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Method to Estimate Needed Personnel for Production of Akkawi and Kashkaval Cheese: A Case Study

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Abstract— *Calculating staffing needs is part of human resource planning, the process of analyzing and identifying staffing gaps and surpluses. Various formulas are used to estimate and predict staffing needs, based on the company's historical and estimated performance data such as sales and production numbers. Human resource planning focuses on staffing the organization with the right number of personnel with the required skills when needed to meet business objectives in the short and long term.*

However, very few depend on the actual process and the target needs. For this purpose, this method was developed as a management tool of two production lines with four rules of thumb. Each movement by a human worker is considered as one second per unit. When an action involves processing, transferring more than one unit, it is considered one second per process or transfer. When a machine is processing huge numbers of units, it is considered one second per machine stage. The technical efficiency of labor was set at 89%.

The above-mentioned method was applied on an Akkawi and a kashkaval production line and the results were validated and proper allocation of personnel increase the production of both by at least 1.2 times.

Keywords—Akkawi, Kashkaval, Units of production, Labor efficiency personnel

I. INTRODUCTON

The importance of good work systems and organized management is recognized by many companies leading to better management, decision-making and quality improvement. At the same time, productivity is becoming more and more difficult to achieve and manage. The demands of the engineers and analysts are continuously rising in view of the rapidly changing market places and competition worldwide. This has made it imperative for organizations to upgrade and keep pace with progress [1].

The work measurement tools, such as M.O.S.T, Generalized Quantum Measurement, etc. existing are too complex and often need lots of expertize to administer [2] [1] [3]. Furthermore, work study is done to reduce the number of motions in performing a task in order to increase productivity. However, none, at least it was not found while doing our search, is done in the reverse i.e to base oneself on the existing operation and calculate the need of personnel per line of production. This is suitable to small to medium size operations have already established their routines and procedures. In certain instances especially in the cheese industry these routines are thought to give an identity to the product. Thus, it is not preferable to change the procedures but to render them more efficient. For this purpose the simple method to calculate needed personnel (S.M.C.N.P) was developed. The concept of the measurement system has been adopted from the M.O.S.T concept but with some modifications. It was applied on an ongoing production of Akkawi and Kashkaval cheeses.

1.1 Akkawi Cheese

Akkawi cheese is one of the white brined cheeses produced in the Middle Eastern region which are classified as rennet-coagulated cheeses with or without cheese) starter culture [4]. For Akawi cheese making, pasteurized milk is used (at 60°C for 30 min or 72°C for 15 s), cooled to about 35°C and then starter culture is added (1.5%). After 60 min,

rennet is added to coagulate milk within an hour. The curd is cut, whey drained, and curd pieces are wrapped in cheesecloth in small portions (150 to 250 g), pressed for about 1 h, and brined in approximately 10% brine solution at 4°C. Typical Akawi cheese contains about 51.0% moisture, 21.6% fat, 22.5% protein, and 5% ash [5].

1.2 Kashkaval cheese

Kashkaval belong to the Pasta Filata cheeses like Provolone, Mozzarela, Ragusano and have a long tradition in the most east Mediterranean and neighboring countries [6]. This type of cheese is different from other cheese types because of the curd "stretching" process contributing to conferring typical characteristics of structure and aroma [7]

Rennet is added to raw milk at 32ºC to complete coagulation in 45 minutes. The coagulum is cut into cubes of one cm^3, left without stirring for 5-7 minutes. Then gradually stirred very gently at the beginning, while keeping the temperature at 32ºC. After the curd has settled, 50% of the whey is drawn off, and stirring is continued with gradual raising of temperature up to 35-40ºC. The curd is placed into the vats ready to be pressed. Curd is pressed by a suitable weight (about 1 kg/1 kg of curd) to hasten the expulsion of the whey. This stage is completed when the titratable acidity of the curd reaches 1.25-1.35% and the pH value becomes 5.2 [8].

The mass of ripened cheddared curd is then cut into large blocks usually (60×10×10cm) which are cut afterwards into thin slices usually (10×7×1.5 cm) and scalded with 8-9% brine at a temperature of 75±2ºC, and worked for about 3-5 min to become a homogenous plastic paste [8].

The scalded or cooked curd is kneaded vigorously to get rid of the remaining hot whey and then moulded. The bundle is squeezed by hand and the excess curd. The cheese is left in the mould until the following day.

The young cheese is removed into a cellar having a temperature of 18ºC and relative humidity of 70-75%. Forty gram of dry coarse salt is sprinkled daily on the cheese surface for 4 days, followed by 30 gm for 6-days. After salting, the cheese is cleaned using smooth brushes and warm water, then rubbed with 2% alcoholic sorbic acid solution or 1% aqueous potassium sorbate. Cheese is kept in piles in the cellar while being turned every two days. When the cheese becomes 35-45 days old, it is coated either with wax or plastic-coat. Then the cheese is ripened at 13±2ºC and 83±2% humidity for 6 months or more.

1.3 Rules of thumb for S.M.C.N.P

To apply the SMCNP we have to abide by four rules of thump:

- **First:** Each movement by a human worker is considered as one second per unit.
- **Second:** When an action involves processing, transferring more than one unit, it is considered one second per process or transfer.
- **Third:** When a machine is processing huge numbers of units, it is considered one second per machine stage.
- **Fourth:** Technical Efficiency of labor should be considered.

II. MATERIALS AND METHODS

2.1 Procedure to determine activities to be recorded

In our case study, we start by observing the work flow to construct a general flow chart. Then an extensive flow chart is established. This extensive flow chart would be constructed at least 3 times and done while processing different milk batches. Once the extended chart is established, it is fine-tuned to see if an activity is missing. Once all the activities are recorded, each activity is assigned one second (Fig. 1).

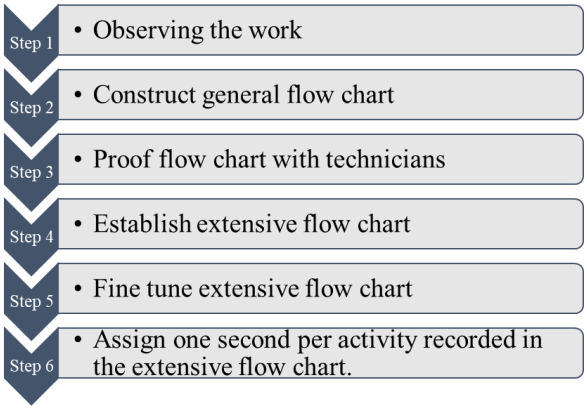

Fig. 1. Procedure to determine activities to be recorded

2.2 Calculations for needed number of personnel

The sum of seconds per unit of production is done. Then the level of production is set. The first value is the actual production level (number of units). Multiplying the seconds attained by summation, we will have the total calculated time needed to achieve this production target.

After achieving the total number of seconds, we divide the total time needed to achieve the target production level by the total shift time (7.5 hrs-0.5hrs for lunch). This would give us the number of production personnel needed to achieve that.

However, this implies 100% efficiency of the personnel throughout the 7.5 hrs. Which is not feasible, thus a level of 89% efficiency is assumed the average recorded technical efficiency by Banker et al. [9] based on the equations set by Charnes et al. [10] [11]. The total number

of calculated personnel needed is then divided by 0.89 to get the final calculated needed personnel and in the presence of decimal the answer is always rounded up (Eq. 1).

Equation 1

$$\text{Personnel needed} = \frac{\text{Production units} * \text{Activity Seconds}}{\text{Shift time (Sec)} * \text{efficiency (0.89)}}$$

2.3 Comparing results with actual situation

Once the calculated needed personnel is estimated it is compared to the actual personnel number. Then it is validated by practice noting that this is conducted in real life factories.

III. RESULTS

3.1 Akkawi Cheese

3.1.1 Akkawi cheese production

Before the study, the factory was processing 11 tons of milk for akkawi production. The average of kg milk to kg akkawi cheese conversion value was 7.61 ± 0.01. the unit of production is a block of cheese of 0.56 ± 0.05 kg. The units of production of 11, 13, 17 and 20 tons of milk were recorded and how many tanks are produced (Table 1).

Table 1 Akkawi cheese production

Milk allocated (Ton)	Units* of Akkawi Mean ± SD	17Kg Akkawi Tank Mean ± SD	18Kg Akkawi Tank Mean ± SD
11	2585±277	80±7	85±9
13	3055±326	101±11	95±10
17	4288±450	140±15	132±14
20	2667±280	157±17	148±16

- *: Unit is Akkawi cheese block of about 0.56±0.06 kg

3.1.2 Akkawi recorded activities

Following the rules of thump to determine and record the activities, there was 52-recorded activity per unit of production (Table 2).

By assigning one second per activity per unit of production we end up having 52 seconds needed to produce one unit of akkawi cheese. Starting from the *receiving milk for akkawi* down to the action of *lift knife up* are actions that involve processing, transferring more than one unit thus according to the second and third rules of thumb and are considered one second each. From *turn to take piece* activity down to *put on new plastic square* follow the first rule of thumb and is considered one second each. The rest follow the second and third rule of thumb (Table 2).

Table 2 Recorded activities in Akkawi Production

Activity	sec
Receiving of milk for Akkawi production	1
Preparation with culture	1
Preparing vat	1
Preparing table	1
Tightening Screws	1
Turning delivery tube to table	1
Delivering Curd	1
Putting big cloth on cheese	1
Putting total curd on table under press	1
Pressing the cheese	1
Releasing pressure	1
Taking cloth out	1
Press Knife down	1
Cutting curd	1
Lift Knife up	1
Turn to take piece	1
Lifting square	1
Turn to deliver cheese	1
Take cheese out	1
Turn to return square	1
Fix it in place	1
Get Cloth	1
Prepare cloth	1
Get Piece of cheese	1
Put it on cloth	1
Wrap side 1	1
Wrap side 2	1
Wrap side 3	1
Wrap side 4	1
Press While wrapping	1
Put on Plastic square	1
When full turn to get new plastic square	1
Put on top new plastic Square	1
Take to press stage 1	1

Press in press 1	1
Take to press stage 2	1
Press in press 2	1
Take away from press 2	1
Take to salt room	1
Get stainless steel racks	1
Mount stainless steel racks	1
Put cheese on stainless steel racks	1
Mount cloth on stainless steel racks	1
Mount side fixers	1
Mount rubber	1
Get internal lift	1
Lift rack plus cheese to salt bath	1
Take cheese from salt bath	1
Go to tank sealer	1
Put cheese in tank	1
Put salt water in tank	1
Seal tank	1
Total	52

3.1.3 Personnel calculations and production potential

To calculate the personnel needed to be able to process the received milk for akkawi production we multiplied the units of production (Table 1) with the total time needed then divided by the total shift time and the estimated technical efficiency (Eq. 1) and rounded up.

The production level at 11 ton milk for akkawi production per day was the standard till the start of this study. According to the calculations we had 2 personnel extra (Table 3) corresponding to 18 working hours available (table 4) which can be either allocated to other needed division or used to increase the level of production.

When the level of production was increased to 13 tons per day there was no problem. This actually validated our calculations which showed an extra of 1 personnel extra. When 17 tons per day was tried, with 8 personnel we needed from half an hour to 45 minutes extra time whivh corresponds to the extra working hours needed (Table 4). Our calculations was further validated by the 20 ton per day level where 3 temporary extra personnel were allocated from other divisions, which corresponds to the values calculated (Table 3) (Table 4).

Table 3 Akkawi cheese production personnel

Milk allocated	Calculated Personnel	Real Personnel	Balance*
(Ton)	Person	Person	Person
11	6	8	2
13	7	8	1
17	9	8	-1
20	11	8	-3

*: Real personnel – Calculated personnel

Table 4 Akkawi cheese production hours

Milk allocated	Work hours calculated	Work hours Available	Balance*
(Ton)	hr	hr	hr
11	42	60	18
13	52.5	60	7.5
17	67.5	60	-7.5
20	82.5	60	-20.5

*: Work hours available – work hours calculated

3.2 Kashkaval cheese

3.2.1 Kashkaval cheese production

Before the study, the factory was processing 30 tons of milk for kashkaval production. The average of kg milk to kg kashkaval cheese conversion value was 9.75 ± 0.18. the unit of production is a blocks of cheese of 250, 350, 700, 3000 and 8000 gr. The units of production of 30 and 36 tons of milk were recorded many pieces are produced (Table 5).

Different from akkawi, kashkaval cheese production plan is more complex since different cheese block sizes are requested by the market. The advised trend in production by the marketing department was to reduce the 8Kg cheese blocks production. According to them the smaller the piece the better. That is why the possibility of having a second production plan for processing 36 tons of milk was considered. The most demanded ones, according to the marketing department, are 350, 700, 3000 and 8000 gr. Thus, we might have the same milk level but different pieces due to different production plans (Table 5).

Table 5 Kashkaval cheese production

Mold sizes	30 tons milk Pieces	36 tons milk Pieces	36 tons milk* Pieces
350 gr	1,344	1,344	3300
700 gr	940	1,177	1681
3000 gr	795	1,041	347
8000 gr	0	209	35
Total	3079	3770	5363

*: Production plan for lower 8Kg cheese blocks

3.2.2 Kashkaval recorded activities

Following the rules of thump to determine and record the activities, there was 44-recorded activity per unit of production (Table 6).

By assigning one second per activity per unit of production we end up having 44 seconds needed to produce one unit of kashkaval cheese. Starting from the *receiving milk for kashkaval production* down to the action before *Taking from calibrating machine* are actions that involve processing, transferring more than one unit thus according to the second and third rules of thumb and are considered one second each. From *Taking from calibrating machine* activity down to *Discard cheese mold in proper place* follow the first rule of thumb and is considered one second each. The rest follow the second and third rule of thumb (Table 6).

3.2.3 Personnel calculations and production potential

To calculate the personnel needed to be able to process the received milk for kashkaval production we multiplied the units of production (Table 5) with the total time needed then divided by the total shift time and the estimated technical efficiency (Eq. 1) and rounded up to the nearest integer.

Table 6 Recorded activities in Kashaval Production

Activity	sec
Receiving of milk for Kashkaval production	1
Preparation with culture	1
Preparing vat	1
Preparing cheese basin	1
Preparing Steel molds	1
Turning delivery tube to table	1
Delivering Curd	1
Putting big cloth on cheese	1
Taking sample	1
Measuring SH	1
Lift cheese plus steel molds	1
Cutting curd	1
Freeing curd	1
Lifting curd	1
Put on table	1
Turn to take another piece	1
Close curd holding table	1
Descending Steel molds	1
Turn to deliver cheese	1
Preparing steam machine	1
Adding salt	1
Prepaid calibrating machine	1
Cleaning machines	1
Take fat Bucket away	1
Pumping whey away	1
Lifting curd to mincer	1
Turn to deliver	1
Turn to take another	1
Taking from calibrating machine	1
Preparing molds	1
Turn to get mold	1
Put cheese in mold	1
Turn mold holding table	1
Prepare table	1
Turn mold 1st time	1
Turn mold 2nd time	1
Turn mold 3rd time	1
Turn mold 4th time	1
Pick mold	1
Release cheese out of molds	1
Put them in Rakes	1
Discard cheese mold in proper place	1
Turn to hold rake	1
Take rakes for storage	1
Total	44

The production level at 30 ton milk for kashkaval production per day was the standard till the start of this study. According to the calculations we had 3 personnel

extra (Table 7) corresponding to 25.5 working hours available (table 8) which can be either allocated to other needed division or used to increase the level of production.

When the level of production was increased to 36 tons per day there was no problem. This actually validated our calculations which showed an extra of 2 personnel extra. When 36 tons per day was tried, with 5363 production units instead of 3770 (Table 5), with 9 personnel we needed around half an hour extra time which corresponds to the extra working hours needed (Table 8).

Table 7 Kashkaval cheese production personnel

Milk allocated	Calculated personnel	Available personnel	Balance[a]
(Ton)	person	person	person
30	6	9	3
36	7	9	2
36*	10	9	-1

*: with different production plan

a: Available personnel – Calculated personnel

Table 8 Kashkaval cheese production hours

Milk allocated	Calculated work hours	Available work hours	Balance[a]
(Ton)	hr	hr	hr
30	42	67.5	25.5
36	51	67.5	16.5
36*	73	67.5	-5.5

*: with different production plan

a: Available work hours – Calculated work hours

IV. DISCUSSION

In the cheese industry the quality of the final product was still dependent on no matter how highly mechanized the cheese-making plant is [12]. The food industry is still labor intensive. It is necessary to control labor costs and forecast labor demands accurately if the business is to succeed. If you have more staff than is required, your labor costs will be too high and the company will lose money. If you have insufficient staff for a particular time period, attaining goals will be more difficult. Thus, the goal in planning staffing and scheduling needs is to match labor supply with production volume so that one can achieve goals without excessive labor cost.

In the akkawi production this method has enabled the management to realize higher production with the same personnel. At 11 ton milk the production was less than the potential and thus some work hours were not exploited. This was validated by real trials, which were conducted in real situation. This has lead to the increase of production by 20% with the same labor.

As for the Kashkaval production which is more complex in output since we have weight dependent units of production. An increase in cheese output using the same number of personnel is achieved. Thus has increased the capacity of milk processing from 30tons to 36 tons. It is also dependent on the number of units in the end product. Where we might have the same milk received but the number of units of production is much higher. Thus the labor need is also dependent on the production plan.

Table 2 and table 6 provide templates for akkawi and kashkaval production activities that should be adjusted to fit the individual factory. The recorded activities should be Adjusted for each factory and validated. Once established it will provided a management tool to assess the optimal point between labor and production plan. Furthermore, if any structural/ operational change, such as change of factory layout or change of operating machine, a recalibration of the method is due.

Last but not least, once the method is validated, it can give the management not only an idea of the current number of personnel needed, but also about the overtime hours needed and the labor needed for the different production plans.

V. CONCLUSION

There is a possibility of assessing the efficiency of the factory labor using this method. Furthermore, it gives a guideline for the akkawi and kashkaval production. It shows how each production with different units of production varies.

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