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Analysis of different types of turnovers between winning and losing performances in men's NCAA basketball

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[Abstract]

Basketball is a highly complex sport, analyses offensive and defensive rebounds, free throw percentages, minutes played and an efficiency rating. These statistics can have a large bearing and provide a lot of pressure on players as their every move can be analysed. Performance analysis in sport is a vital way of being able to track a team or individuals performance and more commonly used resource for player and team development. Discovering information such as this proves the importance of these types of analysis as with post competition video analysis a coach can reach a far more accurate analysis of the game leading to the ability to coach and correct the exact requirements of the team instead of their perceptions. A significant difference was found between winning and losing performances for different types of turnovers supporting current research that states that turnovers are not a valid predictor of match outcomes and that there is no specific type of turnover which can predict the outcome of a match as briefly mentioned in Curz and Tavares (1998). Significant differences were found between winning and tied and losing and tied performance for some types of turnovers, however due to the lack of data collected in this area they cannot be considered valid. Further research could also be conducted in other areas relating to performance indicators where there is currently minimal research in some areas such as assisted baskets, stated about the performance indicators in their own study the performance indicators are inadequate for explaining the complexities of the game suggesting that one indicator will not be constant in every game an research into performance analysis areas would be more appropriate.

▸ **Key words**: types of turnovers, winning and losing, NCAA basketball

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[요 약]

농구는 매우 복잡한 스포츠이며, 공격 및 수비 그리고 리바운드, 자유투 비율, 경기 시간 및 효율성을 분석할 수 있는 경기이다. 이러한 운동경기의 통계는 다른 경기에 영향을 미칠 수 있으며 모든 움직임을 분석 할 수 있어 플레이어에게 많은 도움도 압력도 줄 수가 있다.

스포츠의 성과 분석은 팀 또는 개인의 성과와 선수 및 팀의 개발을 위해 더 객관적으로 사용되는 자료를 추적 할 수 있는 중요한 방법이다. 이와 같은 유용한 정보를 발견하면 경쟁 후 비디오 분석에서 코치가 훨씬 정확한 게임 분석에 도달하여 팀의 정확한 요구 사항을 수정할 수 있는 능력을 얻을 수 있기 때문에 이러한 경기는 경기 유형의 분석은 중요한 자료로서 가치가 입증되기도 한다.

서로 다른 유형의 회전율에 대한 실적의 상실과 상실 간에는 상당한 차이가 발견되었다. 이직률이 경기 결과의 올바른 예측이 아니라는 현재의 연구를 지원하기도 한다.

Curz and Tavares (1998)에 간략하게 언급 된 바와 같이 경기의 결과를 예측할 수 있는 특정 유형의 회전율은 없었다. 현재의 연구를 뒷받침하는 다양한 유형의 매출에 대한 성과의 상실과 상실 사이에 상당한 차이가 발견되었다. Curz and Tavares (1998).

일부 유형의 회전율에서 이기는 것과 잃는 것과 성능 간에는 상당한 차이가 발견 되지만 이 영역에서 수집 된 데이터가 없기 때문에 유효한 것으로 간주 할 수는 없다.

보조 바구니와 같은 일부 영역에서 현재 최소한의 연구가 진행되고 있는 성과 지표와 관련된 다른 영역에서도 추가 연구를 수행 할 수 있으며, 자체 연구에서 성과 지표에 대해 언급한 성과와 지표는 게임의 복잡성을 설명하기에 아직은 부적합하다는 내용이다.

▸**주제어**: 회전율, NCAA 농구, 운동경기의 통계, 이직율, 경기유형의 분석

I. Introduction

Basketball is a high paced, multi-sprint sport, created by Dr. James Naismith in 1891 as a sport for American Football players to play in their 'off-season'. The sport quickly grew and is now estimated to be played by over 400 million people worldwide. Basketball is a highly complex sport, analyses of which are conducted by the recording of a vast amount of statistics. The 5 major statistics kept which are used to judge an individual players performance are points scored, assists made, rebounds, blocked shots and steals; other statistics include field goal attempts and percentages, 3 point attempts and percentages, offensive and defensive rebounds, free throw percentages, minutes played and an efficiency rating.

Statistics are also kept per 48 minutes a player plays which shows their statistics if they were to play every minute of every game and is a similar concept to the efficiency rating. At the most amateur end of the competitive basketball scale a score sheet will chart field goals made, 3 point field goals made, player fouls, free throw percentage and points for each individual player allowing many statistics to be kept. These statistics can have a large bearing and provide a lot of pressure on players as their every move can be analysed, that in a game in 2003, Ricky Davis, then of the Boston Celtics attempted a shot at his own basket from which he collected the rebound to secure his 10^{th} rebound of the game meaning he achieved double figures in three of the 5 main statistical categories – a 'triple-double' – a highly coveted feat in basketball.

Performance analysis in sport is a vital way of being able to track a team or individuals performance and provides a distinctly viable and more commonly used resource for player and

team development. The first recorded instance of notation in sport was of baseball players by Fullerton (1912; cited by Hughes and Franks, 2004); however the first attempt to record analysis specifically for sport was by Messersmith and Bucher (1939; cited by Hughes and Franks, 1997) who looked at the distance covered by basketball players during a match. Hughes and Bartlett (2002) described performance indicators as aspects that have been used as a measure of positive or negative aspects of performance in the analysis of a particular sport. A study conducted by Franks and Miller (1986) proved performance and notational analysis to be important further still, this study stated that in basketball matches a coach will only accurately remember 30% of the game and will often come out with perceptions and impressions of major incidents of the game and not necessarily an accurate holistic picture. Discovering information such as this proves the importance of these types of analysis as with post competition video analysis a coach can reach a far more accurate analysis of the game leading to the ability to coach and correct the exact requirements of the team instead of their perceptions. However this study shows the importance of using statistical aids.

This study will look closely at turnovers in basketball. Described as a quality indicator (Hughes and Bartlett, 2002) the turnover is often considered to be a big factor in why basketball teams loose matches (Choi et al., 2006). Gubby (2003) conducted a study on critical events in elite male basketball and in his study found that the losing team committed more turnovers than the winning team, the same conclusion was drawn by Tsamourtzis et al. (2005). This could be related to the fact that turnovers often result in 'easy' scoring opportunities such as 1 v 0, 1 v 1, 2 v 1, 3 v 1 or 3 v 2 fast break scenarios; the fast break, described by Van Wieran (1993) as a powerful weapon if performed effectively. Fast breaks were analysed in a study by Tsamourtzis et al. (2005) who concluded that winning teams had more fast break scenarios. Fast breaks and turnovers have a very close link to each other in (Tsamourtzis et al. ,2005) they merely had a fast break starting after a defensive rebound, steal or an opposition scored basket. Analysis of steals is something that could be developed further and is the only form of turnover Tsamourtzis et al. (2005) used in their study. The different types of turnover, therefore, would give a different outcome even to the extent of offensive fouls, three second violations, travelling and other violations that result in a team being awarded sideline possessions and could also result in fast break opportunities and may impact the way a team scores, although the game is slowed down. Somers (1992) presented the 'sideline fast break offence' which allows teams to break from a dead ball situation.

II. Methods

The study analysed turnovers from (n=7) Men's Division 1 NCAA College basketball matches from the 2005 – 2006 season. Matches took place in the regular season, conference tournaments and NCAA championship tournament. Analysis was conducted post event. The data was collected post analysis using either DVD or VHS recording of NCAA men's basketball matches. The data was collected using a pen, data collection sheet and basketball court diagram (see Figure 1). A Pilot Study was conducted of the University of California, Los Angeles (UCLA) vs. Louisiana State University (LSU) played on 1 April 2006. Table 1 shown the notation symbols of types of turnovers, offense and outcomes.

Table 1. Abbreviations of hand notation system

CATEGORIES	EVENT	SYMBOL
W/L	WINNING PERFORMANCE	W
	TIED GAME	T
	LOSING PERFORMANCE	L
TYPE	STEAL	S
	INTERCEPTION	I
	FUMBLE RECOVERY	F
	TRAVELLING	T
	PASS/DRIBBLE OUT OF BOUNDS	OOB
	SHOT CLOCK VIOLATION	SC
	BACK COURT VIOLATION	BC
	OFFENSIVE FOUL	OF
	THREE SECOND VIOLATION	3S
	POSESSION ARROW	PA
	TECHNICAL FOUL	TF
	CARRYING	C
OFFENSE	SET UP OFFENSE	SUO
	SECONDARY BREAK	2ND
	FAST BREAK	FB
SHOT	2 POINT FIELD GOAL ATTEMPT	2PT
	3 POINT FIELD GOAL ATTEMPT	3PT
	SHOOTING FOUL	SH. FOUL
	NON SHOOTING FOUL	FOUL
	TURNOVER	TURNOVER
	NO SHOT	NO SHOT
MADE/MISSED	MADE BASKET	MADE
	MISSED BASKET	MISSED
	MADE BASKET + FREE THROW ATTEMPT	MADE + 0/1 FT
	FREE THROW ATTEMPTS	2/2 FT
DEFENSE	HALF COURT MAN	HCM
	FULL COURT MAN	FCM
	HALF COURT ZONE	HCZ
	FULL COURT ZONE	FCZ
	TRANSITION DEFENSE	TRAN

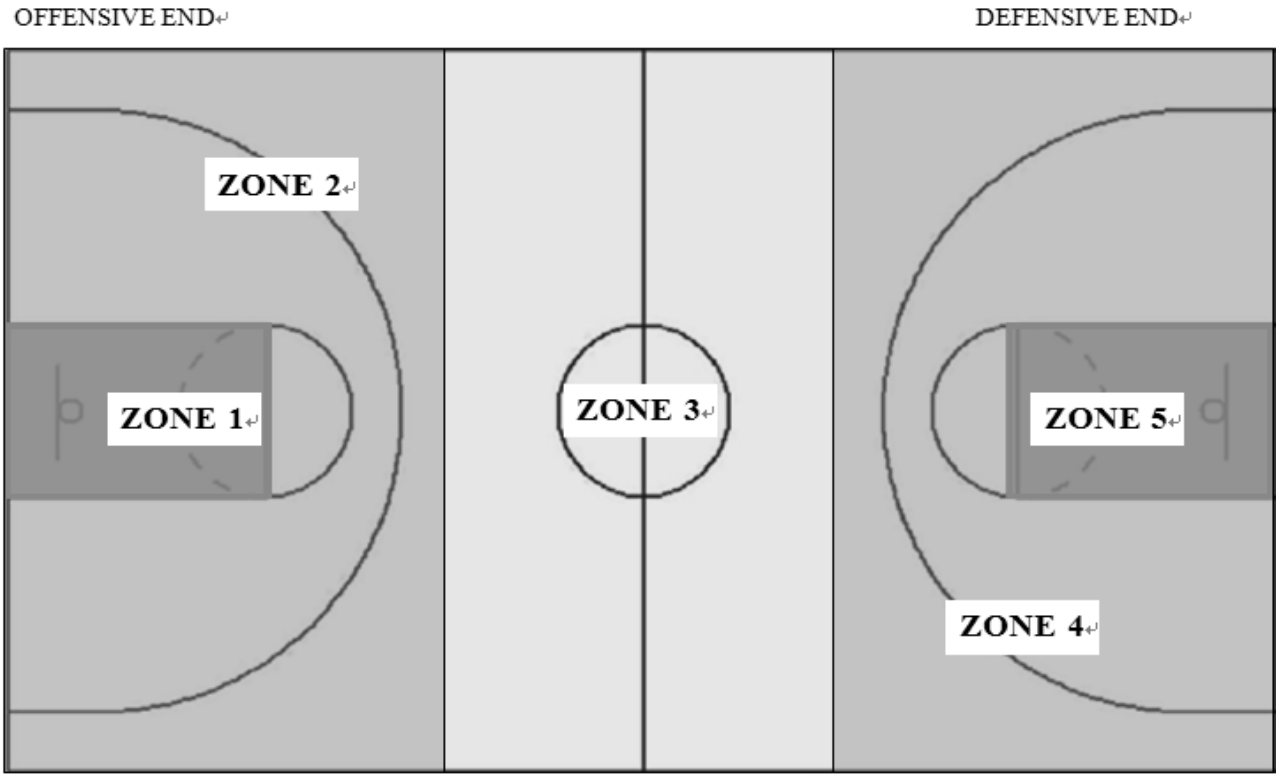

Fig. 1. Example of data collection sheet for the turnover locations

Table 2. Example of data entries on the data collection sheet

							Outcome of Team's actions Possessed ball after turnover			
Time	W/L	Team	Score		#	Type	Offence	Shot	Made/Missed	Defence
19.25	T	UCLA	0	0	1	T	SUO	3PT	MISSED	HCM
16.3	L	LSU	2	7	2	OF	SUO	2PT	MADE	HCM
15.3	L	LSU	4	9	3	I	3V1 FB	NO	SHOT	TRAN

Table 2 shown the example of data entries using the notations in Table 1. Within the data collection process, the team had a turnover, scores at the turnover, types of turnovers were firstly gathered. Continuously, the data related to the situation after the turnover such as type of offence, shot types, outcome of shots and type of defence has collected.

The reliability of data has considered with Total % error as following Figure 2 that the inter-operators reliability method was concerned.

$$\text{Total \% Error} = \frac{\sum (\text{mod } (S1 - S2)) \times 100}{\sum (\text{mean } (S1 + S2))}$$

Figure 2: An equation of % error for reliability test used

As statistical analysis of data, Kruskal-Wallis H tests were used to determine the significances between winning, losing and tied games then the Mann-Whiney U tests intended to present the post-hoc comparions of differences.

III. Results

Table 3 shown that of the games notated, the most common forms of turnover committed were steals (23.0%), interceptions (24.1%) and loosing the ball out of bounds (20.2%), these three categories accounted for 67.3 % of all turnovers. Almost exclusively turnovers were committed when a team was winning or losing; only 8 turnovers were committed in tied game scenarios. Most turnovers were committed by teams who winning at the time of the event.

Table 4 shows that a 2 point shots made (21%) and missed (22%) was the most common outcome after a team turned the ball over, The third most common event was another turnover by the opposing team (17.7%) A non shooting foul (4.3%) or not achieving a shot (3.2%) was the least common post event actions.

Table 3. summary of frequencies on different types of turnovers among the winning, losing and tied game

Type of Turnover		W	T	L	Total
Steals	(S)	17	3	21	41 (23.0)
Interception	(I)	23	1	20	44 (24.1)
Fumble	(F)	8	0	3	11 (6.2)
Travelling	(T)	15	1	1	17 (7.3)
Out of Bounds	(OOB)	14	1	21	36 (20.2)
Shot Clock Violation	(SC)	3	0	0	3 (1.7)
Back Court Violation	(BC)	2	0	1	3 (1.7)
Offensive Foul	(OF)	11	2	13	26 (12.9)
3 Second Violation	(S3)	1	0	0	1 (0.6)
Possession Arrow	(PA)	1	0	1	2 (1.1)
Technical Foul	(TF)	0	0	1	1 (0.6)
Carrying	(C)	1	0	0	1 (0.6)
Total		96 (51.6)	8 (4.3)	82 (44.1)	186 (100)

* Note: Numbers of blankets indicated percentages of the types of turnovers

Table 4. The results of outomce after the turnover

Turnover Type	2PT - A	2PT - M	3PT - A	3PT -M	Turnover	Sh.Foul	Foul	No Shot
S	4	7	2	7	9	9	1	2
I	9	10	7	4	4	3	4	3
F	3	2	3	0	2	1	0	0
T	5	3	3	2	2	1	0	1
OOB	8	8	3	5	8	2	2	0
SC	3	0	0	0	0	0	0	0
BC	1	2	0	0	0	0	0	0
OF	6	6	3	1	7	2	1	0
S3	1	0	0	0	0	0	0	0
PA	1	0	0	0	1	0	0	0
TF	0	0	0	1	0	0	0	0
C	0	1	0	0	0	0	0	0
Total	41	39	21	20	33	18	8	6
%	22.0%	21.0%	11.3%	10.8%	17.7%	9.7%	4.3%	3.2%

Table 5. summary of frequencies on different types of turnovers among the winning, losing and tied game

	Zone1	Zone2	Zone3	Zone4	Zone5	Total
W	36	49	8	3	0	96
L	23	47	10	1	1	82
T	2	4	2	0	0	8
Total	61	100	20	4	1	

Table 6. the results of statistical comparisons of different types of turnovers between the categories

Type of turnover	Kruskal-Wallis H		Mann-Whitney U (Winning - Tied)		Mann-Whitney U (Losing - Tied)		Mann-Whitney U (Winning - Losing)	
	Chi-squre	P	Z-score	P	Z-score	P	Z-score	P
Steals	10.36	* 0.01	-2.71	* 0.01	-2.84	* 0.00	-0.53	0.62
Interception	14.10	* 0.00	-3.28	* 0.00	-3.22	* 0.00	-0.74	0.54
Fumble	7.62	* 0.02	-2.63	* 0.03	-1.47	0.38	-1.53	0.17
Travelling	11.20	* 0.00	-2.68	* 0.01	0.00	1.00	-2.68	* 0.01
Out of Bounds	13.90	* 0.00	-3.16	* 0.00	-3.22	* 0.00	-1.14	0.32
Shot Clock Violation	4.20	0.12	-1.47	0.38	0.00	1.00	-1.14	0.38
Back Court Violation	2.22	0.33	-1.47	0.38	-1.00	0.71	-0.63	0.71
Offensive Foul	5.75	0.06	-2.27	* 0.04	-1.92	0.10	-0.40	0.71
3 Second Violation	2.00	0.37	-1.00	0.71	0.00	1.00	-1.00	0.71
Possession Arrow	1.10	0.59	-1.00	0.71	-1.00	0.71	0.00	1.00
Technical Foul	2.00	0.37	0.00	1.00	-1.00	0.71	-1.00	0.71
Carrying	2.00	0.37	-1.00	0.71	0.00	1.00	-1.00	0.71

* is the significant difference found ($p<0.05$)

Table 5 shown different frequencies of turnover in different Zones. It presented that Zone 1 & 2 was clearly the most common areas in which a turnover was committed. The main disparity between winning and losing incidents in certain zones was in zone 1, more turnovers were committed in this zone by the winning teams.

The statistical results of comparisons between the categories are shown with Z-scores, chi-squares and p-values in Table 4. The Kruskal-Wallis H test of comparisons shown that steals, interception, fumble, travelling and out of bounds ($p<0.05$) were significant differences among the categories. Additionally, the offensive foul was an addition of findings compared to the result of the Kruskal-Wallis H test in Mann-Whitney H test between winning and tied game situation. Less numbers of significant differences found in losing-tied and winning-losing comparisons (also see Table 6).

IV. Discussion

A significant difference was found between winning and losing performances for different types of turnovers supporting current research that states that turnovers are not a valid predictor of match outcomes and that there is no specific type of turnover which can predict the outcome of a match as briefly mentioned in Curz and Tavares (1998). Significant differences were found between winning and tied and losing and tied performance for some types of turnovers, however due to the lack of data collected in this area they cannot be considered valid.

In regards to analysis after the turnover, scoring occurred at a high percentage, nearly 50%, suggesting that a turnover results in effective scoring opportunities. However, over 20% of offences resulted in not achieving a shot or another turnover. Turnovers were seen to be exclusively committed in the offensive end of the court, largely due to the fact that full court defences were rarely seen so pressure and defence was not applied to attacking teams until they reached these areas of the court.

Winning teams attempted less set up offences after a turnover than losing teams and attempted more fast breaks. Notably attempting more positive fast breaks where there are more offensive players than defensive players and less negative fast breaks where there are more defensive players than offensive, suggesting good decision making and potentially the reason why they were winning. In 5 out of the 7 matches analysed the winning team scored more points off turnovers committed by the opposing team.

There is a large amount of scope for future research in the area of basketball and performance analysis and specifically performance indicators. The current study has raised several questions which would prompt further research such as comparison between fast breaks from turnovers and fast breaks from defensive rebounds to distinguish whether these factors make a difference and why it could make a difference. In terms of performance analysis, fast break decision making and decision making on a wider scale could be analysed, as many of the potential theories discussed were based around decision making, for example player's ability to refrain from shooting in a negative fast break scenario and their ability to successfully convert positive fast break opportunities in winning and losing performances (Tavares & Gomes, 2003). Further research could also be conducted in other areas relating to performance indicators where there is currently minimal research in some areas such as assisted baskets, having said this further research into performance indicators must be approached with some caution, as Sporis et al. (2006) stated about the performance indicators in their own study the performance indicators are inadequate for explaining the complexities of the game suggesting that one indicator will not be constant in every game an research into performance analysis areas would be more appropriate.

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