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Patterns for Analysis of Human Resource Flexibility in Manufacturing

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Abstract

Human resource flexibility has to reflect manifold demands, influences and stakeholders, each with individual and different criteria. The main external drivers of flexibility are volatile markets and short delivery times. Additional demands for flexibility are internal caused by machine breakdowns, material shortages or unplanned absence times of workers. Nevertheless, the employees themselves claim more and more flexible working hours to reflect their individual and personal requirements.

This paper highlights the requirements for human resource flexibility and describes rules and patterns to analyze the current situation and solution for human resource flexibility in manufacturing companies. The patterns give operational advices to experts how to analyze the requirements and to compare them with a specific solution. The rational is not to implement the highest possible human resource flexibility, but to find a solution with the most appropriate flexibility, which reflects the requirements exactly and, at the other hand, avoids costs for an unnecessary or wrong flexibility.

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1. Introduction

Manufacturing companies are more and more subject to a high degree of flexible utilization of their production resources and, especially, their workforce. Various external and internal drivers influence the workforces' flexibility demands.

External drivers are mainly short-term as well as overlapped medium- and long-term fluctuations of customer demands. Short-term fluctuations are results from marketing campaigns or large, singular orders in combination with an increasing number of product variants, individualized products and shortened delivery times. Typical long-term effects are flows of seasonal demands, product lifecycles or the worldwide economic activity [1]. In combination with the globalization of the markets and upcoming international competitors, it is difficult to estimate the actual workload for a specific period [2]. It seems to be especially impossible to predict the worldwide economic activity reliably [3]. Consequently, manufacturing companies cannot predict and plan their production quantity and workload in advance. Nevertheless, they have to meet high requirements in terms of short delivery times, low stock quantities and competitive costs [4, 5]. They have to fulfil customer demands for products of high quality faster and more reliably as the competitors [5]. The commonly used approach of a centralized planning and scheduling of production demands and orders [7] is too slow and to inefficient to meet new requirements of dynamic and volatile markets. Nowadays companies are forced to utilize flexible forms of production activities, schedules, and labor [8]. In a survey of the Fraunhofer IAO 72% of the participating companies agreed, that they need to increase their possibilities of flexible labor utilization within the next five years [9] (Fig. 1a).

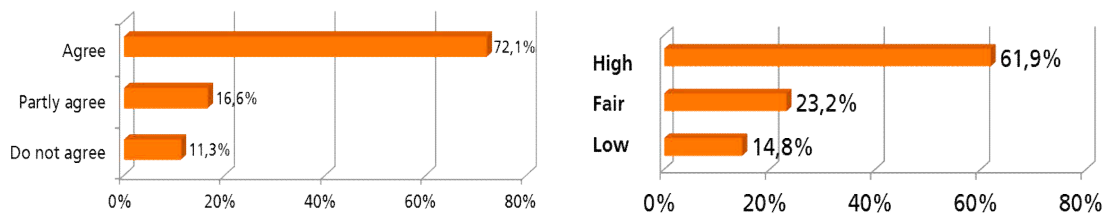


Fig. 1. (a). Demand for flexibility (Spath); (b) Effort for short-time production control [9]

Especially in countries with high wages and turbulent market environments, companies have to maintain their business responsiveness. They have to adjust their capacity more quickly to the changing market trends, to be able to operate successfully in future as well [10]. As a key element, flexible labor utilization has to reflect the short-time fulfilment of individualized customer demands in real-time as well as the fluctuations of volatile markets.

Internal drivers for flexibility are reflecting planning constraints and personal requirements of the workforces themselves. The personnel planning have to meet strategies for the flexible adjustment of human resource allocation. There are some criteria such as total or periodical amount of overtime hours or the share of part time workers. Employees require to be involved in the process of the personnel planning and scheduling. More and more they call for a transparent personnel planning which better combines the business demands with their private concerns and leisure interests. The upcoming demographic change of the job market, with aging workforces on the one side and the Generation Y at the beginning of their business careers empathize this trend additionally.

The personnel planning therefore have to meet divergent targets in terms of business demands, reliability and productivity. Moreover, it has to reflect the individual requirements and personal concerns of the employees. Obviously the personnel planning and scheduling is a complex task, with include several stakeholders with divergent targets, as depicted in figure 2. In the survey mentioned above, 62% of the participating companies stated, that their effort for short-time production control is high [9] (Fig. 1b).

The drivers introduced so far forcing companies to increase the flexibility of their labor utilization [8]. This challenging task requires a systematic analysis of the workforces' flexibility. Within the following paper, the basic concepts of flexible labor utilization will be introduced. Afterwards patterns for the analysis of a flexible labor utilization will be described and explained.



Fig. 2. Forces on the organization of flexible working hours.

1. Human Resource Flexibility

The flexibility of the workforces in a company depends on specific measures and constraints for the utilization of working hours. The measures to implement a flexible labor utilization are often and throughout this paper called ‘flexibility instruments’. For a comprehensive discussion of the common flexibility instruments look e.g. in [11]. In the following chapter a brief overview is given.

1.1. Flexible Labor Utilization

A flexible labor utilization describes a situation where the daily working hours are no longer be on fixed times and equally spread throughout the day. There are two principle ways for flexible labor utilization in general. First, the working time of a group of employees can be reduced or enlarged, perhaps day by day. Second, the group of employees can be reduced or enlarged [12]. Figure 3 gives an impression for the two ways by the example of a so-called “U-Shape assembly system”.

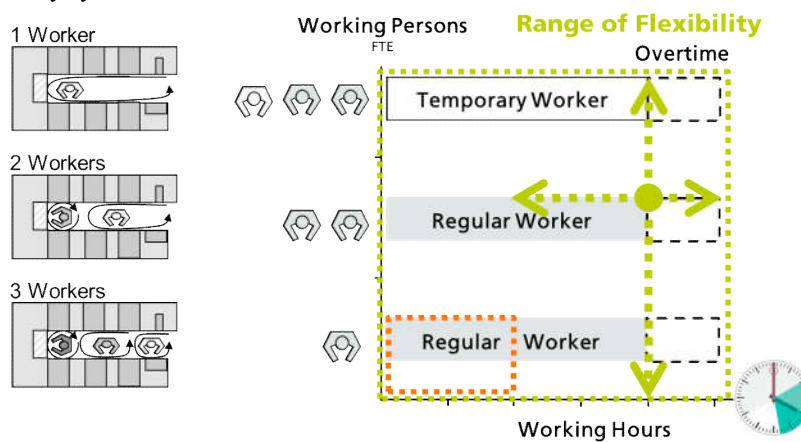


Fig. 3. Flexible Working Hours [12]

Within this system, one worker can assemble a whole product by passing all work places in one walking circle. According to German law, she or he is allowed to work at maximum ten hours per day in Germany. There is no law for the minimum working hours. However, there is a minimum amount for the daily working hours because of economically reasons. If a higher utilization is needed, an additional worker may be added to the assembly system. The two workers split the assembly tasks between them. Obviously, the maximum amount for workers within the assembly system is given by the number of work places.

1.2. Flexibility Instruments

Many flexibility instruments, i.e. possible forms for flexible labor utilization are known. For example, increased demands for capacity can be covered by the core employees in additional shifts. Alternatively, the increased demands can be also handled through use of temporary workers. Whereas both flexibility instruments can cover the additional demand, they are different in terms of cost, time to utilize and coverable amount of capacity. The mix of different overlaid and sized flexibility instruments has to cover the adjustment levels of the partial emancipation strategy. Further restrictions may result e.g. from long training periods or high qualifying requirements. Therefore, the mix and size of the flexibility instruments has to be determined thoroughly based on a calculation of the total benefit and the financial budget needed [13]. In addition, a short-term control of flexibility instruments and the use of staff is necessary [14].

Various current studies display the widespread distribution of instruments of personnel flexibility in the Germany. The project FlexPro surveyed more than 1200 companies on the application of different flexibility instruments in Germany. More than 2/3 of these companies do business in the manufacturing industry [15]. The results demonstrate the wide range of flexibility instruments, which are regularly used in manufacturing area (Fig. 4). Instruments that are quickly available, such as overtime and extra work or internal personnel shifts are highly prioritized by the companies surveyed. Furthermore, part-time and temporary workers are used strongly. The working time of these employees can be adjusted flexibly to the short-term changes in capacity requirements of volatile markets.

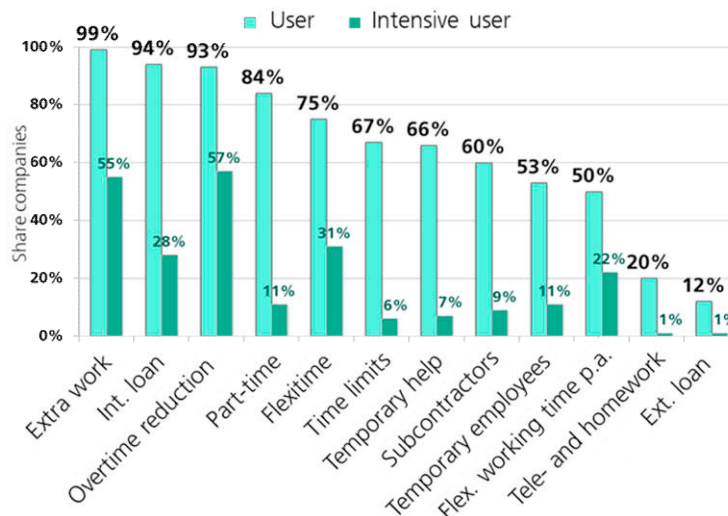


Fig. 4 Share of flexibility instruments in German companies [15]

To realize a particularly fine adjustment of manufacturing capacities, companies are required to use different flexibility instruments jointly and parallel. Unfortunately, there is no simple and absolute measured value for the needed degree of flexibility or the “right” mix of flexibility instruments. Therefore, a thorough and comprehensive analysis of the flexibility of human resources is needed.

2. Analysis of Human Resource Flexibility

In the past ten years, the authors of this paper analyzed the flexibility of the human resources in the manufacturing departments of different companies. The following patterns displays the general experiences of the authors in the analysis process.

2.1. Define strategic flexibility targets

Like every analysis task, also the analysis of the demands for and the solution of flexible labor needs a target. Therefore, it have to be oriented on a clear and comprehensive strategic target. In the first chapter of this paper, the general demands for human resource flexibility has been introduced. In its ‘generality’, these demands are existent in every company more or less. Especially this ‘more or less’ is exactly the important and notable difference. Each company is faced with its own and specific set of this demands.

For example, automotive suppliers usually are struggling very hard with the more long-term fluctuations of market demands, product lifecycles und economic crisis, but in comparison with the short-term fluctuations are moderate. Companies of the machine building industry are stressed by long-term as well as short-term fluctuations of customer orders. The food and beverage industry typically have to manage massive seasonal demands, but the lack of economic crisis plays a secondary part.

Figure 5a shows an example of the workload of a production unit in a machine building company. The workload is calculated in working hours needed to assemble the customer orders with delivery due date in each week. The diagram is easy to calculate with an analysis of the production orders and the corresponding work plans, which contains the assembly time for one piece of the product. The orange line is the capacity demand resulting from the customer orders. The blue line displays the actual workload. Figure 5b displays another example the same diagram for the weekly workload of a factory for food processing industry. The workload is comparably very good balanced with soft peaks and only one slack at the turn of the year.

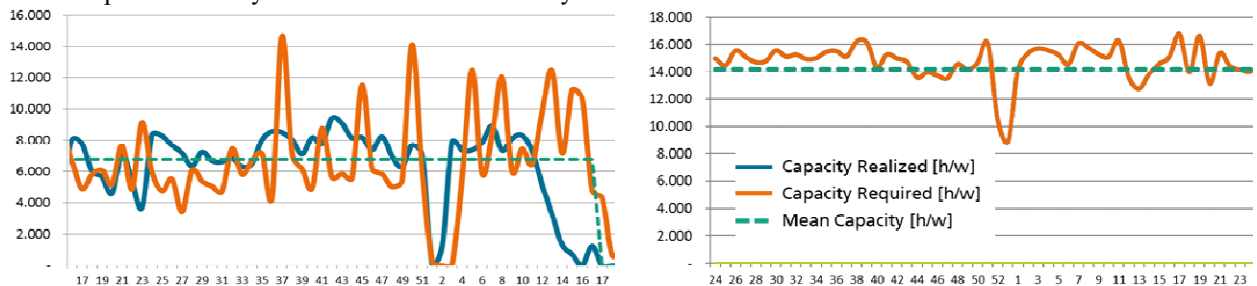


Fig. 5. (a) Workload machine building company, (b) Workload food processing industry.

Therefore, it is important to define the company’s demands for human resource flexibility in precise, specific and operational way. It has to make clear what the short-term demands are, which long-term demands exists and how the internal requirements of the employees are.

2.2. Analyze real flow of distributions

In many companies, the demands and solutions for human resource flexibility are calculated with average figures or with statistical distributions. There is no rational that the demands are standardized normal distributed or follow any other mathematical distribution. Figure 6 shows an example of the evaluation from the delivery times of orders the customers’ demands from a specific company (green line). As the diagram displays, there are three main classes and not one mean value.

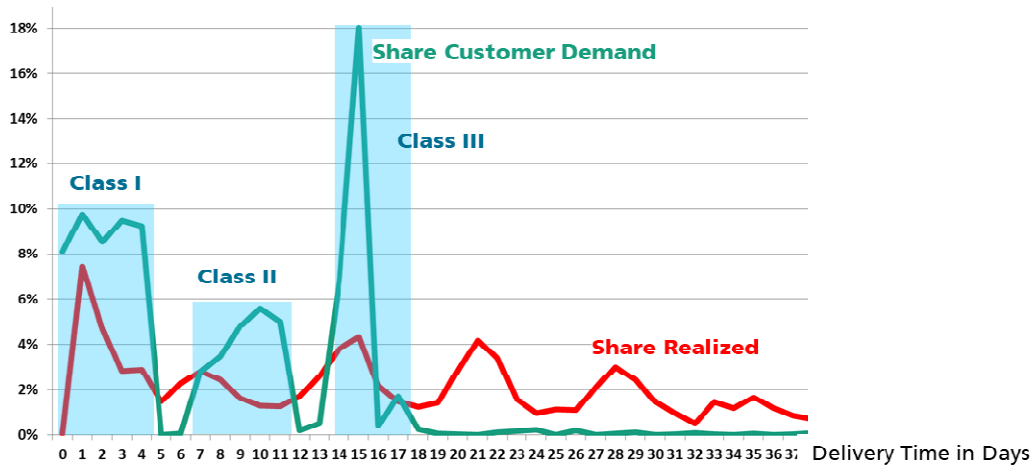


Fig. 6. Example for the distribution of delivery times

Another example may be the rate of absent employees, which is calculated in most companies with an average rate, typically close to 6% of the workers. In practice, it may be for example in peak weeks sometimes 15%, in other weeks near to zero. The flexibility of human resources should contain solutions for weeks with 15% absent workers as well as for weeks, where all of the workers available.

Consequently, the analysis of human resource flexibility have also to show the flow and peaks of the distributions of the demands for a sufficient period. To analyze the flow over one year is a sufficient practice in many cases, since all seasonal flows and most of the order cumulating are covered.

2.3. Drill down to production units

Very close to the rational of analyzing flows of distribution is the pattern to drill the demands down to production units and working groups. Looking at a company's demand and his staff at a whole, the analysis results contains balancing effects, which often are not realizable in practice. For example, if one production unit is overloaded, where another unit is running calm, switching employees between the units may balance the human resource capacity. However, this is not easy in some cases, because of different needs of units' competencies and qualifications.

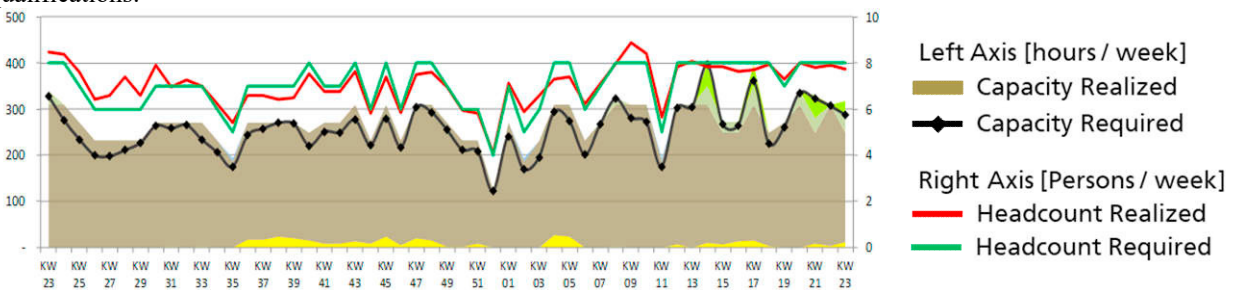


Fig. 7. Workload of one production unit in food processing industry

Figure 7 is an example for the drill down to production units. The diagram displays the workload required (black line) and the capacity realized by the workforce (brown shape), both expressed in hours a week, of one production unit. The production unit is one of the fifteen production units of the food processing company, which total workload is presented in figure 5b. Whereas the weekly workload of the whole company is good balanced with only soft peaks, the flow of the production unit is obviously higher with stronger peaks and slacks.

Therefore, the analysis has to show the workloads of the individual units over the time. Then the experts can decide, whether a balancing of the human resource capacity between the units is applicable or not.

2.4. Distinguish capacity and headcount

The analysis of workload has to distinguish between the demand for capacity and headcount. The capacity is expressed in demand for working hours in a period. The demand for headcount is the amount of employees needed at a specific time in a working unit. Both figures are closely related. The product of headcount and working time results in the capacity needed respectively offered in a period. Therefore working with half of the headcount for the double time results in the same capacity. In practice, there are often constraints to the relation between headcount and capacity. For example, a production unit needs an exact amount of employees to operate every workplace in the production unit. Especially in a production unit with a so-called “one-piece-flow” between the workplaces this may be true.

In many cases, the analysis of the flexibility therefore should show the capacity demand as well as the demand for headcount. In figure 7, the black line shows the drill down of the workload to a production unit. In the same diagram, the green line and the red line display the demand respectively the offering of headcount in the production unit at the same time. If the red line is visible, the offering of employees is higher or lower as the demand, although the demand for capacity may be met.

2.5. Characterize demands for flexibility and flexibility instruments

Human Resource Flexibility is the ability of a company to arrange the working hours of their workforce very close to the flow of the demand. Nevertheless, flexibility is not only dependent from its flow. It is expressed more precisely in the four basic categories deviation, response time, duration, and frequency.

Deviation is the difference of amount of capacity needed in specific period from the average amount over the whole time. Response time is the delay between the occurrence of a triggering event for a capacity deviation and the time where the deviation has to take place. Duration is the time the deviation takes place. Frequency is the mean time between the triggering events. With these basic categories, triggers and demands for flexibility can be distinguished and characterized. Triggers for flexibility may be, for example, large orders or machine malfunctions. A fictitious large order may triggering a deviation of plus 5% from normal capacity, the order is placed two weeks before start of production, so response time is two weeks, the duration of the processing of the order is one week and the company can process not more than 10 large orders in a period. A fictitious machine malfunction may also triggering a deviation of minus 100% of normal capacity, since no processing is possible, the response time is zero, in case of malfunction the workforce have to adapt their capacity immediately, the duration is in many cases not longer than one shift, and the frequency is hopefully low. Obviously, the flexibility instruments used to arrange the working hours are still different.

Almost every company is subject to the same kind of typical events triggering the flow of demands, like cumulated orders, machine malfunctions, absence and illness of employees, shortages of materials etc. Although the events are of the same types, their differences in the basic categories may be huge. The response time to cumulated orders may be, for example, in a machine building company several weeks to months, in al logistic service provider only a few hours. The analysis of human resource flexibility therefore has to detect what kind of events will trigger the flow of demands in a specific company and characterize them in the basic categories described above.

2.6. Look at the preparation level of existing flexibility instruments

Many flexibility instruments, especially those for “fighting” against volatility, need some time for preparation of the. An example are big flextime records of working hours with the capability to store several hundreds of working hours. In practice, the companies have to monitor and to control the average growth rate of the records. Figure 8 shows the result of a very easy analysis in a company, which agreed in the past on records with up to 400 hours. The

target was to establish a volatility reserve in range from 250 to 350 hours for every employee. The diagram shows the current flextime record of every of the 254 employees sorted along the amount of the record. It is easy to see, that the company misses its target.

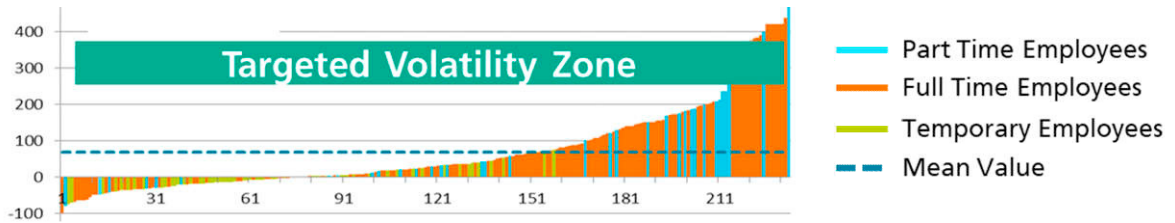


Fig. 8. Example for the reparation level of flexibility instruments.

The example shows, that only to agree on instruments and to formally to establish them is only half the way. Many of them need time and measures to prepare them. An analysis of the current utilization proves the success of the instruments and agreements.

3. Conclusion

The idea of describing general rules and experiences as “patterns” was originally invented by the architect Christopher Alexander, who published a comprehensive collection of patterns to design towns and buildings [16]. His idea was successfully adopted later to Software Engineering [17] and the analysis of business processes [18] in a more formal notation of patterns.

In the chapter above, patterns for the analysis of flexible labor are presented in a natural and more expressive style. Patterns are experience-based, their source is not formal theory or calculation. Nevertheless, they provide a helpful guidance for the analysis process in real situation and a specific company. The patterns presented are the essence of round about twenty projects with German companies to analyze their specific demands for the utilization of flexible working hours. Also the patterns look more or less “obviously clear and evident” to experts, many of the responsible stakeholders in the companies are impressed and gain strong impulses for their future work in analyzing and reconfiguring their solutions for human resource flexibility. In this case, especially the “obviously clearness and evidence” of patterns may be one success factor herein, because they represent experience in a natural scheme. Experts are usually able to immediately expand their existing experience, to applicate the new patterns and add their own patterns.

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