One-Day Absence in Industry

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INTRODUCTION

Much has been written about absence from work taken in spells of three days or more, little about spells of one or two days—possibly because they do not ordinarily count for National Insurance benefit Nevertheless, this short-term absence is a pressing problem common to all branches of industry Some think it reflects too high wages, some that it represents hidden ill-health, some that it implies failure of work incentives to complement a policy of full employment, some even that it portends social decay The survey problems are actually less formidable than with accidents—which have been extensively studied This *ennui* is puzzling and unexplained

This paper presents part of a much larger study into one- and two-day industrial absence It considers only one-day absences and is further restricted to examining only one aspect of the data, namely whether there are grounds to suppose that an analogue to "accident proneness", viz "one-day absence proneness" exists

BACKGROUND AND LITERATURE

Industrial absenteeism i e failure to voluntarily report for work when it is available, is essentially a product of the factory system There was a substantial proletariat in parts of Europe before the eighteenth century, e g in the German metal-ore mines and the Flemish cloth industry, and absenteeism certainly occurred (Agricola, 1556, Carus-Wilson, 1952, McDonnell, 1957), but in Britain it is largely a phenomenon of the last two centuries' industrialisation Much has been written of its socio-economic causes (e g Furniss, 1920, Ashton, 1949, Langenfelt, 1954, Coats, 1958), and it seems fair to state that orthodox opinion views absenteeism, over at least the early part of the period, in terms of difficulty in orientation to a discipline of continuity and regularity in working hours —allied to "new" philosophies and economic theories—of a people to whom these were alien (Thomas, 1964) for example, Saint Monday, i e any Monday—traditionally a holiday (George, 1925)—was frequently observed by early factory workers (Pollard, 1963) and to some extent persists to the present day (e g Behrend, 1951, Froggatt, 1965) Available data, even those from the nineteenth century (e.g. Factory Commission, 1834, National Association of Coal, Lime, and Iron-Stone Miners of Great Britain, 1863), though sparse, broaden the base by indicating the importance of sickness as well as general factors. Today medical and non-medical factors are acknowledged, but their relative importance is unknown.

For a direct comparison with the present work data must specify the number of one-day absences incurred by each employee over a certain period. Such data from the last century exist among the records of many companies and government departments notably the East India Company and the Admiralty—with respect to their dockyard personnel (Factory Commission, 1834), and more recently in the civil service and nationalised industries (Buzzard & Liddell, 1963). These data, however, have not been published in a comparable form and the primary records are now either destroyed—as with the East India Company and the Admiralty—or are for exclusively internal information—as with the National Coal Board. When frequency distributions have appeared in the literature they deal, not with one-day absences *per se*, but with "spells of sickness", "spells of absence", or "claims on a sickness fund", irrespective of absence duration (Newbold, 1927, Lundberg, 1940, Fox & Scott, 1943, Wyatt, Marriott & Hughes, 1943, Russell, Whitwell & Ryle, 1947, Sutherland & Whitwell, 1948, Norris, 1951, Arbous & Sichel, 1954, Fortuin, 1955, *vide* especially Lokander, 1962, for review). The data presented here are therefore to some extent unique.

DATA AND DEFINITIONS

The data were taken from the records of two light engineering concerns in Belfast and relate to about 1,500 employees (out of about 8,000) from 1955 through 1959 in one company, and about 400 (out of about 1,500) from 1953 through 1959 in the other. Only the results from the larger company are considered in this paper. The employees studied were all those in six "centres" or grouped "centres"—out of perhaps sixty centres in the company—these centres being chosen because between them they covered hourly paid workers and weekly and monthly paid staff, and supplied groups considered most homogeneous for working conditions, skills, and job performed. (A "centre" contains a group of men and/or women employed in similar or related occupations often in the same site or location in the factory.) For each employee the following were specified for each year: name, address, centre, clock number, year of data, sex, whether married or single, whether or not in a supervisory capacity, age, length of service in the company, number of "works passes", number of "medical passes", date of leaving if has left employment, total number of days off work irrespective of cause, number of one- and two-day absences with day of week and month of year of each, total minutes (for staff) and occasions (for hourly paid workers) late, duration of sickness allowed on full- and half-pay (for staff), and, for 1957 and 1958 for three of the six centres, in addition the day and month of each "works" and "medical" pass and each occasion late, and, for two centres for 1959, the date and amount of overtime worked.

A *one-day* absence is defined as being an absence, for a half or whole day, when the employee concerned attended the whole of the preceding and succeeding working days (Saturday, Sunday, statutory, and company holidays, are non-working days)—other than absence on account of labour disputes or company business or sanctioned by a pass As an entity they therefore ignore, for example, the day of the week on which each absence was taken.

Within each selected centre eight groups were delimited as being all the possible permutations of the dichotomies of sex (male or female), supervisory capacity (junior or senior), and marital status (married or single), e.g junior married male, junior married female, senior single male, etc. This gives a possible 240 groups (five years, six centres, eight groups), but frequently a group was too small for consideration or there were, for example, no women in some centres Finally, about 100 groups provided the data.

For the statistical analyses presented in this paper the performance of an individual over two, and over four, consecutive years was required Thus, only those in continuous employment over 1957-58, and 1955-58, were initially accepted, and, since homogeneity for important variables was mandatory, only those absent for less than sixty-five days in any year and who did not change their marital status or supervisory capacity over the relevant period, were finally included.

For brevity only two of the many possible groups are here used· these are Junior Married Males (J M.M.) of Works Centre A and Staff Centre B Works Centre A contains exclusively "semi-skilled" operatives on hourly wage rates—with bonuses—who lose wages when absent, Staff Centre B contains skilled inspectors paid a weekly salary who enjoy the privilege of being allowed a certain time off work per year (depending on length of service) before loss of earnings. In studies of industrial absence this distinction between Works and Staff is fundamental.

ARGUMENT

In 1926 two psychologists coined the term "accident proneness" (Farmer & Chambers, 1926) to explain their observation that certain industrial workers seemed more likely to incur an accident than their fellows. They later modified their initial opinions (Farmer & Chambers, 1929, Farmer, Chambers & Kirk, 1933, Farmer & Chambers, 1939, Chambers & Yule, 1941), but the basic connotation of the term, viz. that some individuals are at all times more likely than others to sustain an accident when exposed to equal risk, became widely accepted Recently this concept has been challenged (Cresswell & Froggatt, 1963, Froggatt & Smiley, 1964)—though not altogether successfully (Irwin, 1964). For one-day absence the analogue would be that, in a homogeneous industrial group, there are individuals who consistently take more one-day absences than their group colleagues.

To test this hypothesis (one-day absence proneness) three items of evidence are adduced

(1) the comparison between the observed frequency distribution of one-day absences among the group members and the theoretical frequencies which would result if the hypothesis was a complete explanation of the facts,

(2) the magnitude of the correlation coefficient between the number of one-day absences incurred by the same individuals in two equal periods of time, and

(3) the stability or otherwise of these correlation coefficients when both contiguous and non-contiguous periods are considered

This is not the only possible method but it is that classically employed in accident investigation (e g Greenwood & Woods, 1919, Newbold, 1926, 1927) and fully discussed by Lundberg (1940), Maritz (1950), Arbous & Kerrich (1951), and Arbous & Sichel (1954) It is accepted as valid Three other hypotheses are similarly tested

(A) that one-day absences are chance events,

(B) that individuals have "spells" (periods of time) when all their one-day absences are taken, that these spells are randomly distributed among the individuals and that the absences are themselves randomly distributed within each spell though each spell has no defined length, and

(C) as (B) above only some one-day absences are now allowed to occur outside a "spell" in which case they are also randomly distributed

These three hypotheses are relevant to accidents—an involuntary event, but may not be *a priori* tenable for one-day absences—which are consciously taken

These hypotheses, applied to accidents, have been fully developed before this Society (Cresswell & Froggatt, 1962) and commented on in detail by Irwin (1964) It is sufficient to restate briefly the form of the distribution and the order and behaviour of the correlation coefficients to be expected on each hypothesis

A *The "chance" hypothesis* The frequency distribution should approximate to a Poisson (1837) distribution the correlation coefficient should not differ significantly from zero and should be independent of the time interval between the two observational periods

B *The "spell" hypothesis* The frequency distribution should approximate to a Neyman Type A distribution (Neyman, 1939), the correlation coefficient could be zero on purely mathematical reasoning (Irwin, 1964), or small and positive (and significant) if the spells straddled the two observational periods (Cresswell & Froggatt, 1963, p 62)

C *The "spell" hypothesis with some independent random absences.* The frequency distribution should approximate to a particular compound Poisson distribution, called here the Short Distribution (Cresswell & Froggatt, 1963, ch 5) the correlation coefficient should behave as in (B) above.

D *The "one-day absence proneness" hypothesis* The frequency distribution should approximate to a Negative Binomial distribution (Yule, 1910, Greenwood & Yule, 1920) the correlation coefficient should be positive, significant, reasonably stable, and independent of the length of the interval between the two observational periods

The theoretical requirements of the data for these analyses are

(a) each group under study should be homogeneous for variables likely to have an independent effect on one-day absence experience,
(b) the individuals in each group should be exposed to equal "risk" of incurring a one-day absence, i e should be available to attend work on an approximately equal number of days over the period and not be removed from risk by being, for example, off work through sickness for a significant period,
(c) all one-day absences should be recorded with equal likelihood, and
(d) each group should be statistically of reasonable size

(a) can never be fully satisfied, though each population under study *is* homogeneous for sex, marital status, and supervisory capacity, but *not, inter alia*, for age and length of service, (b) is largely fulfilled by accepting only individuals who were in employment at the start and end of the observational period and who were not absent for any reason more than sixty-five days in any calendar year—this latter being considered sufficient restriction in view of the mean (about 2 0 to 3 0) annual number of one-day absences, (c) is, one hopes, completely fulfilled in the recording system used by the company, (d) is not wholly satisfied, the group numbers being modest (195 and 113) However, increasing the numbers by "pooling" centres would, in the author's opinion, introduce heterogeneity which would compromise (a) above and make logical inferences difficult

RESULTS

It is advisable to state immediately the conclusions that can logically be drawn from the tests If the data favour one of the four hypotheses it can be inferred that this hypothesis was a more likely explanation of the facts than were the other three It is, however, illogical to argue that it explained the facts to the exclusion of all other possible hypotheses, there may be others, unformulated, which would more readily satisfy the data Nor can a probability level be placed on the adequacy of the hypothesis since one should not reason from observed events to the probabilities of the hypotheses which may explain them but only deductively from given probabilities to the probabilities of contingent events

Tables 1 and 2 show the observed frequency distributions for junior married males over 1957-58 in Works Centre A and Staff Centre B respectively, together with the frequencies expected on the four theoretical distributions associated with the hypotheses under test The "goodness of fit" of these theoretical distributions to the observed distribution is tested by a simple χ^2 text "not significant" implies concordance, "significant" non-concordance Table 3 gives exclusively technical statistical information on the sample estimates of the parameters of the theoretical distributions (as estimated from the moments) from which the graduations are calculated, and their standard errors In the case of the Short Distribution the standard errors are very large indicating that the frequencies obtained in this distribution may be imprecise and therefore any conclusions drawn, using this distribution, should be tentative It would be more efficient to "fit" the Short Distribution by the method of maximum-likelihood, and this is being done for all possible groups using the ATLAS electronic computer at Harwell

The conclusions drawn are in both cases the Poisson is inadequate, thus the random hypothesis is *ad interim* discarded, in both cases the Negative Binomial and the Short are adequate, thus the "proneness" and "spells with some random absences" hypotheses are for the moment retained, the Neyman Type A is adequate in one population and inadequate in the other, thus the "spells" hypothesis is also tentatively retained

The second part of the analysis, viz the magnitude of the correlation coefficients of one-day absences between 1957 and 1958, are shown in Table 4 The coefficients are respectively 5 43 and 9 86 times their standard error and are thus considered to differ significantly from zero This further invalidates the "chance" hypothesis However, in the case of Works Centre A, $(1-r^2)=0\ 792$, and in Staff Centre B, $(1-r^2)=0\ 673$, which means that approximately 79% and 67% respectively of the distribution in one-day absences in either year is unexplained in terms of their distribution in the other year Nevertheless, the conclusion is drawn that, as a group, those incurring an excessive number of one-day absences in 1957 are also likely to incur an excessive number in 1958 This is more in accord with the "proneness" hypothesis than with either of the "spells" hypotheses unless the spells of many men were long enough to embrace a generous part of the two years

The third part of the analysis, viz the stability of the correlation coefficient as the interval between the years becomes more remote, is shown in Table 5 Here the populations have had to be further restricted to comprise only men in continuous employment over four years and not two For both Centres every coefficient differs significantly from zero, as they did in Table 4, but there appears to be a tendency for the coefficients to be greater for contiguous than for non-contiguous years, i e the coefficients for 1955-56 are greater than for 1955-57 and 1955-58, and those for 1956-57 greater than those for 1956-58 This variation, though consistent, is small and statistically not significant, it is conjecture as to whether or not larger numbers would have shown this to be real The conclusion is drawn that, since the coefficients are reasonably stable and always significant, this favours the "proneness" over either of the "spells" hypotheses since with the latter the coefficients should tend to zero as the years involved become more remote It is noted, however, that if the "proneness" hypothesis were a complete explanation of the facts the correlation coefficients should be closer to unity than is observed

As a net result the three tests favour "one-day absence proneness" over the other hypotheses considered, though it cannot be a complete explanation The consistent Negative Binomial "fit" observed in most groups tested (in the larger study) taken with the large correlation coefficients (+0 5 to +0 7 in the larger study) compared to those in accident studies (+0·2 to +0 3, *vide* Cresswell & Froggatt, 1963, ch 6 for review), indicate that, if there was any justification for accepting the concept of accident proneness from accident records, there is more for accepting one-day absence proneness from absence records (Further evidence which can be adduced for and against the hypothesis is outside the scope of this paper) Nevertheless, it seems prudent not to encourage the use of any catch phrase especially on the results of one study on comparatively small numbers

IMPLICATIONS

No one hypothesis could possibly explain the entity of one-day absence, grossly heterogeneous for causation Some absences are for physical or psychosomatic illness, some for social, domestic, or "economic" reasons, some are frank malingering Categorising one-day absences by cause is obviously important Unfortunately, there is no easy direct way of doing this since certification is not required and employees' replies likely to be unreliable However, this failure does not prevent examination of the main practical implications of the findings These are three

(1) The magnitude and stability of the correlation coefficients could allow some prediction of an employee's likely future one-day absence experience *given* his one-day absence experience over an observational period of reasonable duration

(2) It might be possible to demonstrate some consistent social or biological differences between groups of "high" and "low" one-day absence takers

(3) Contingent on (2) it might be possible to isolate such factors and, if they correlate reasonably highly with one-day absence experience (as they should), use them, if required, as "predictors" of an employee's likely future one-day absence record The practical importance of this is obvious

On these points it is necessary to state the following

(a) Variables, *inter alia* age and length of service, have an independent effect on the one-day absence record but have not been considered in this paper

(b) The observed correlation coefficients, of the order of +0 5, while high for work involving human behaviour, suggest that the predictive ability of previous for future one-day absence experience will be poor since only $(0{\cdot}5)^2 = 25\%$ of one-day absence experience in any period can be explained in terms of the one-day absence experience in any other

(c) The author, from his work in this field and from his previous experience of accidents (Cresswell & Froggatt, 1963, *passim*), is not optimistic that efficient or equitable "predictors" will be isolated Admittedly the chance of doing so should be better than with accidents—where they have never been identified—but is probably not high

SUMMARY AND CONCLUSIONS

1 The respective abilities of four stated hypotheses to explain the one-day absence experience of two groups of junior married male employees in a large light engineering concern in Belfast over a four-year period, are tested using (a) the power of certain theoretical distributions to graduate the observed frequency distributions, and (b) correlation techniques

2 The most satisfactory hypothesis is, that each group studied contains a sub-group of individuals who take an undue number of one-day absences, and that some individuals feature in the sub-group every year—though other individuals fall in and out of the sub-group from time to time

3 The implications of accepting such an hypothesis are mentioned. It is stressed, however, that this hypothesis is not fully adequate and moreover no one hypothesis could possibly explain the facts

4 The results are part of a much larger study to be published elsewhere.

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TABLE 1

OBSERVED AND THEORETICAL FREQUENCIES OF INDIVIDUALS FOR DIFFERENT NUMBERS OF ONE-DAY ABSENCES

JUNIOR MARRIED MALES, WORKS CENTRE A, 1957-58

No of One-Day Absences	Observed	Poisson	Negative Binomial	Neyman Type A	Compound Poisson (Short)
0	9	0 8 }	11 6	23 8	6 6
1	12	4 0 } 14 6	14 2	5 8	16 0
2	21	9 8 }	14 1	9 4	19 4
3	12	16 2	12 9	10 9	16 1
4	14	20 0	11 2	10 5	10 8
5	8	19 8	9 5	9 4	7 1
6	6	16 3	7 9	8 2	5 4
7	5	11 6	6 5	7 0	5 0
8	7	7 1	5 2	6 0	4 8 }
9	5	3 9 }	4 2 }	4 9 }	4 4 }
10	2	1 9 } 7 4	3 4 } 19 9	4 0 } 22 0	3 8 } 26 6
11	2	0 9 }	2 7 }	3 2 }	3 1 }
≥12	10	0 7 }	9 6 }	9 9 }	10 5 }
TOTAL	113	113	113	113	113
χ^2		96 64	6 77	33 37	4 18
D F		6	7	7	5
P		P<0 001	0 50>P>0 30	P<0 001	0 70>P>0 50
Significance of the difference		Very highly significant	Not significant	Very highly significant	Not significant

Mean=4 9469

TABLE 2

OBSERVED AND THEORETICAL FREQUENCIES OF INDIVIDUALS FOR DIFFERENT NUMBERS OF ONE-DAY ABSENCES

JUNIOR MARRIED MALES, STAFF CENTRE B, 1957-58

No of One-Day Absences	Observed	Poisson	Negative Binomial	Neyman Type A	Compound Poisson (Short)
0	8	0 7 }	7 2	13 1	7 4
1	13	3 8 } 15 3	15 1	13 2	16 6
2	22	10 8 }	20 4	18 1	21 1
3	23	20 5	22 8	20 3	21 8
4	20	29 0	22 7	20 8	21 1
5	29	32 9	20 9	20 0	19 8
6	16	31 0	18 3	18 2	17 8
7	10	25 1	15 3	15 9	15 4
8	15	17 8	12 5	13 3	12 8
9	8	11 2	9 9	10 8	10 3
10	4	6 4	7 7	8 5	8 1
11	7	3 3 } 5 8	5 9	6 5	6 2
⩾12	20	2 5 }	16 3	16 4	16 6
TOTAL	195	195	195	195	195
χ^2		149 78	9 79	13 89	11 13
D F		8	10	10	9
P		P<0 001	0 50>P>0 30	0 20>P>0 10	0 30>P>0 20
Significance of the difference		Very highly significant	Not significant	Not significant	Not significant

Mean=5 6667

TABLE 3

ESTIMATES OF SAMPLE PARAMETERS AND THEIR STANDARD ERRORS FOR THE NEGATIVE BINOMIAL, NEYMAN TYPE A, AND SHORT DISTRIBUTIONS, FOR THE POPULATIONS IN TABLES 1 AND 2

Distribution (and mean)	Parameter and Standard Error (σ)	Works Centre A	Staff Centre B
Negative Binomial (mean=p/c)	p	1 6395	3 2847
	$\sigma(p)$	0 3685	0 6002
	c	0 3314	0 5796
	$\sigma(c)$	0 0745	0 1062
Neyman Type A (mean=$\lambda\theta$)	λ	1 6395	3 2847
	$\sigma(\lambda)$	0 3195	0 5516
	θ	3 0173	1 7252
	$\sigma(\theta)$	0 5592	0 2863
Short (mean=$\lambda\theta+\Phi$)	λ	0 4332	1 3989
	$\sigma(\lambda)$	0 3640	1 5877
	θ	5 8699	2 6436
	$\sigma(\theta)$	2 8307	1 6248
	Φ	2 4040	1 9686
	$\sigma(\Phi)$	0 9286	1 9568

TABLE 4

CORRELATION COEFFICIENTS "r" (AND STANDARD ERROR) BETWEEN THE NUMBER OF ONE-DAY ABSENCES INCURRED IN 1957 AND 1958 BY JUNIOR MARRIED MALES OF THE EXPERIMENTAL POPULATIONS

Correlation coefficient (r)	
Works Centre A (113 men)	Staff Centre B (195 men)
0 456 (0 084)	0 572 (0 058)

TABLE 5

CORRELATION COEFFICIENTS "r" (AND STANDARD ERROR) BETWEEN THE NUMBER OF ONE-DAY ABSENCES INCURRED IN YEAR X AND YEAR Y BY JUNIOR MARRIED MALES IN CONTINUOUS EMPLOYMENT 1955-58

Works Centre A (97 men)				Staff Centre B (142 men)			
y \ x	1955	1956	1957	y \ x	1955	1956	1957
1956	0 628 (0 079)			1956	0 695 (0 060)		
1957	0 516 (0 088)	0 603 (0 082)		1957	0 521 (0 072)	0 582 (0 068)	
1958	0 619 (0 081)	0 566 (0 085)	0 418 (0 093)	1958	0 501 (0 073)	0 488 (0 074)	0 585 (0 069)

DISCUSSION

Mr C D Kemp emphasised the value of epidemiological studies of this type He then discussed the distributions used in the paper Both observed distributions had very long tails (roughly 10% of individuals were in groups $\geqslant 12$). The exact behaviour of the tail (apart from being of interest to the employer) could be critical in fitting theoretical distributions The poor fit of the Neyman Type A distribution (N T A) in Table 1 might be due to use of the method of moments for estimating parameters. This method, whilst relatively much easier to compute, was usually appreciably less efficient than the method of maximum-likelihood (M -L). M -L solutions had been known for the negative binomial and N T A for some years Very recently with Mrs A W Kemp he had derived the solution for the "Short" Computer programmes had now been prepared for M.-L.

estimation for all three distributions and it was hoped to re-examine much of Dr Froggatt's data

However this did not mean that it would necessarily be possible to decide between "proneness" and "spells" Irwin (1964) had pointed out that both "N T A." and "Short" may be interpreted as proneness models It should also be noted that the Negative Binomial could be given a "spells" interpretation (absences within spells are now logarithmically distributed) Thus all three distributions might be interpreted both ways—this duality of interpretation being characteristic of compound Poissons which are also generalised Poissons There was also the possibility of interpretation in terms of "contagion" (e g. the occurrence of an absence alters the probability of future absences) The bivariate approach seemed more promising but it was still possible that essentially "non-proneness" models could lead to "proneness" distributions.

It seemed therefore, in common with most survey work, that fitting distributions was unlikely to lead to unequivocal interpretations and that either more non-statistical considerations must be brought in or more fundamental investigations, such as Dr Froggatt was already considering, must be carried out

This had been a most interesting and stimulating paper and he had great pleasure in proposing a hearty vote of thanks