

# THE CROATIAN MODEL OF INNOVATIVE SMART ENTERPRISE (HR-ISE MODEL)

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## Abstract

The aim of project Innovative Smart Enterprise is to understand how manufacturing enterprises in Croatia acquire new manufacturing technologies, integrate ICT within processes, implement new organizational concepts in production such as group work or relocation of production, develop new products that emerge from process and organizational innovation such as production-related services, and how they implement all other demands related to Industry 4.0.

A synthesis of analysis of Croatian manufacturing enterprises is made through the development of Croatian model of Innovative Smart Enterprise (HR-ISE model). The paper presents HR-ISE model, which is based not just on State-of-the-art theoretical models but also on State-of-the-art practical models like Lean Management philosophy from Toyota Production System.

## 1. INTRODUCTION

During history lot of enterprises were finding different methods to increase their productivity, reduce losses and maximize profits. The enterprises invest a very large amount of money and effort in the improvement of their production systems. It is noticeable that production systems and technologies have been evolving according to guidelines of Industry 4.0. Today major competitors are focused on creating innovative business models according to guidelines for Industry 4.0. They realize how difficult is to survive in today's market conditions with an old way of thinking and old business models. The smart environment within production system is the main characteristic of Industry 4.0. It is created of smart products, smart processes, and smart procedures. All devices within the enterprise are connected so information is dispersed properly. Each information is available at any time, what is necessary for the high-quality organization. The main features of Industry 4.0 are virtualization, decentralization, modularity, interoperability, real-time capability and service orientation. The idea about Industry 4.0 originates from German High Tech strategy in

2006. In 2012, the German government made Industry 4.0 as one of 10 future projects of their High-Tech strategy [1]. Industry 4.0 represents the coming fourth industrial revolution on the way to an Internet of Things, Data, and Services [2]. Internet of thing refers to communicating objects based on internet technologies, Internet of Data means well managed and shared data by internet and Internet of Services represents a new approach for providing internet based services [3]. The fourth revolution is here and it is fast and disruptive so there is no going back. All guidelines from Industry 4.0 can help enterprises to predict possible future scenarios. It is essential because of today's market conditions that change very fast. Market conditions force companies to change as fast as they can. That results in development of the new management techniques which are necessary for optimal performance of the entire production system. The Enterprises should use all opportunities of new technologies and organizational innovations, that provides Industry 4.0, to defend themselves. All mentioned is motivation to follow the good examples from companies that entered in the fourth industrial revolution. The aim is to develop Croatian model of Innovative Smart Enterprise considering a specific way of thinking, manufacturing and organizational tradition in Croatia. Earlier research phases of the project Innovative Smart Enterprise resulted in selection of six lean tools and creation of generic HR-ISE model [4]. New research generates a more detailed definition of the HR-ISE model which is presented in this paper.

## 2. RESEARCH CHALLENGES FOR ACHIEVING PRODUCTION IMPROVEMENT

The first step in every enterprise should be to determine its actual state and to get a real picture of their state. The current state in Croatian manufacturing industry is that majority of manufacturing enterprises belong to the second industrial revolution and some of them belong to the third industrial revolution. The current state is not Industry 4.0, it is unfortunately 2.15 [4]. After the first step, it is necessary to determine where enterprise wants to be. Further enterprise needs guidelines for action. When looking at the

renowned international manufacturing enterprises it can be concluded that they are developing their production system with the selection of lean tools from the palette of proven lean tools. Many companies explicitly state that the Toyota production system and lean production heavily influenced their own production systems [5]. There is the list of ten most common principles among the 30 international manufacturing enterprises, figure 1.

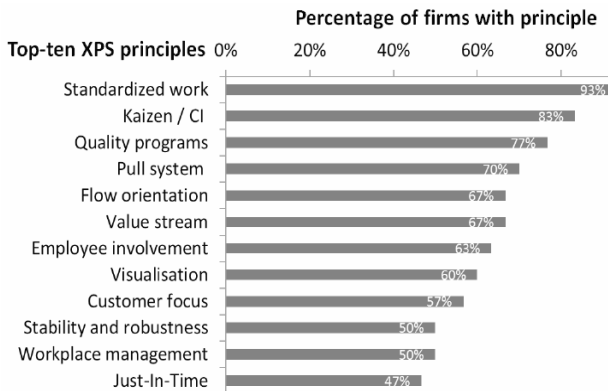


Figure 1. Top ten principles among 30 international enterprises [5]

The strategic initiative of Industry 4.0 leads to new business models and innovative social infrastructures. The results of the survey on Industry 4.0 trends shows how important is this topic for the competitiveness of German industry, 278 enterprises took a part in the survey. Three greatest challenges connected with implementing were identified as standardization, work organization, and product availability [6], figure 2.

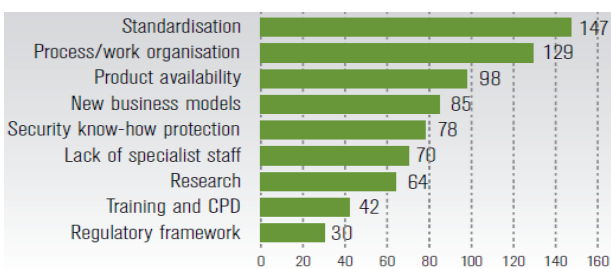


Figure 2. Greatest challenges connected with implementation of the Industry 4.0 [6]

The changes are not easy for enterprises, especially when that changes are big. They need help from several sides (e.g. from experts in this field, from enterprises with some experiences, from the government). The enterprises answered the questions about support during the implementation, figure 3. In the literature, there are numerous lean principles so it is not clear which principles to implement or not to implement at the beginning.

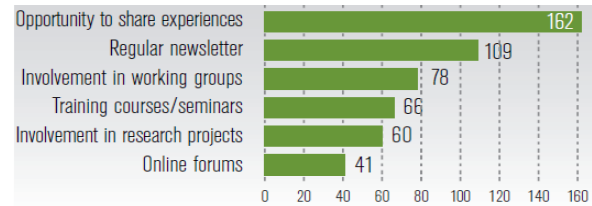


Figure 3. Greatest challenges connected with implementation of the Industry 4.0 [6]

That is the reason why the HR-ISE model is necessary for Croatian companies. It is the new business model which presents a big challenge.

### 3. RESEARCH METHODS

The research for the detailed definition of the HR-ISE model was based on questionnaires that were sent to manufacturing enterprises within Croatia, in order to determine what lean principles are currently used and what lean principles are needed in their production systems. The research included 37 successful and developed Croatian enterprises from different industrial areas. Most of the enterprises that were surveyed belong to shipbuilding and automotive industry (33% of surveyed enterprises). The survey covered enterprises from all regions in Croatia and some regions in Bosnia and Herzegovina. There are a different number of employees in the surveyed enterprises, figure 4. Most of them have over 250 employees.

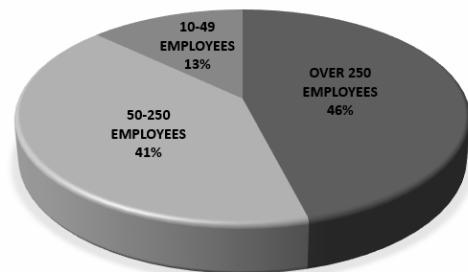


Figure 4. Number of employees in surveyed enterprises

The HR-ISE house with basic lean tools originates from previous researches [4] and it was presented to enterprises with the aim to collect their opinions about presented house, figure 5. There is unreplacable part of HR-ISE house and manufacturing enterprises were completing HR-ISE house with their own priorities, objectives and other lean tools (in the cells at the right side of the house) they consider important for their enterprise. Collected data were analyzed and new HR-ISE house was created. The HR-ISE house for achieving production improvement offers a

potential strategic program with lean principles for companies in Croatia, considering the current state of Croatian industry. First is necessary to implement lean tools and then is possible to move forward Industry 4.0.

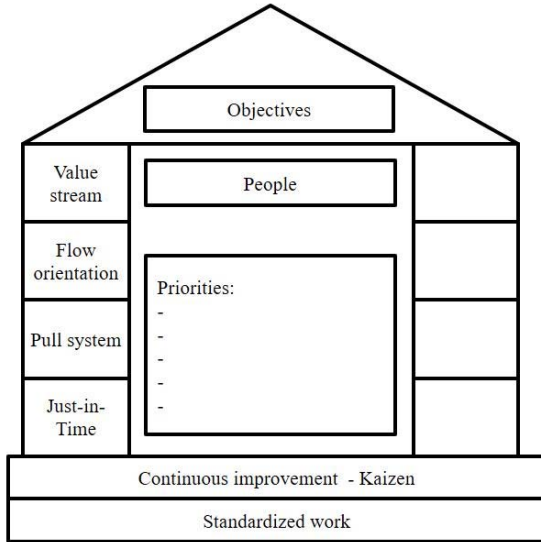


Figure 5. The HR-ISE house with basic lean tools [4]

**4. RESULTS AND DISCUSSION**

The surveyed enterprises consider that proposed model HR-ISE house is right and real so most of the enterprises have favored model as a starting point for further progress. The HR-ISE house covers very well everything that is currently missing inside of Croatian enterprises by their opinion. All enterprises fully agree with standardized work and continuous improvement as foundations of HR-ISE house. This model can also help them with their strategic guidance. Most enterprises view model as a platform where they can upgrade the rest of lean tools that are their priority, according to their specific features and economic activities. As the meaningful area in the HR-ISE house, enterprises listed education of employees because employees currently do not know what is lean and how to use lean tools. The enterprises often throw money with their lack of knowledge so surveyed enterprises emphasized that the HR-ISE model can lead them to their improvement without throw away their money. Improvement must have its meaningful chronology in every part of the enterprise and this model can help as a guide by their opinion.

**4.1. Exploring new lean principles for the HR-ISE model**

Figure 6. sums frequency of principles that surveyed enterprises mentioned as important for their production systems. The first principle is pull

system where is obvious that Croatian enterprises need production based on actual demand.

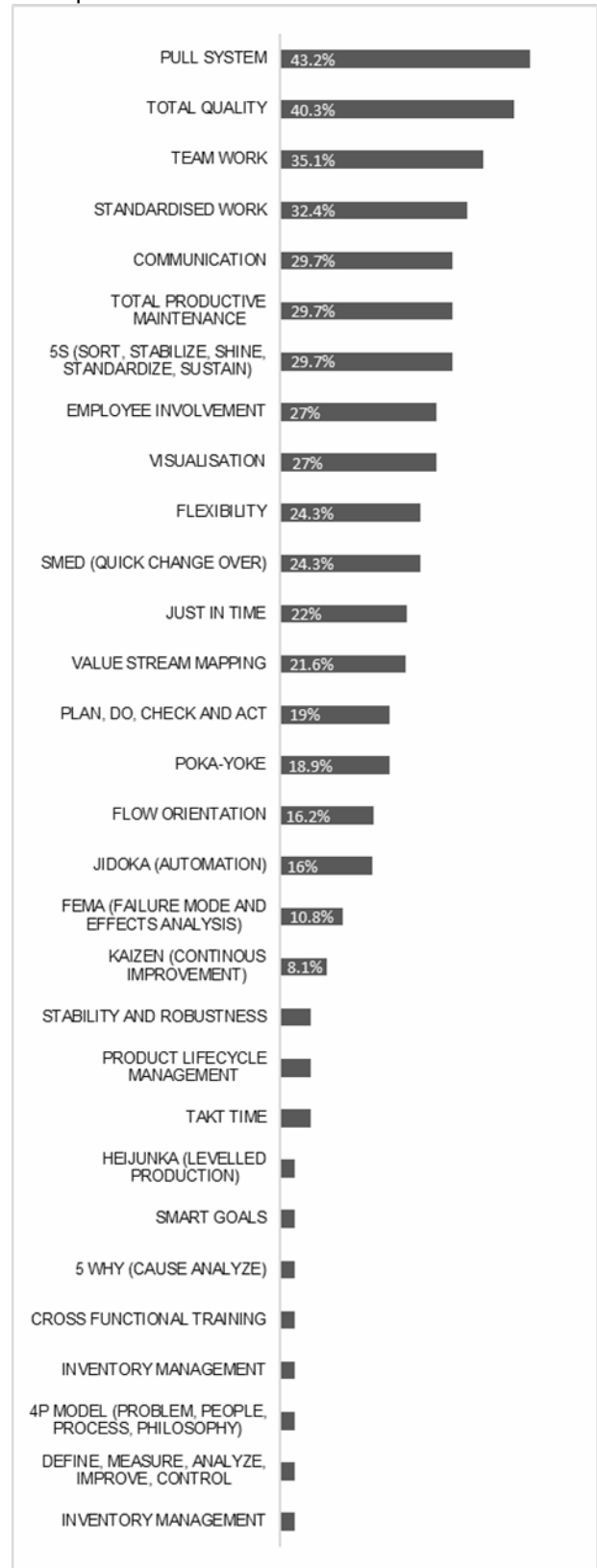


Figure 6. Lean principles sorted by priorities of the 37 surveyed enterprises

It is necessary to implement a new way of flow regulation for manufacturing goods in the production system but also with suppliers and customers. This principle reduces losses and overproduction what characterizes a lot of Croatian enterprises. Following this rule in practice is little complicated but pull systems can be in different forms to suit a different set of circumstances. All of them have in common fact that releases are regulated according to internal system status in a manner that prevents inventory from growing beyond a specified limit [7]. This lean principle has already been

in the HR-ISE house. The second principle, total quality was not part of the house so it became a part of it. The total quality management represents a strategy that is focused on quality in all organizational processes, not only in production processes what is the case of the Croatian enterprises. The quality is very important in Croatian enterprises and the majority of them had ISO 9000 standards introduced in their systems. At the other hand that does not mean that product or service quality is guaranteed because sometimes receiving certification for ISO 9000 is more important than achieving quality. There is a lot of literature that is searching for critical success factors for implementation of total quality management. According to study from 2016, there are top ten critical success factors: the role of top management, customer focus, training and education, data information and analysis, collaboration with supplier, process quality management, continuous improvement, total quality management as a strategic issue, organizational culture, employee commitment and attitude [8]. All mentioned success factors are a big challenge for Croatian enterprises so that might be a reason why the majority of surveyed enterprises selected the total quality management as the important lean principle. The third principle according to figure 7. is team work. Team work is the principle that helps enterprises to respond to today's turbulent environment. It is not easy to create an effective team because of abilities, expectations, needs, communication, knowledge exchanges, values, social and cultural background of employees. The teamwork is not always effective but contemporary perspectives on team effectiveness regard teams as part of a multilevel system, put emphasis on the dynamic nature of team work, and view team processes as phenomena that develop over time. Over time teams develop a relatively stable way of work division and coordination [9]. Fourth principle standardized work is the foundation of the HR-ISE house. The fifth principle is communication, which is key principle because of its role in the

implementation of other lean principles. In the research of early stages of implementing lean manufacturing principles [10], there was a strong evidence that dissemination of information to all employees about lean manufacturing did not occur. The executive management team and the area leads appeared to understand the concept of lean manufacturing but the employees did not receive enough information. Some employees identified communication with management as improved but most of them did not. The three communication practices were found [11]: blending, positive engagement and soft words. Blending is the practice where manager strives to become part of workers' work situation rather than being an outside actor. Positive engagement is the practice where the manager is always positive in the sense of implementing lean principles with energy. Soft words are the practice where the manager always responds in a positive manner. The sixth principle is total productive maintenance. The total productive maintenance is an integrated set of activities aimed at maximizing equipment effectiveness by involving everyone in all departments at all levels, typically through small-group activities with aim of achieving zero breakdowns [12]. Behind total productive maintenance, there is the 5S method with the same percentage. The 5S method is the principle that includes clean, organized and effective workplace, so it helps to eliminate losses. The 5S is created of 5 key activities: sort, set in order, shine, standardize and sustain. It belongs to fundamental principles in the HR-ISE house so it is placed next to standardized work. The 5S naturally leads to total productive maintenance, which is key to machine stability and effectiveness [13]. Most important is to prevent and correct problems so there is a lot of space for integration of lean approach in PMFEA (Process Failure Mode and Effect Analysis) for problem prevention improvement [14]. After 5S method, in figure 6., three more principles are listed: employee involvement, visualization, and flexibility. All of them are included in HR-ISE house through priorities or some other parts. The principle behind them is SMED method (Single Minute Exchange of Die) which is placed in HR-ISE house. The short changeover times are critical for the majority of manufacturing companies. The enterprises that belong to the automotive industry underline this method as very important.

#### 4.2. Defining objectives

After enterprise determines its actual state it is necessary to decide where it wants to be, like it is mentioned at the beginning. At the top of the HR-ISE house are objectives, figure 7. Customer

satisfaction is the most frequent objective among the 37 surveyed enterprises. The enterprises focus its attention on the customer, what is a good way for improvement. They realize how important is the customer and it is necessary to emphasize that importance through entire enterprise and create a culture that really puts the customer first. Each enterprise should investigate what customers think about their products or services, enterprise, and competitors. They should know customers better than they know themselves. The continuous improvement is the second objective, so it is the fundamental principle of the HR-ISE house. The improvement of quality is third and enterprises emphasize how important is the role of leadership in this objective. The leadership should build quality in the whole production system so every employee will become, step by step, familiar with ways of quality improvement. The customers want a quality built in every product they pay for.

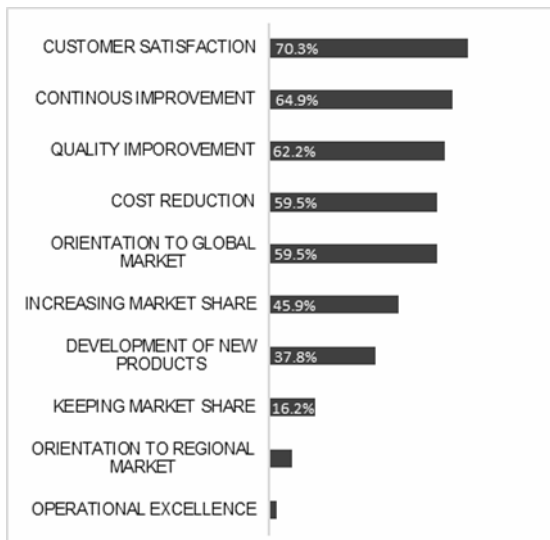


Figure 7. Sorted objectives of the 37 surveyed enterprises

Through all production system, there are opportunities to reduce costs. Many lean principles are focused on what is value-added and what is not so enterprises can completely reduce some costs. The Croatian enterprises are looking to expand to global market because they believe they can compete on the global market but only under the conditions that are mentioned before in this paper, introducing lean principles and moving toward Industry 4.0.

**4.3. The role of employees**

The orientation to the employees is part of the HR-ISE house, which requires full involvement of employees in every step of improvement way. There are several things important to Croatian

enterprises that employees should have or try to gain, figure 8. The surveyed enterprises say how employees often resist to new education or to new methods of work. That is the reason why there are motivation and employee qualification at the top, shown in figure 9. Trough the education of employees, enterprises should pay attention to the company strategy but also take into consideration employee satisfaction. In Croatian enterprises is necessary to educate employees who lead processes about management skills and continuously expand their knowledge about lean principles. The term “lean leadership” appears in the literature [15,16]. The four key areas for leaders are self-development, coaching, developing others, supporting continuous improvement, creating a vision and aligning goals [16]. Through four key areas, they can develop into great leaders. The role of education is crucial for the implementation of HR-ISE model.

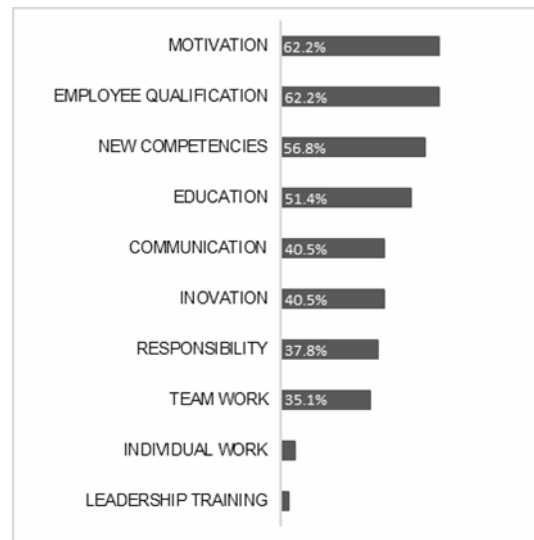


Figure 8. The basic requirements for employees

According to surveyed Croatian enterprises, the top management should be well informed about lean principles and understand presented HR-ISE model before the implementation. After the first and most important point, knowledge should be transferred to other employees. During the education, it is necessary to spread a positive attitude about the whole process of implementation and affect positively on employee motivation. In Croatian enterprises, knowledge is sometimes ignored because it is a process that takes time. Only educated employees can work on the proper implementation. The lack of knowledge within the enterprise is a strong impediment to development. Today enterprises can successfully compete through innovations. Surveyed enterprises stimulate innovations by involving employees in

solving problems. They sent employees to fairs, seminars so employees can track latest trends in the industry and think about new creative ideas. The role of leaders is to encourage employees to realize their innovation. Most of the surveyed enterprises give money to their employees for innovations. All enterprises tend to be more innovative and a lot of them believe that innovation is a priority for their further improvement.

**4.4. Defining priorities**

In order to reach defined objectives, it is essential to define priorities, figure 9. Education is mentioned before as a crucial for improvement so it is clear why it is the most important priority with 59,5%. Second priority refers to new technologies, so for example, there is a strong correlation between the use of digital technologies and lean principles in production [17]. Implementation of lean principles without digital technology is a rare case. Through survey, Croatian enterprises mentioned orientation to the global market, development of new products and an introduction of new technologies as their priorities. All mentioned is an opportunity for parallel implementation of lean principles. New markets have the lowest percentage because there are numerous risks, especially if enterprise decides for the Blue ocean strategy. The Blue ocean strategy means that enterprise will work to create a completely new market place [18].

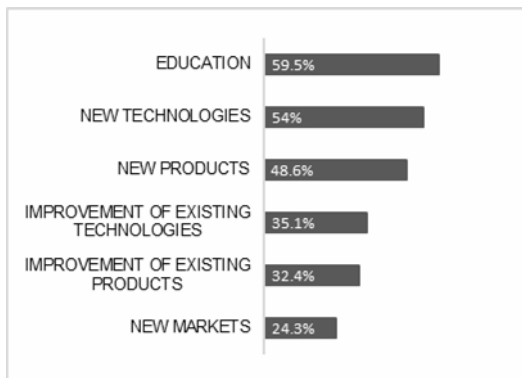


Figure 9. Sorted priorities of the 37 surveyed enterprises

**4.5. The HR-ISE house**

For successful implementation of the HR-ISE model, education and communication are most important. Regarding the situation in Croatian enterprises, it is necessary to implement lean principles mentioned in HR-ISE house, figure 10. The team of experts should be determined and implementation should start with the implementation plan for the enterprise. It must be perfectly clear and understandable to every employee. This implementation should be

evaluated every specified period by independent experts. With continuous analysis of the current processes and products, the entire production system can be well organized.

Manufacturing strategy is the foundation of any enterprise. The HR-ISE model should be part of manufacturing strategy. If the enterprise uses few lean principles, the HR-ISE model will complement existing manufacturing strategy. The cost reduction is the fourth important objective so an existing production strategy can only be better with the introduction of the HR-ISE model. At the beginning, it is necessary to find a balance between existing manufacturing strategy and the HR-ISE model, with communication about implementation it is possible to influence on a positive thinking about changes.

Most surveyed enterprises never had some model that is close to the HR-ISE model and only 15% of surveyed enterprises had already implemented a few lean principles. At the top of the HR-ISE model is just one objective, customer satisfaction, but results in figure 8 show several objectives. The second objective is continuous improvement and it is not shown at the top because it belongs to the foundations of the house. The third objective is the improvement of quality which is contained in the total quality principle. The HR-ISE house represents a model that helps reduce costs and that is the reason why it is not included at the top of the house. Other defined objectives are aligned with priorities.

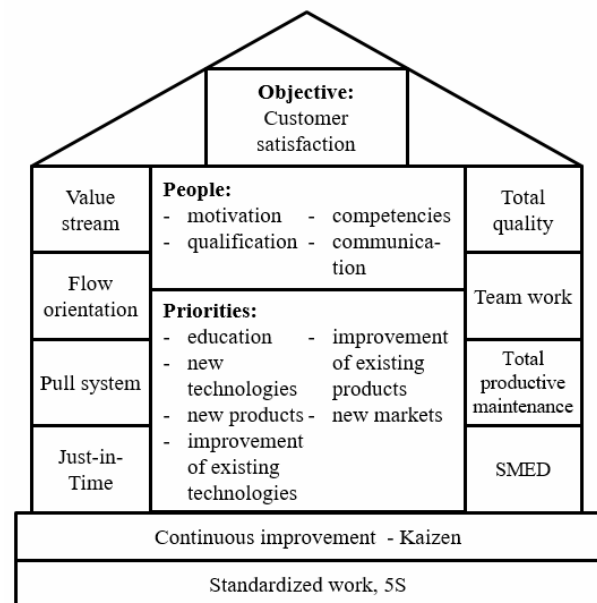


Figure 10. The HR-ISE model

**5. CONCLUSION**

Developing a model that can help manufacturing enterprises with a new way of work is a strong trend today. Implementation of the

model like HR-ISE house can significantly reduce costs. This paper presents the attitudes of the surveyed enterprises and their way of thinking about lean principles and necessary changes. It is positive that companies are aware of the current state and high degree of surveyed enterprises are working to change and improve their production systems. According to the results, we can conclude that education is necessary to employees in Croatian enterprises, education which is directed to lean principles and new business models. The role of employees is crucial for the HR-ISE model, especially their motivation to move forward.

In earlier research, the HR-ISE model was created with basic lean tools that should be implemented. The basic lean tools represent unreplaceable part of the HR-ISE model. The main aim of this research was to find other lean tools that are necessary to Croatian enterprises and define the HR-ISE model in detail. Now there is a big challenge to apply a model. This research opens many questions that remain unanswered so, in further research, the HR-ISE model will be tested.

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