier suppliers and organizing giant powerful suppliers with the ability to design, manufacture and assemble part and components.
- Defining the company approaches regarding its participation with world class automotive firms in designing and forming supply chains based on common platforms.
- Planning to obtain economics of scale for suppliers by reducing the variety of production elements.

3. Results

3.1. Analysis of Interactions between SCM & CP

The main aim of this paper is to study that which requirements and characteristics should be taken into consideration in order to design a supply chain that enables the utilization of CP strategies (supply chain based on common platform), and also how can CP concepts be applied to an existing supply network (platforms based on supply chains). Figure 2, demonstrates a portfolio matrix that discusses different occurring situations.

Table 1. Interactions between SCM & CP

Supply Chain Management (SCM)	Starting	II Supply Chains Based on Common Platforms (SCBCP)	IV Development Planning
	Existing	I Continuous Improvement	III Platforms Based on Supply Chains
		Existing	Starting
		Common Platform (CP)	

Situation I: In this situation both supply chain and platform structures exist and therefore only continuous improvement policies have to be taken into consideration in order to improve the performance and effectiveness of SC and CP.

Situation II: In this situation, it is important to find solutions and methods to design and develop a supply chain which is consistent and compatible with existing platforms or in other words, arrange the supply network based on existing platforms. Other developed concepts such as Design for Logistics (DFL), Design for Supply Chain (DFCS), Design for Variety (DFV) and Design for Mass Customization (DFMC) reveal that all the time, one of the main concerns of researchers has been to design and develop supply chains in the most effective and efficient way regarding the decision making in manufacturing and variability of products (Martin & Ishii 2002, Huang 2005, Lamoth et al. 2006). Observing the evolution process of these subjects in figure 3 reveals the compatibility and consistency of design operations with manufacturing, supply and logistics, product variety and finally ultimate excellence (Appelqvist et al. 2004, Zha & Shiram 2006, Herrmann et al. 2004).

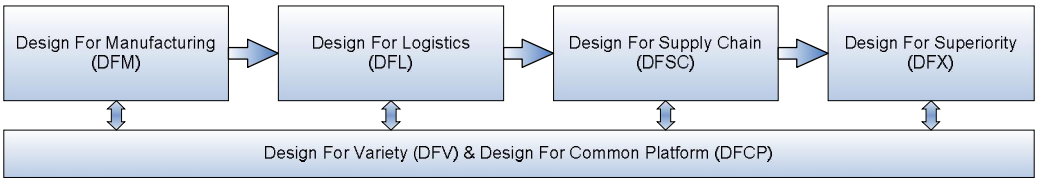

Figure 2. Evolution process of Design for Excellence

Situation III: This situation occurs when development and implementation plan for CP strategy is considered in an existing supply chain. Even if there is no possibility of redesigning and changing the structure and combination of the chain, the platform strategy should be developed in a way that it can be compatible and consistent with the existing chain. That is, platform design and development and product architecture policies are adopted due to the existing capabilities of the supply, manufacturing, distribution and logistic network (Mikkola et al. 2006).

Situation IV: Refers to the situation in which development policies for both product platform and supply network are taken into consideration at the same time in a way that the most possible consistency and compatibility is achieved in performance measures such as flexibility, time and cost factors.

3.2. Supply Chains Based on Common Platforms (SCBCP)

The interactions and relationships between product architecture, platform design and supply chain were studied and brought into attention by Salvador (2000). Moreover, there has always been an emphasis that while designing and architecting a family of products, the designers and producers has to consider the product family and supply chain plans at the same time (Lamoth et al. 2006).

Accordingly, a supply chain based on common platform (SCBCP) proposes a decision making and decision building framework based on which the supply network and product architecture plans are developed consistently which will lead to the support and advancement of competitive advantages. It can be said that strategic and operational decisions throughout the chain may be influenced by the platform approach. For example by assuming the usage of platform, topics like quantity and combination of products, structure of distribution and logistic networks, quantity and combination of suppliers, product architecture approach, decision making regarding the decoupling point, making a tradeoff between pull and push policies through the chain, policy making regarding commonality, diversification, standardization and product modularity, new product development, the number and combination of platforms and their development policies, structure and mixture of common/different elements in bill of materials, time and cost

management through the chain, resource management, and so on may get very important and require special attention. Hence, it is important that supply chains are designed and developed in a way that they can support the policies and requirements of platform development (Simpson 2003, Appelqvist 2004 and Ghosh 2004). Some of the main advantages of SCBCP are as follows:

- ✓ Emergence of mega suppliers due to resource sharing and economics of scale in supply and logistic processes.
- ✓ Changing the role of suppliers from being operational executives of the build contracts with manufacturer to being associates of production planning and assembly of components and modules.
- ✓ Simplification of supply and manufacturing processes and single modules along with facilitation of giving responsibilities to suppliers.
- ✓ Reduction of component variations and simplification of production planning, supply and procurement processes.
- ✓ Possibility of promoting network structures, combining and tiering the suppliers and distributors consistent with policies regarding commonality and diversification of products and production elements.
- ✓ Providing the possibility of utilizing common logistic equipments and sharing of hard and soft resources amongst chain members.
- ✓ Development of agility, quick response capabilities and flexibility in the chain.
- ✓ Support and development of interactions and relationships between chain members via sharing the resources and consequently gains and risks.
- ✓ Providing the possibility of developing and promoting competitive advantages in world class level, benefiting from network economy and economy of scope and scale.
- ✓ Providing the possibility of grading and tiering suppliers based on platform design and product families.
- ✓ Worldwide development of supply, production and distribution networks due to platform architecture and worldwide product architecture.

3.3. Decision Making Framework for Utilization of Platforms in SCBCP

Compatibility between platform policies and supply chain is one of the key points in platform based supply chains that calls for fundamental decision building and decision making. Therefore a decision making/building framework is proposed in this paper. Considering the effective elements in product architecture design, the framework attempts to provide a decision making basis for communization, in accordance with properties of the supply chain. Moreover, the framework tries to contribute the realization of supply chain goals and improvement of its performance indicators.

Although several approaches have already been discussed in this field such as: PFA (Product Family Architecture) (Jiao & Teseng 2000), PVTEM (Product Variety Trade of Evaluation Method) and PPCEM (Product Platform Concept Exploration Method) (Simpson 2001), PPCTM (Product Platform Constructional Theory Method) (Hernandez 2003) and other similar works (Yang et al. 2005, Zha & Sriram 2006); However, the main emphasis of these approaches is mostly on maximizing the product performance and increasing the product commonality elements to obtain the goals of product architecture (Simpson 2003). It is important to note that none of these instances have ever analyzed the platform design in accordance with SCM policies. Thus, the main idea of the proposed framework is to support decisions that take SCM policies into consideration. The framework is developed based on detailed analysis of literature and case study in automotive industry. Before presenting the framework, noting the following is of great importance:

(1) A comprehensive look on the system: Studies reveal that SCM and CP systems are influenced by several factors that have to be taken into consideration. These factors include: industry type, capabilities and properties of supply and distribution chains, customer needs, market size, form and structure, nature of the competition, product type, and the structure of product architecture. The framework tries to consider most of these factors.

(2) Product Architecture Approach: According to Simpson (2001) there are two basic approaches in product design and architecture based on common platforms: top-down approach (proactive platform) and Bottom up (reactive redesign). In a top-down approach, industries strategically follow the management and development of a product family based on a product platform. On the other hand, in a bottom-up approach, the companies take a major redesign and reconsideration, taking into account the similarities and differences between their existing products and try to improve their product architecture process and achieve the economy of scale by using common and standard elements (Meyer & Lehnard 1997, Farrel 2003). The proposed framework ties to enable the utilization of both approaches.

(3) Strategies in Platform Application: Although due to the novelty of the subject, there is no general consensus about the related strategies and the levels and hierarchy of their application and each work has its own classification (Blecker & Abdelkafi 2006); however, subjects like commonality, modularity, standardization, reusability, diversification, and postponement can be confidently remarked as main

strategies. It is important to note that the following framework investigates the commonality, as one the key and challenging strategies in this field (Huang et al 2005).

(4) Hierarchy Levels of Product Elements: Zha et al (2006) have considered the product hierarchy levels as: product family, product, module, and components. It is clear that utilization of platform strategy and commonality can be applied in all these levels which has also been considered in the proposed framework.

(5) Regulating Pull & Push Systems: Studying different manufacturing policies throughout the chain reveals that in order to implement the platform strategy, many industries have improve their supply chain structure from make to stock (MTS) push methods to market and customer based pull methods. However, the key point is to make a tradeoff between pull and push policies when using platform strategy and commonality approaches. In other words, platform based supply chains utilize both push and pull policies. Push policies are considered in order to provide the possibility of using the maximum combination of common items; and pull policies are considered to provide the possibility of diversifying products dependent upon market and customer needs (figure 4). Obviously, identifying the place of the decoupling point in the chain is a strategic decision that has to be taken, in accordance with commonality and diversification goals.

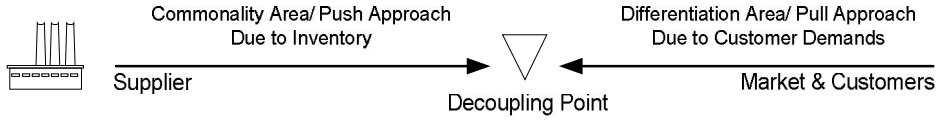

Figure 3. Location of decoupling point and pull and push policies in SCBCP

According to the aforementioned, the decision making framework is developed in two levels as shown in figure 5 and figure 6. The key steps of the framework are described below:

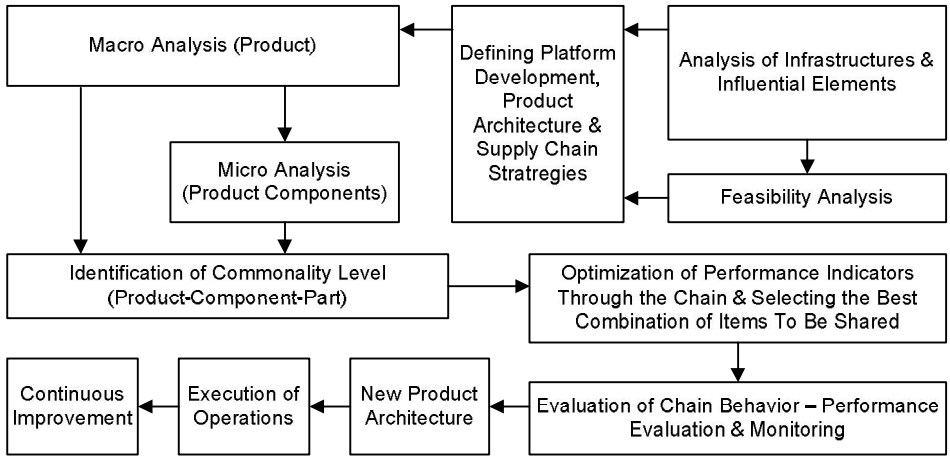

Figure 4. Decision making framework for product architecture in SCBCP (Zero Level)

Product architecture plan and component commonality in the supply chain are influenced by the structure of the industry, status of the market and relevant infrastructures, and other environmental elements that have to be analyzed in the first step. It's obvious that further steps in the implementation of the plan call for deep feasibility analysis to support its success from technical, economical and operational aspects. Following the study of infrastructures and influential elements and feasibility analysis, architecture strategies are defined and the product development process is planned. According to the proposed framework, the architecture plan can be studied in different levels of products, modules, and parts. The platform or common element can be considered in each of these levels.

It is important to note that in design and development of new platform based products, there is always an effort on taking the best advantage of existing and similar items using commonality and standardization approaches. Accordingly, the similarity level between the properties of new designed product, module or part and the existing and available samples is identified. The goal here is to choose the most similar sample as the platform or the basis for development of the new product.

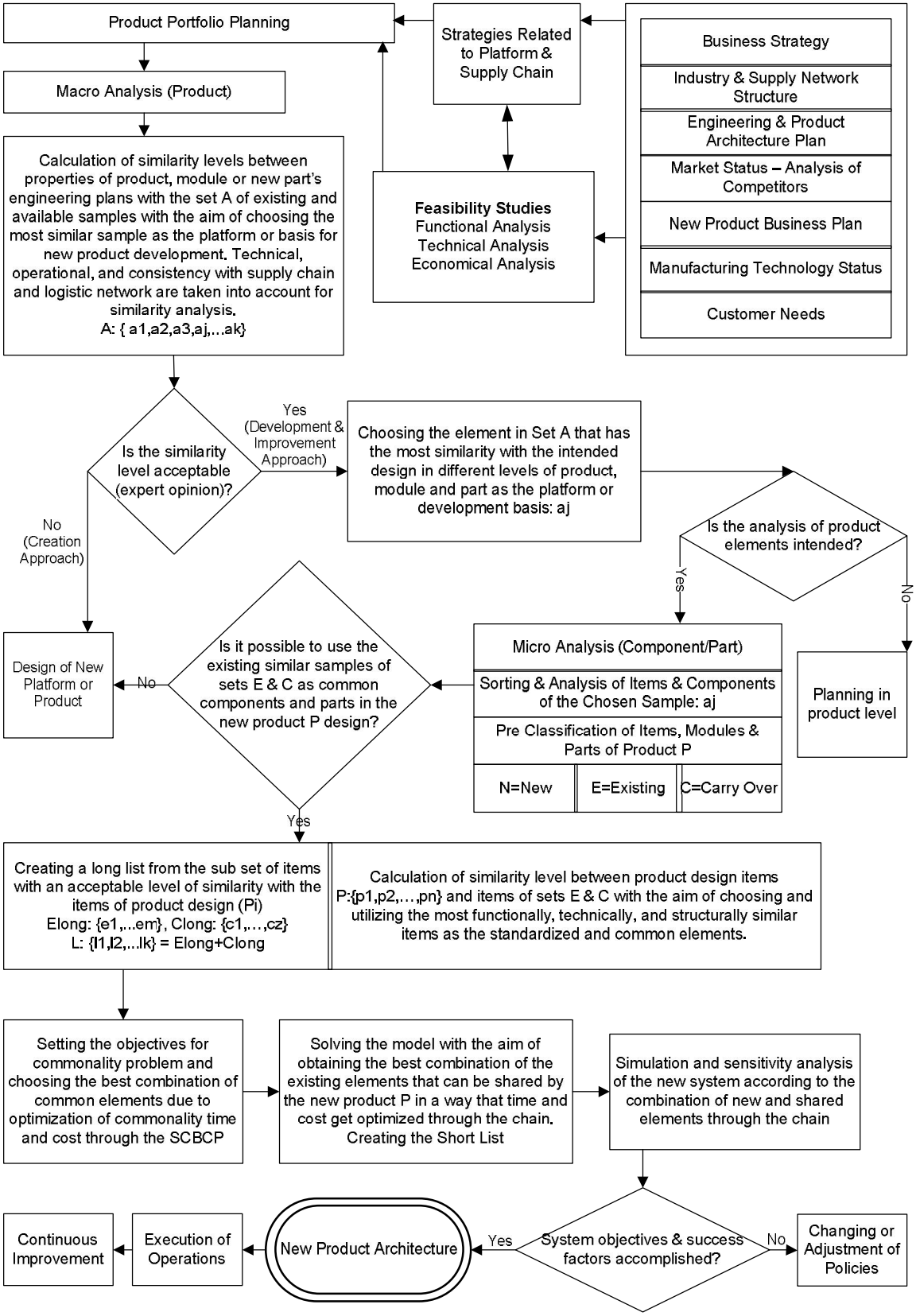

Figure 5. Decision making framework for product architecture in SCBCP (Compound/multilevel approach–Level 1)

Technical and operational factors along with the consistency with supply and logistic chain are considered in defining the similarity level. By identifying the most similar element, the common platform can be developed and improved consistent with the product architecture plan and supply chain policies. On the other hand, if it was not possible to utilize the existing and similar elements, the platform creation plan will be taken into consideration. Following the identification of commonality plan, it is important to provide a situation in which success factors of the supply chain such as cost reduction, lead time reduction and flexibility are improved while choosing the best combination of common elements. Simulation and behavior evaluation of the supply chain along with performance assessment and monitoring of the product architecture and commonality plan can reveal the extent of achieved goals and provide more confidence in further operations and management of new product development plans. Finally, it is important to consider reconsiderations and continuous improvement along with environmental changes and evolutions.

In conclusion, it is believed that the practical use of the presented framework can be considered from three aspects. First, decision makers will have a roadmap, based on which they can manage their supply chain development and product architecture policies based on the platform strategy in a more effective way. Second, the possibility of identifying the best combination of common items is provided in accordance with effective factors through the chain for the achievement of goals, and third, the managers and deciders will be able to structure their decision making process based on this framework and focus their efforts on the improvement of their companies' operations, effectiveness and performance.

3. Results

The paper tried to study and analyze the interactions between supply chain management and common platform subjects and propose a conceptual model for supply chains based on common platforms. Therefore following an extensive study of related works and case studies, the relationships and interactions between two subjects of SCM and CP were analyzed and modeled. The necessity of making a consistency between supply chains and product platform properties does rationalize the proposed idea of the paper regarding the design of supply chain in accordance with product platforms. Thus, the possibility of producing variable products conforming to market and customer needs in a short period of time is provided. Moreover, taking advantage of platform strategy and commonality, it will be possible to improve the performance of supply, production and distribution chain and reengineer the structure and combination of supply and distribution chains conforming to platform design and product architecture. This achievement will be obtained by the resultant reduction in the multiplicity of production elements and components and facilitation of process management. Finally, it can be said that designing supply chains based on common platforms, can lead to increase in flexibility and reduction of time and cost through supply chains and consequently gain sustainable competitive advantages for industries. Future research concerning the topics in this paper may include:

- Further development of the proposed conceptual model and studying other aspects of the portfolio matrix in order to analyze the effect and management of supply chain and platform.
- Design and modeling platform based supply chain in operational levels, for example studying purchasing or outsourcing models.
- Development of SCBCP concept in other value chains such as: service sector, banking networks, education, etc, using soft and hard platforms .
- Studying the effects and interactions of additional factors like production technology, organization architecture, information management and architecture on the SCM and CP.
- Development of a mathematical model for measuring the similarity levels between products and components as mentioned in the proposed framework

Corresponding Author:
Dr. Kia Parsa
Department of Industrial Engineering
Islamic Azad University North branch
Tehran, Iran
E-mail: kiaparsa55@yahoo.com

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