Iran Khodro Company (IKCO) is a major car producer in the Islamic republic of Iran. The company has become the largest vehicle manufacturer in the Middle East, Central Asia and North Africa. In Iran, it is the largest vehicle manufacturing company, having an average share of 65 percent of domestic vehicle production.

Iran Khodro was founded with registered capital of 100,000,000 Rials on 18th August 1962 by Khayami families in Ekbatan Street in Tehran. Founded in 1962 by members of the Khayami family, the company's original name was Iran National. It is a public joint stock company which was established to manufacture passenger cars and pickups.

The production factories as well as the administration offices, warehouses and personnel residents and units were all established in an area of 3,190,000 sq/m. The covered area of the company equals to 4,100,000 sq/m. More than 19,000 employees work directly for Iran Khodro (IKCo). IKCo has been engaged in a diverse range of vehicles including passenger cars, light trucks, minibuses, buses and heavy trucks. Following table 4.1 depicts the general information about the Iran Khodro Company (IKCO) in detail.

In 2003, IKCo was ranked the best company among the top 100 Iranian companies. IKCo has a long lasting dominance in the internal
market, which has remained unchallenged during the last four decades. IKCo is working towards globalisation.

Table 4.1

<table>
<thead>
<tr>
<th>General Information About The Iran Khodro Company</th>
</tr>
</thead>
<tbody>
<tr>
<td>Location</td>
</tr>
<tr>
<td>Type of Company</td>
</tr>
<tr>
<td>Date of establishment</td>
</tr>
<tr>
<td>Number of Employees</td>
</tr>
<tr>
<td>Products</td>
</tr>
<tr>
<td>Total Products</td>
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<tr>
<td>Registered Capital</td>
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<tr>
<td>Shares Quantity</td>
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<tr>
<td>Site Area</td>
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The company changed its role from a mere assembler into car manufacture in 1995 when the first 7-year plan was drawn up with the objective to develop new capabilities in the mass production, diversity of products and enhancement of engineering and designing capabilities.

Since its establishment in 1962, it has produced and assembled more than four million cars in about 50 different models. This company is in contract with some giant car producers in the world and implements the assembly line for the manufacturing of the automobiles designed and
produced by these companies in the past. The goal is to localize the car manufacturing technology imported from the major car producers in the world. Besides, Iran Khodro produces some car models designed by its own engineers (like Samand, the national Iranian car).

The company started operating the "Paykan" assembly line followed by the production of "Mercedes Benz Bus 302" and "Minibus 309" as well as "Paykan Pick up". Afterwards, following the closure of British Talbot Company, Iran Khodro purchased related production line machinery and launched it in Iran. At the same time, this company concluded an agreement with French "Peugeot" to target the production of "Peugeot 405, 206, RD and Persia". Furthermore, Iran Khodro initiated the production of a national automobile "SAMAND" as of June 2001. Currently, the main car families produced and assembled by this company are Peugeot 405, Peugeot 206cc, Peugeot Pars, Samand, Logan and Roa. Also, it produces commercial vehicles considering the company's recent purchase of the stock of several vehicle-manufacturing companies.

In 1997, Iran Khodro Company (IKCO) broke its own production record by producing 111,111 units of various passenger cars and vans. The opening of the country’s largest car assembly plant in Khorassan in July 2008 is expected to increase capacity with the ability to turn out 100,000 vehicles per annum by late 2009. However, it will not necessarily increase production. Export opportunities are restricted to relatively low volumes ($60 million worth of cars were exported in 2007). Iran Khodro, the largest car manufacturer in the Middle East,
plans to increase its production to 730,000 vehicles by 2011 from around 680,000 in 2010.

The firm has a long-term relationship with European and Asian manufacturers including PSA Peugeot Citroën manufacturing and assembling a number of models under license from these firms. In 2009, Peugeot 206, Peugeot Pars, Peugeot 405, Peugeot Roa, and Samand sedans were IKCO's export-bound cars sent to Azerbaijan, Iraq, Armenia, Uzbekistan, Turkmenistan, Syria and Afghanistan.

It also manufactures trucks, buses and E-Class passenger cars under license from Mercedes-Benz. In a joint-venture with Daimler AG, Iran Khodro is soon to start production of sophisticated 900-class Mercedes-Benz engines.

Iran Khodro production system is based upon 4 main manufacturing technology platforms. Since there is a lot of variety in options and models of each car type and, at the same time, the majority of parts and processes in these models are similar and can be shared (between various models of one type and also between different types), this company is concerned with the utilization of the Common Platform Strategy. However, little has been done about it and the often occurring problems and issues make this company a good case for studying the impact and probable benefits of the Common Platform Strategy application.

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By entering the international market and competition with global car producers, the essentiality of applying improvement strategies and manufacturing paradigms was much more sensed in IKCO. SCM and CP were two important factors that could perfectly speed up the improvement trend that IKCO was following. This company has done much more about organizing and managing its supply chain than the Platform Strategy. Since the last decade, the company has started an extensive study and research on its suppliers and tried to organize and manage its supply chain in order to reduce the chain costs, improve the quality and decrease the delivery time. One of the main results of this investigation was the creation of SAPCO, which is the major first tier supplier of IKCO.

As mentioned, there are many issues concerning the CP strategy in Iran Khodro. In the following sections, we will study the model of the supply chain system of this company and try to address one of the most important issues concerning the CP strategy in the supply chain of the company.

**Conceptual Modeling of the Iran Khodro**

The conceptual model of the Iran Khodro supply chain: This is a high level model and includes the information and part flow for the majority of the company’s products. It is important to note that this model will serve as a guide for modelling the flow of the specific parts. Therefore, appropriate levels of abstraction are applied in this model. However, it is important to understand the physical flow of products and the decision making logic of the company in order to recognize and model the problems and issues related to the specified company (Figure
4.1). The following section will provide a brief description of the high level conceptual model and discuss the supply network of IKCO.

According to customer orders, company’s vision and master production policies, a master production schedule (MPS) is created on a yearly basis. SAPCO is the main supplier of IKCO which was established by IKCO itself to serve as the exclusive first tier supplier of the company. Generally, most of the supply tasks and schedules of IKCO are conducted by SAPCO. Of course, the IKCO’s Orders Department is responsible for the supply of some specific parts. Hence, the MPS is presented to SAPCO and IKCO orders for the planning of the supply strategies and approaches. There are approximately 32 first tier suppliers, more than hundreds of second tier suppliers and an unknown number of third or superior tier suppliers which form the complex supply network of IKCO and have the responsibility for raw material supply, part production, and sub-assembly.

From the suppliers, the physical flow of the parts begins in the system. Produced parts are delivered to the Logistic Area (Part Receiving) where the initial inspections and quality control issues are taken care of. Confirmed (accepted) parts are then taken to the IKCO’s warehouse.

Supply chains are life cycle processes to support the physical, informational, financial, and knowledge aspects for moving products and
services from suppliers to customers. Supply chain management is a process of integrating/utilizing suppliers, manufacturers, warehouses,

Fig. 4. 1

Product Development Levels

and retailers, so that goods are produced and delivered in the right quantities, and at the right time, while minimizing costs as well as satisfying customer requirements. In fact, in today’s market, there is no competition among companies but a competition among supply chains and it is the effective management of the supply chains, that defines who will stay and who will leave the market.

One of the most important key factors in today’s tightening competition between companies is to increase the product variety and, at the same time, maintain the high quality and short delivery time. Considering the network, and nature of the supply chain system, providing variable products can cause a great complexity throughout the whole network. The end-result of this complexity is a proliferation of products, parts, suppliers, and a multiplicity of processes performed within a company. In order to reduce the level of complexity resulting from the increased product variety, concepts and strategies which are vital for the effective management of a supply chain system have been developed.

In recent decades, the Common Platform (CP) concept has been introduced as one of the important factors leading to valuable competitive advantages for industries. Meyer and Lehnard describe the

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4 Ibid.
platform as “a set of subsystems and interfaces that form a common structure from which a stream of derivative products can be efficiently developed and produced”.

According to Robertson and Ullrich\(^7\), the platform can refer to a collection of assets, components, processes, knowledge, people and relationships. In the case of CP as the common components, other terms like “Component Commonality” or “Component Standardization” have been used in the literature. Hillier\(^8\) uses the term “commonality” to address the replacing of several parts by a single common part. It is important to note that common components can refer to shared parts in normal designed products or shared product “modules” in modular designed products.\(^9\) Modules are defined as physical structures that have a one-to-one correspondence with functional structures. They can be thought of quite simply as building blocks with defined interfaces. Modular products may be defined as machines, assemblies or components that accomplish an overall function through combination of distinct building blocks or modules.

According to figure 4.1, the platform is the base of products or even product generations. Product families can be derived from a platform in a platform based design. Each product family is made of product models and each product model consists of several modules if


\(^9\) Ibid.
the product is modularly designed. In the highest level of modules these are decomposed into parts. The product variety level includes the main output products and models to be manufactured. From a bottom up point of view, a single platform can be the basis of different product families and as a platform, common basis of technology, process or brand can be used in order to develop the product families and consequently manufacture variable products. From a top down point of view, the parts can be shared between different product modules and product modules can be shared between variable products in the case of modular product design. It is important to note that the common parts in manufacturing is a family of products (part commonality among products).

Based upon the Common Platform concept, great impacts have been impelled into the design and development of products and the relationships between different members of a supply chain.\(^{10}\) Some competitive advantages and benefits reported in CP area are as follows\(^{11}\):

- Reusable engineering and design
- Enable rapid development of derivative products
- Design and production based on modularity
- Reduced supplying of common components
- Faster innovation and new product development (NPD)


• Enable dramatic reductions in product time-to market
• Improvement of hardware maintainability and availability
• Increasing flexibility between and within plants
• Ability to move & share resources between & within plants
• Increasing variety of products
• Standardization of components & parts commonality
• Improved planning and control in manufacturing
• Adjust for use and mass customization
• Shorter cycle times and reduced time to market
• Reduced number of components & part variety
• Reduced complexity of production & operation management

Taking a brief look to the benefits of CP strategy listed above, one can realize that most of these benefits are derived from or have an impact on the supply network of the product. In fact, one can say that the final goal of applying the Common Platform Strategy is to gain sustainable competitive advantages for the whole supply chain and quickly respond to the needs of the consuming market.

The implementation of the Common Platform Strategy (or designing a common platform based supply chain) calls for special considerations and obligations in planning, management, control and synchronization in a supply chain management system. Thus, an integrated framework is considered for the supply chain management and the common platform which has led to the introduction of Supply Chains
Based on Common Platforms (SCBCP). SCBCP is introduced as an approach which encompasses the aforementioned vital considerations and obligations, including the utilization management of common resources along the chain, coordinating, enhancing and controlling supply and distribution networks under special circumstances of minimizing the production elements and maximizing the variety of products and services and changing management along the chain, considering the variety of products.

Hence, SCBCP as “A chain of related companies that work together as a network with the ability to share gains and risks and a resource sharing strategy that allows the chain members to develop derivative products for increasing value in an effective way.”

According to Fathollah and Shafia, there are three challenging issues encountered in the integration of SCM and CP:

(1) How to model and coordinate the supply chain business processes, specifically in the common platform area of supply chain workflows.

(2) How to analyze the performance of an integrated supply chain network, and how a common platform can be employed to improve customer service and reduce inventory cost.

(3) How to evaluate dynamic supply chain networks and common platform to obtain a comprehensive understanding of decision-making issues related to supply network and CP configurations.

In order to decide about forming a platform-based supply chain, organizations should consider the above issues and quantify the changes made in the form of possible advantages or disadvantages. This will call for a supply chain modeling approach wherein the designing issues and the impacts can be investigated and measured.

**Supply Chain Simulation**

According to Kim et al.\(^\text{15}\) four techniques are commonly used to model the supply chain for problem-solving: linear programming, integer/mixed-integer programming, network models and simulation modeling. Mathematical approaches often require too many simplifications to model realistic supply chain problems, although they may be valuable for gaining an understanding of general supply chain principles and effects. Hence, Simulation is considered as one of the most powerful techniques to apply within a supply chain environment.\(^\text{16}\)

The simulation approach offers several advantages. Simulation is recognized to allow more realistic observation of the supply chain behavior or of complex economic models in general. It allows an analysis of the supply chain dynamics and leads to an observation of the


Production Planning and Control Division Works

The Production planning and control division works as a brain for controlling and planning the system. Taking inputs like MPS, customer order options, inventory levels and order information, this division generates the production plans on a monthly basis. The Line Feeding Department works as a facilitator and buffer for feeding parts to the production and assembly line. According to the weekly production plan (and informed revisions in the plan), the line feeding demands the needed parts from the warehouse and has to provide the right parts to the assembly line on time. In addition to the safety stocks held in the warehouse, the line feeding has its own safety stocks with much less amount and for a much shorter period of time.

Prepared parts are brought to the production and assembly line consisting of four production saloons. The finished products are taken to the parking area which serves as a large car warehouse. The sales

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17 Ibid.
organization then delivers the ordered products to end-customers or sales representatives.

Simulation Framework

After conceptualizing the common platform strategy and its use in the supply network, we studied the impacts of a new concept called “Supply Chain” based on the common platform in an automotive company. In fact, we extracted the barriers and problems caused by the complexity of part and process multiplicity in the selected supply chain and identified the critical success factors and performance indicators according to the possible solution of these problems by the CP strategy.

It is important to validate the identified success factors by an analytical model and measure the impact of part commonality on each of the identified factors. Considering the complexity of the supply networks, discrete event simulation (DES) is discussed, we will develop a simulation framework for the modeling of the defined system. It is tried to stick to a high level view and avoid the details. The goal of this section is to provide a conceptual framework for the simulation of the case study as a guide to simulation of other related systems and processes. The detailed simulation model can be studied as future research and variables to be measured can be chosen from the list of CSFs presented in Table 4, according to the objectives of the simulation modeling.

A Conceptual Framework (CF) is an underlying structure and organization of ideas which constitute the outline and basic frame that
guides a modeler in representing a system in the form of a model.\footnote{Derrick, E. J., Balci, O., Nance, R. E., “A Comparison of Selected Conceptual Frameworks For Simulation Modeling”, Proceedings of the 1989 Winter Simulation Conference, 1989.} There is some research dedicated to developing and comparing CFs for simulation. Derrick et al.\footnote{Ibid} introduced and compared about ten different frameworks for discrete event simulation. Rossetti and Chan\footnote{Rossetti, M.D., Chan, H.T., A Prototype Object-Oriented Supply Chain Simulation Framework, Proceedings of the 2003 Winter Simulation Conference, 2003.} have presented a simulation framework for a prototype object oriented supply chain. Vieira and Junior have developed a comprehensive conceptual model for the creation of supply chain simulation models. In their conceptual framework, they have considered the four elements comprising suppliers, manufacturer, retailers and the consumer market and used the ARENA software as the simulation programming platform.

To define the simulation framework for the supply chain model presented some specifications to the overall simulation framework models are required to be made. It is important to note that for the goal of developing a simulation framework to measure the impact of the common platform strategy on a supply network, it is necessary to emphasize the supply chain stages which are most affected by the CP strategy. Hence, the framework presented consists of the functional decomposition of the defined supply network and developing an hierarchical modeling approach. Moreover, in order to execute the simulation process, one needs to follow the 9 operational stages given below:
1- Scope Definition
2- Conceptual Model Development
3- Specific Model Development
4- Input Data Gathering
5- Data Input Analysis
6- Computer Model Development
7- Computer Model Validation and Verification
8- Applying the ‘to be’ state changes
9- Data Output Analysis and comparing the Results

Being the biggest automaker in the Middle East, its employees rose to more than 30,000 people and its sales rose up to $2.5 billion per year. Additionally, this company has experienced a decent growth in the past 10 years, while rate of sales were about 50000 cars a year ten years ago. Today its sales are more than 500000 cars. Moreover, its production diversity has branched off in recent years from only one type of car to more than ten types; almost all of them have various options. Competition in the car market has increased gradually during these years and as a result marketing and selling the products became harder propositions and the previously employed polices would not be as effective as before and should be subject to change.

Not long ago, IKCO was the only automaker in Iran. Also, because of high import taxes and government regulations, firms desiring to import cars were facing a strong barrier. Excess demand had led to formation of a long queue of customers for IKCO products. IKCO was able to "Presell" all of its products effortlessly. Even customers were required to prepay the price of their cars up to one year.
Due to current more competitive automotive market, IKCO is not able to presell its products as before. The increase in production level of IKCO and also the rising number of automakers in Iran and the decrease in import restrictions have reduced the gap between supply and demand. Supply might be excess of demand in the following years. Hence customers are unwilling to pay for a car prior to receiving it (advance booking). The decrease in number of customers who participate in presell programs has a noticeable effect on the cash flow of IKCO. The company has evolved two solutions to respond to this problem. First, IKCO began to consider the time value of the customers’ money with a suitable interest rate. Second, IKCO offered a sizable discount to some of its dealers who participate massively in its Presell programs. We will call the second solution "Wholesale".

**The Process of Model Building**

The process of model building is crucial; it determines not only the outcomes but also the acceptance of the results and hence the commitment to them. Confirming that the system dynamics approach is appropriate for the problem the organization was facing, the modeling team was assembled. This team carefully considered special issues with the client organization. Since the issue (market instability and price fluctuations) were implicit and concepts of the model are not physically equivalent in the external world, the modeler's mental model might influence the model. To minimize this effect, two modelers were introduced. Two data and information collectors and one modeling supervisor were also included. The supervisor was to communicate the role of modelling to the client to understand and extract his mental model
and also communicate the system dynamics model to him for discovering underlying assumptions of both client and modelers. This process would help the convergence of the client’s mental model and simulated model.

**Figure 4.2**

**Group Model Building Framework**

Relevant questions:
- Is the problem dynamically complex?
- Short-term and long-term effects?
- Reference mode of behaviour
- Qualitative or quantitative model?

- **Client organization experiencing problem**

- **Is System dynamics appropriate**
  - Yes: Use Preliminary model
  - No: Look for alternative

- **Preliminary model based on**
  - Documents
  - Interviews
  - Questionnaires
  - Workbooks for participants

- **Group model building session(s)**
  - Conclusions

- **Start from scratch**
  - Interviews e.g. to build rapport
  - Group model building session(s)
  - Conclusions

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for personalised and tailor-made product. One of the data collectors was made in charge rather co-ordination of managing the whole process of the project.

The evolution process of the model was gradual. As Vennix suggested in 1996, The Company developed a Preliminary model to comprehend the issue in the first step. \(^{21}\) (Figure 4.2) Based on data gathered through documents and interviews, the modelers started modeling separately. On a regular basis, the modelers discussed among

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\(^{21}\) Vennix, Jac., A. M. Group Model Building: Facilitating Team Learning using System Dynamics (Chichester: Willy), 1996.
themselves to unite the model with the help of the modeling supervisor. The Team determined the necessary data requirement for the next step.

**Model Structure**

Some speculators in the market take special advantage by buying cars at low prices through some sales methods of IKCO and selling them at higher prices. So there was hypothesis that "market prices would fall after Wholesales happen". But there was no consensus about this proposition among the managers. The problems were outlined by the use of simple supply-demand model introduced by Sterman to construct the above mentioned hypothesis. (Figure 4.3)

IKCO dealers were the only formal distributors of products of this company but some other automobile galleries and unofficial intermediaries re-sell the products of IKCO to the end-users. There are some good reasons why consumers prefer to purchase from these intermediaries. While one who desired to buy a car from IKCO dealers should wait for an average of 20 days to receive his/her car. Using intermediary, he could receive his car immediately and get rid of formal and time consuming processes required for purchasing from dealers of IKCO. Additionally, one could inspect the car before deciding to buy it. Moreover, surprisingly, in some cases, the prices proposed by unofficial intermediaries were lower than IKCO official prices due to the fact that they wanted to convert their cars into cash as soon as possible. Regarding their cash volume, each of these unofficial intermediaries may behave differently in the same market situation and

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"Programmed instruction" as the most useful technique where knowledge acquisition and knowledge retention were important. "Sensitivity training" ranked highest on changing attitudes and developing interpersonal skills. The "case study" method led in the problem-solving skill category, and the "conference" method was said to be most effective in gaining participant acceptance.\(^6\)

\begin{table}[h]
\centering
\begin{tabular}{|l|c|c|c|c|c|c|}
\hline
Training Method & Knowledge Acquisition & Changing Attitudes & Problem Solving Skills & Personal Acceptance & Knowledge Repetition & \\
\hline
Case Study & 2 & 4 & 1 & 4 & 2 & 2 \\
Conference & 3 & 3 & 4 & 3 & 1 & 5 \\
Lecture & 9 & 8 & 9 & 8 & 8 & 8 \\
Business Games & 6 & 5 & 2 & 5 & 3 & 6 \\
Movie Films & 4 & 6 & 7 & 6 & 5 & 7 \\
Programmed Instruction & 1 & 7 & 6 & 7 & 7 & 1 \\
Role Playing & 7 & 2 & 3 & 2 & 4 & 4 \\
Sensitivity Training & 8 & 1 & 5 & 1 & 6 & 3 \\
\hline
\end{tabular}
\caption{Ratings of Training Directors on Effectiveness of Alternative Training Methods for Various Training Objectives (Mean Rank)}
\end{table}

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there was not any precise information available about their behaviour.

Dynamic Hypothesis

As it is shown in the figure 4 when the company became underfunded, it lapsed into discounted sales like Wholesale or sizeable discount on presell, specially Wholesales which increase sales revenue instantly and solve the problem in the short run.

**Figure 4.4**

*Preliminary Causal Diagram*

But in the long run, because of the significant profit margin in speculation, the number of speculators in automotive market would obviously increase. This leads to an increase in supply in the market.
which affects the automotive market prices. The fall in market price in turn decreases IKCO official prices which are governed by economic, social and political pressures. This leads to a period of low prices and hence a decrease in income and cash flow of the company.

Stock and Flow diagram

For building the model, all determinants of supply and demand of the market were taken into account, though event-based changes such as seasonal changes in demand is not considered in model. The supply of the market is provided with two sources:

1. Presell: The statistical studies showed that 50 percent of customers who had bought car through Presell method were not end-users; they were investors who preferred to keep time value of their money through this way instead of putting their money in bank deposits, because of the higher interest rate offered by IKCO. Also fluctuation of price and discounts of IKCO encouraged individual investors to participate in these programs.

2. Wholesales: Some people buy a huge number of cars from IKCO, taking advantage of sizeable discounts. But the dealers want their money back quickly, so they resell the cars to the car traders with lower rates than the market prices. Part of stock flow model is presented in the following figure 4.5.
In the figure above core part of stock-flow diagram is presented.

**Putting it into System Archetypes or “Shifting the Burden” Archetype**

IKCO’s incompetence in selling its products made it underfunded. In response to need for immediate resolution of this trouble, discount sales were effected. But the “Fundamental problem” was the misfit between production and demand. In fact, wrong
estimations of demand for each type of product led to such imbalance but the latent point was that this “Symptomatic solution” affected rather deteriorated future estimations.

First, selling of low demanded products below official prices led to the wrong impression about demand for these products and it did mislead managers in estimating the demand.

Figure 4.6

“Shifting The Burden”

Problem
Symptom: Cash
Price
Symptomatic
Discount Sales

Problem in Selling
Solution
Products

Selling Low -
Demanded Products

Fundamental Problem:
Disproportionate Production

Wrong Estimate of
Demand

Second, affording sizeable discounts encouraged speculators’ activity in automotive market. If implemented, the presence of these unofficial intermediaries (speculators) would result in more confused market in two ways. One is that the demand of speculators is influenced by many external factors like return on investment which made the
demand more chaotic and, in fact, it is a lot different from end-users’ demand. And the other is that, these speculators may buy types of cars for which they predict noticeable increase in demand in future months.